"There is nothing wrong with America that the faith, love of freedom, intelligence and energy of her citizens cannot cure" (Dwight 1). President Dwight D. Eisenhower uttered these words during a commencement address given at Columbia University in 1950. His words can effortlessly be applied to the crisis America faced when the Cold War turned hot. When the United States needed a reliable air defense system, her citizens bound together to make it a reality. This effort was under way not just in Washington, but in every corner of America including the Hudson River Valley. The International Business Machines Corporation, better known as IBM, played a pivotal role in the development of the America's "shield" against a Soviet air strike. Working out of various facilities along the Hudson River, IBM spearheaded the development of the core of this revolutionary system. In doing so, IBM made giant leaps in the field of computer science along with contributing to the traditions and history of the Hudson River Valley.

The design and development of a comprehensive air defense network has been a gradual evolution of technologies that began during the Second World War. In the immediate post-war world, the task of securing America's skies was, "performed by a manual ground environment system, and the functions of detection, evaluation, and interception were completely dependent on human operation" (Introduction 4). When the Air Force started the Continental Air Defense System Project, or CADS, the business of air defense took an evolutionary leap into the modern computer age. Paralleling CADS were other projects that combined the use of, "…digital computers and radar-data transmission equipment for application to air defense" (Introduction 4). These efforts eventually gave rise to the 1953 and 1954 Cape Cod Systems, which were based on the Whirlwind I, an early digital computer developed at the Massachusetts Institute of Technology's Digital Computer Laboratory (MITRE 1).

The Semi Automatic Ground Environment, or SAGE, was the culmination of these projects and studies. "SAGE was not the whole body of continental air defense. It was its brain and nervous system. It comprised the communications links from the sensors/radars to the interceptors/missile batteries, together with the analytical capability of the computer and the operators on the scopes" (Briggs 87). At the core of the SAGE system was the IBM AN/FSQ-7 digital computer, which had 55,000 vacuum tubes, 175,000 diodes, and weighted 175 tons. The computer required a massive amount of electricity to operate and be maintained at a specific temperature (Briggs 87). The AN/FSQ-7 computer encompassed seven major systems that enabled it to process the large volumes of data required by the Air Force. These components were: the input system; the drum system; the central computer system; the display system; the output system; the power supply and marginal checking system; and the warning light system (Introduction 11). The AN/FSQ-7 computer was the end result of hard work and dedication of IBM employees right here in the Hudson River Valley. Chief among these was IBM's Military Products Division in Kingston, New York, which played a major role in the production of the air defense computer (Introduction 1).

The SAGE system was comprised of two main units, the Combat Direction Center and the Combat Control Center. The Combat Direction Center was where, "air surveillance data [was] processed, evaluated, and developed into air situations at a sector level from which threat evaluation, weapons assignment, and appropriate weapons guidance orders [were] generated" (Introduction 5). IBM's AN/FSQ-7 computers were built into each Combat Direction Center and were designed to evolve and receive upgrades in radar technology. An important characteristic of this computer was its ability to quickly process data from multiple radar centers (Introduction 6). The AN/FSQ-7 was also tasked with identifying friend or foe aircraft as they were

continuously tracked. The computer utilized three different methods: Mark X signals, the Multiple Corridor Identification System (MCIS), and basic flight plans. If an approaching aircraft is equipped with the Mark X system, then SAGE identifies them as friendly automatically. Military aircraft using the MCIS would have had to use check words and maneuvers in specific identification zones. The final process was by flight plans which were inputted into the AN/FSQ-7 and were automatically tracked with radar returns. If an aircraft digressed off its assigned course the computer would automatically note it and inform the proper personnel (Introduction 6).

If the Combat Direction Center needed to execute a response to an incoming threat, the computer would have had all the necessary weapons data available. The operational status of interceptor, antiaircraft, and guided missile units were constantly updated into the computer. If the computer needed to launch any aircraft, they were automatically given coordinates mid-course as well as when returning to base. SAGE computers were also connected to point-defense systems that guarded small important targets or large ones. These included industrial sites or major population centers. When SAGE achieved operational status, these units consisted of antiaircraft and Nike missile batteries, but were designed to accept future weapon developments (Introduction 7).

