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Call Me Johnny

T. F. Ramos

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A biography of John S. Foster, Jr.: He designed the modern atomic bomb and directed Defense research & acquisition for two Presidents

1943, World War II, among American bomber crews in Italy

by

Tom Ramos

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Preface

We were sitting together in my back yard, enjoying delicious red wine from McGrails, one of 56 wineries in Livermore, California. This was a special occasion for me; earlier that day I received a call from a Laboratory administrator that Dr. Foster would like to meet with me at four-thirty in the afternoon. He was then with a prestigious review committee meeting in a large conference room in one of the Laboratory's science buildings. The committee was tasked with reviewing programs of the Lawrence Livermore National Laboratory, one of two laboratories in the United States charged with designing nuclear weapons for the country. I had once seen Dr. Foster back in 1991, at the height of the Gulf War, as I peered into a meeting room at the Pentagon, and I watched him interact with eager young Army officers who were responsible for supporting our soldiers fighting in Kuwait, and later Iraq. Their faces betrayed their rapt attention to his every word of advice.

I arrived for my rendezvous with Dr. Foster and announced myself to the administrator, who then rose from her desk and stepped into the conference room. Much to everyone's surprise, when Dr. Foster heard I was standing outside, he rose up from his seat and stepped into the lobby; the mood of the bevy of administrators occupying the lobby changed as they wondered who is this guy who got so much attention from Dr. Foster. I noticed them stare at me as I said, "Hi Johnny, what can I do for you?" You see, when I established an informal relationship with Dr. Foster several years earlier, one of his first admonitions to me was, "Call me Johnny."

He asked me if we could spend a little time together to discuss something that was important to him. I said, "Sure Johnny, no problem; but look, it's getting late in the day, why don't I drive you over to my home and we can talk over a glass of wine?" That was fine with Johnny, and within a few minutes we were sitting in the shade of a patio deck at my home, watching humming birds skim around their feeders. Then Johnny looked at me and said, "Tom, I'd like you to write my biography." I was startled, and I looked around, actually thinking there was a "Tom" standing behind me whom Johnny was talking to. I said, "Johnny, you could get any writer in the country to write your biography, why me?" He said, "Because you understand what it is I've done, and I trust you."

I could not say no to this man. John S. Foster is an icon of the Laboratory, the man who led a team of physicists in the 1950s to design what would become the modern atomic device in the American nuclear stockpile. We agreed to a plan for us to regularly meet while I interviewed him about his remarkable life. In the following months, Johnny and I met during weekends, and I began to admire a man who is bigger than life; a man who has devoted his energies to defending this nation of ours. I was especially drawn to that part of his life when he volunteered to go to a theater of war and help American bomber crews fighting Nazis. You see, the man I'm named after, my Uncle Tommy, was a bombardier on a B24 bomber and he was killed while on a mission over France. I wondered if Johnny had only arrived in the war zone earlier, if he would have helped save my uncle's life.

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In a dimly lit room the size of a small auditorium, a very young man stood looking at a sea of young faces surrounding him. He was speaking to them with passion, and they listened intently. After all, what he had to say could save their lives. The speaker spoke with an authority that belied his youth, and his words conveyed a rich Canadian accent. Johnny Foster, all of 22 years old, was a technical advisor to the 15th Army Air Force, stationed in Foggia,

Italy. This was World War II, with armadas of American bombers pummeling Hitler's Third Reich. The air raids came with a price though: casualties in the Army-Air Forces were extraordinarily high – they had one of the most dangerous missions of the war. More American airmen were dying over the skies of Europe than the entire Marine Corps was losing in the Pacific theater. Johnny was passionately determined to help the young men in front of him survive the wrath of German anti-aircraft weapons.

The airmen surrounding him were crewmen of large Consolidated B24 bombers, striking targets in eastern Germany, Hungary and Romania. Johnny had been studying German tactics, he knew how the Germans used radar; so, he knew how they were able to intercept American bombers and shoot them down with deadly efficiency. Johnny was telling the aircrews how to be smart and stay alive.

Ten years later, Johnny had a PhD in physics, and he was leading a team of physicists to design atomic weapons for the nation. He feared the country faced a threat to its existence from a growing tide of Communism. He had taken over his team after a previous team had suffered through two failures. With the same fervor he had shown in Italy, Johnny took stock of the situation and organized his team to figure out what to do. He was determined to get his team to design something new, something that would make a difference against a Soviet Union that was flexing its newly won nuclear muscle.

In another 10 years, Johnny was serving the country at an even higher level. He was in the Pentagon, nominated by President Lyndon Johnson and confirmed by the United States Senate, to be the Director of Defense Research and Engineering. He was responsible for deciding what weapon systems the Pentagon would invest in. The country was falling headlong into a war in Vietnam, and the President expected him to give our servicemen the best equipment possible with which to fight.