Along with operational requirements, the Air Force had maintenance and reliability specifications for SAGE. Chief among these was that the AN/FSQ-7 computer could be operational around the clock. To attain this IBM incorporated these critical features: duplex installation of critical equipment; marginal checking of component deterioration; rigid control of component operating temperatures; circuit designs that permit large component value changes before failure; and reliable components (Introduction 34). Of these five features, the duplex

strategy was the key to its success. "Wherever individual equipment failures could cause complete system failure, this equipment was duplicated…Thus, the central computer, drum system, and magnetic tape units were duplexed" (Astrahan 1). Another breakthrough in computing technology incorporated into SAGE was its advanced error detection programs. These programs were, "…capable of checking out computer system circuits and components very rapidly, and provide[d] audible and visual indications that enable[d] maintenance personnel to pinpoint failure locations" (Introduction 35).

The second major sub-component of SAGE was the Combat Control Center, equipped with an IBM AN/FSQ-8 digital computer. Overall, the FSQ-7 and FSQ-8 are the same computers, "…differing primarily to the extent that some of the input and output equipment [was] eliminated in the AN/FSQ-8, since it receive[d] no raw data" (Introduction 8). Although the Combat Control Center had slightly less equipment than its counterpart, it had a wide range of activities including:

a. Evaluation of the nature, strength, and direction of the threat
b. Supervision of the air battle
c. Allocation of weapons to the sector, deployment of weapons, and use of augmentation forces
d. Co-ordination with adjacent Control Centers
e. Ordering conditions of alert for the division
f. Ordering overall status for weapons in each sector
g. Manual plotting of distant early-warning information
h. Dissemination of defense warnings to civilian and military agencies
i. Implementation of Security Control of Air Traffic (SCAT) and Control of Electromagnetic Radiations (CONELRAD) plans
j. Forward air situation and status of the division to higher echelons of command (Introduction 8)

This defense technology that emerged out of the Hudson River Valley represented the cutting edge of research and development. The implementation of IBM's computer was not limited to a localized area, but was installed in sites all across the nation. The Air Force

established twenty-four of these control and direction sites by the late 1960s (MITRE 1). Syracuse, New York was the first operational SAGE site when it was activated on January 26, 1959. This site was responsible for protecting the air space for three states and one Canadian province (Federation 1). Out of the fifty states in the Union, seventeen played host to SAGE. From Maine to Alabama and from Virginia to Oregon, IBM's digital computer stood as the vanguard watching over America's skies (SAGE 1).

Until the late 1960s, the nerve center of the Boston air defense sector was located directly in the Hudson Valley in New Windsor, New York. On the site of what once was Stewart Air Force Base sits a four-story lead-reinforced concrete building known as "the blockhouse" ,which once housed one of IBM's massive AN/FSQ-7 computers (Preserving 1). The building was first designated as a direction center and then in 1966 it was turned into a combat control center until it was finally deactivated in December of 1969 (SAGE 1). Since the downfall of its heyday it has become a forgotten relic of the Cold War. Fortunately, however, Susan Zimet, co-director of the Hudson Valley Media Arts Center, and Karl Rodman, president of River Valley Tours wish to turn this historical artifact into a Cold War museum. The purpose of the museum would be to explain the technology which was once housed at Stewart as well as educate people on what life was like during the Cold War. Zimet and Rodman have many supporters in their endeavor including retired Air Force major Chris McWilliams, who served as a radar operator at Stewart, who sees a real need to inform people about this early technology. "The SAGE computer was a marvel not seen in civilian circles, compared to the older manual radar consoles…the SAGE consoles looked like something out of Buck Rogers" (Preserving 2).

Nevertheless, there are still a number of serious obstacles to building this museum. One of the most difficult problems is raising interest and money for sites that lack any kind of

architectural sophistication or beauty. Another issue is that the Air Force stripped the blockhouse of all its unique electronics equipment. The giant IBM computer and support equipment is gone, leaving three of the four floors completely bare. The only remnants of the SAGE site are some old East Coast maps and the colossal air-conditioning unit that kept the facility at a constant temperature. It is hoped the museum can be linked to other military history sites, such as West Point, to help attract tourists. "The goal is to have visitors walk out with their hair standing up on the back of their necks" (Benjamin 2).