Throughout the decades of service that Johnny Foster gave to his country, he showed a consistent, devoted passion towards those in harm's way. It was this strength of character that made him such a powerful and effective public servant. He had an innovative mind which, combined with his natural leadership skills, he created a legacy of revolutionary ideas that continue to have an effect to the present day. The idea of using drones, like the Predator, to fly over far-reaching areas to strike terrorists from the sky, had its origins with Johnny.

Once out of the Pentagon, he continued to serve the public through a civilian corporation, TRW. As the country was about to experience fuel shortages triggered by the OPEC boycott, he devoted himself to addressing the nation's energy needs. He seemed to get involved with events that were important in their times, and he made a positive impact on how they would evolve. The country owes a debt to him; he made it a better place.

Chapter 1

The Ancestors

The Foster name came from the German word *Forster*, which means forester. Around the time of the Middle Ages, the *Forster* was an official appointed by a lord to manage his *Forst* (forest), so he could have a good hunting ground. The tradition of having a *Forster* may have gone back to the times of the earliest Holy Roman Emperors, Christian leaders of central Europe crowned by the Pope. One medieval Forster was the ancestor of the Foster clan that eventually settled in Nova Scotia. He held responsibility for protecting royal forests in Flanders, in what is now the northern section of Belgium. At some point the Forster clan moved west to a land that had been colonized by Norsemen from Scandinavia, the part of northern France known as Normandy.

Forsters were among the Norman horde that invaded England in the 11th century, and they settled down in the rich fertile farmlands of the eastern part of the country bordering the North Sea. In later times this countryside became the counties of Suffolk, Essex and Cambridge, which were home to towns like Boston, Cambridge, Lincoln, Milford, Worchester, and Ipswich. It was at this time that the Forster clan's name became Anglicized to Foster. The folk of this part of the English countryside were hardworking, God-fearing people, who formed tight-knit communities. They were merchants, craftsmen, and farmers, and they were relatively well-educated by the standards of the time. It was this section of England as well that became a center for a Protestant sect called Puritanism. The Puritans were followers of the French theologian John Calvin.

There was inevitably a clash between Puritans and the Church of England, and Puritans began to suffer persecution. The loss of religious freedom became serious enough that it evoked a massive migration to the Massachusetts Bay Colony in the latter half of the 17th century. Ironically, for these seekers of religious freedom, all settlers in the colony could only practice Puritanism. For the most part, the Puritans in each ship that made the crossing of the Atlantic Ocean came over as family units from the same town. This was because the elders of the town making the migration organized their movement carefully, so that not everyone in the town could simply board a chartered ship and migrate. Families had to provide the funding for their passage, and the father in the family brought with him the tools he would need to support himself and his family once they were settled in the New World. As a result, each shipload of refugees landing in Massachusetts held the capacity for creating a new and independent settlement. And that was precisely what happened. Townships sprang up radially around the port of Boston, as boatloads of immigrants created settlements that bore the names of their hometowns in England: Milton, Cambridge, Ipswich, and Bedford (to name just a few), became hubs of Puritan culture, spreading forcefully into the interior of the continent. Within forty years, 50,000 Puritans had settled into New England.[1]

The Foster clan was part of this migration. They were farmers who, when they landed in Boston, joined their fellow migrants and settled into a new community, claimed their parcel of farmland, cleared the forest, built their home, and planted crops. One hundred years had passed when the colonists went through an epic struggle in the New World called the French and Indian War, a conflict that saw France lose all of Canada to England. In 1751, the British ordered the expulsion of all French settlers from Nova Scotia and resettled them on the delta

of the Mississippi in New Orleans. To occupy the evacuated countryside, British authorities offered farmsteads to Puritan settlers in Massachusetts, and the Fosters accepted the offer. Settling down in Nova Scotia, the clan established a modest homestead in the township of Clarence in County Annapolis.

A hundred years later Delacy Evans Foster was born on July 9, 1856. Delacy was a natural farmer and his farm did well, helping make him a respected member of the community. He was a slender man with a sinewy toughness he gained from countless hours of plowing fields. In one of the most fortunate choices of his life, he married Mary Sophia Vroom, a small woman with a jutting jaw and strong facial features who was four years younger. Mary's Dutch ancestors had moved north to Nova Scotia from New York. Delacy was a skilled enough farmer that even at the age of 90, he was able to win a county ox-pulling contest. He was proud that he still didn't need eyeglasses to read. He was able to prove it to a reporter by picking up his family Bible and reading from it, while exclaiming, "You don't think I've memorized the Bible, do you?" Delacy and Mary had four sons. The Fosters were not wealthy, but the farm provided a good, healthy environment for their boys. It had an apple orchard, which became a center of family life, and the boys loved climbing the trees to pick and eat fresh apples. Rural life had a natural rhythm then, and solutions to daily problems were plain and simple. A family remedy for an upset stomach was to eat boiled apples off of the apple orchard.