For nearly three decades SAGE faithfully served the country in its effort to guard against Soviet bomber attacks. The program surpassed all expectations and requirements during its continuous 25-year career. The legacy of SAGE is just as impressive as its service record, as it "broke new ground in radar, communications, computer, information display, and computer programming technologies" (MITRE 2). One example of this was its use of, "telephone lines to communicate from computer to computer and computer to radar laid the groundwork for modern-day modems" (MITRE 2). Other key innovations that developed were interactive graphic displays, continuous operation, and the capacity to handle multiple users concurrently (MITRE 2).

SAGE, however, was not entirely perfect or foolproof. On October 5th 1969 an Air Force fighter pilot was approaching Homestead AFB to land when he noticed something out of the ordinary. In his immediate area there was a MiG trying to land. As it turned out it was a lieutenant of Castro's Air Force who wished to defect. What troubled most people about the incident was that SAGE did not detect the intruder since he simply flew underneath the radar by hugging the terrain. Even more embarrassing was the fact that the MiG had arrived just after Air Force One dropped off the President at Homestead. The fallout from the episode was swift as

Congress quickly demanded cut backs in continental air defense. The North American Air Defense Command suffered slashes, some SAGE centers were closed, and interceptor squadrons were deactivated (Biggs 337).

Nevertheless, the SAGE program left its mark on all the companies and contractors involved, especially IBM. "While this contract was not the only factor, it is doubtful that IBM would have become the world's dominant 'mainframe' computer manufacturer without SAGE" (Briggs 87). It was World War II, however, that put IBM in the position it was in to build the SAGE computer after the war. During the war, IBM founder, Thomas J. Watson, placed his facilities at the disposal of the U.S. government. IBM's accession to the Hudson Valley began when Mr. Watson was asked to build a plant near the Watervliet Arsenal to manufacture the Hispano-Suiza 20mm cannon. Moving south from Watervliet, he settled on Poughkeepsie as the site for IBM's new plant (International 26). In 1948, IBM built an additional plant and during the dedication ceremony Mr. Watson addressed the community:

> I want to pay another tribute to our organization here in Poughkeepsie…we are proud of the patriotic manner…to do a good job on the home front during the war…they never missed one shipping date on the thirty-eight different articles of war munitions…and never had a single product returned owing to poor workmanship. I pay tribute to all of our people for that fine record. (International 27-28)

Even in the post war world, IBM has continued its dedication to researching the latest technologies and the Hudson Valley has been the host. IBM originally began in a small apartment near Columbia University in Manhattan. In 1961 it opened the T.J. Watson Research Center in Yorktown Heights, New York. Today this facility is researching the physics of computer science. One of its major projects is the Low Frequency Array that is in cooperation with the Netherlands Foundation for Research in Astronomy. In the field of mathematical

sciences, IBM is pioneering research into new ways mathematical sciences can help solve problems. This will aid IBM in producing more efficient computer chips (Yorktown 1).

Another IBM facility located in the Hudson Valley is their T.J. Watson Research Center in Hawthorne, New York. The site is home to one of IBM's Industry Solutions Labs, "which give IBM clients the chance to discover how leading-edge technologies and innovative solutions can help solve business problems" (Hawthorne 1). Other research at the site include: advanced database solutions; technology for knowledge management; cryptography; and computational biology (Hawthorne 1).

The Hudson River Valley has always been a place of high prestige from its natural beauty and grandeur. The story of IBM and their development of the SAGE air defense computer embodied the true spirit of American innovation, dedication, and love of freedom. Although the purpose of SAGE was to defend the United States against Soviet attack it simultaneously added a unique chapter in the already rich history and culture of the Hudson Valley. This tale echoes the words of President John F. Kennedy, "The American, by nature, is optimistic. He is experimental, an inventor and a builder who builds best when called upon to build greatly" (John 1).

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