Then something very atypical for the Fosters happened. Whether it occurred because of a captivating teacher at the grammar school, or because Mary had a persuasive influence upon young minds, we do not know. But Delacy was the last male member of this part of the Foster clan to farm. Perhaps it was simply a strong desire by Delacy and Mary to see their children get an education they enrolled each of them at an early age into an academy. The taste for education became awakened in the boys, for all four of their sons sought entrance into college, each graduated from Acadia University, and each pursued professional careers away from agriculture.

The oldest boy, William Bernard Foster, took a liberal education and entered the world of journalism, becoming an advertising manager for News Publishing Co. Ltd. The next three boys, John Stuart, Malcolm Cecil, and Donald Delacy, all became scientists. Malcolm became a mathematics professor as Wesleyan University in Connecticut, and Donald became a researcher for the American government in Cambridge, Massachusetts. John went on to become a renowned physicist, an inventor, and was inducted in 1935 as a fellow of the Royal Society. He placed his signature into the Journal Book of the society after the signatures of distinguished physicists and mathematicians such as Isaac Newton, Michael Faraday, and James Clerk Maxwell. How John Stuart went from farm boy to distinguished scientist is a tale of perseverance.

John Stuart Foster was born at home on the family farm in Clarence on May 30, 1890. He was a medium-sized fair-haired boy whose face showed off his calm, friendly demeanor. He began his academic career in earnest, just as he became a teenager, when he left home and was enrolled into Pictou Academy. The Academy had been founded almost a century earlier by an act of the Nova Scotia legislature, and it quickly excelled in bringing an outstanding education to the region's students. The emphasis on an academic curriculum with competition and examinations led Pictou Academy students to dominate Nova Scotia in prizes over any other academy. By 1885 it had become the largest secondary school in Nova Scotia. John flourished in Pictou's environment, which demanded athletic participation as well as academic

studies.

After graduating from Pictou, John traveled to Wolfville, Nova Scotia to attend Acadia University, which although a secular institution, had a strong Baptist denominational leaning. Acadia was primarily an undergraduate institution, and it must have struck John during his studies that if he wanted to pursue a scientific education, he needed a curriculum more heavily accentuated toward mathematics and science. So after two years, he moved out of Nova Scotia to the province of New Brunswick to continue his education at Mount Allison University, which was noted as being a leading liberal arts school, but still had an engineering school and offered degrees in science. It hadn't been entirely a sure thing for John to major in physics; his brother William felt obliged to give his younger sibling advice that "…physics was the most distasteful subject offered to unsuspecting students." William's efforts were wasted, for John had become smitten with being a scientist.

It was at Mount Allison that John began to really flourish as a scientist. It was there he met, and was mentored by Harold D. Arnold, an eminent physicist who conducted an excellent course in experimental physics. Arnold was able to impress upon his young protégé the excitement of exploring science through experiments, and through him, John became a polished and well-disciplined experimental physicist. He loved designing experiments to test the mysteries of new theories of physics that had caught his imagination. After a couple of years, Arnold moved on to become the Director of Research at Bell Laboratories in Murray Hill, New Jersey, where he experimented with improving vacuum tubes. He was one of the first to recognize the significance of the audion tube, invented by Lee de Forest, which was used to amplify telephone signals. Finding that he could greatly increase the audion's performance by applying a vacuum to it, Arnold built the first amplifying vacuum tube on October 18, 1913. These tubes can be used to amplify long distance telephone calls.

Arnold showed John how to build a successful career in science, and it made an impression on the young student. While they were together at Mount Allison, Arnold introduced John to the field of wireless communications and electronics; Arnold also opened up John to the world of advanced research institutions in the United States. That awakened in John a taste for seeking a career outside of the parochial region of Northeastern Canada – the only world he had known until then. John may have harbored dreams of following Arnold to the United States, but finances for the Foster family were tight; not nearly adequate to allow for an education at the great institutions of America. John graduated and took a job teaching mathematics at a preparatory high school.

Then fate intervened. After four years of being a prep school teacher, the school burned down, and John was out of work and out of money. About all he had left was his love for playing the violin. Then he made the decision of his life: he took whatever savings he had and left Canada for the United States. Using Professor Arnold as a reference, he continued his education as a graduate student at Yale. In 1917 the United States entered World War I and John enlisted in the Army. He won an assignment to Fort Monmouth, New Jersey, the home of the Army's Signal Corps, where he conducted research with electronics.

He became enamored with two new inventions of the 20th century: the radio and the airplane. He decided to link them together by integrating a wireless communication device into the cockpit of an airplane so that he could remotely fly it. To do that, he had to convert electrical signals from the ground into a servomechanism that manipulated the plane's controls. The research was well ahead of its time.

His wartime service in the Army made John an American citizen. His dream of continuing his education in science could be realized if he only had the means of paying for it. Because he was a citizen, he was eligible to apply for a newly established National Research Fellowship; John won the fellowship over stiff competition, and in 1920, he used it to go back into Yale's graduate physics program. He was later able to supplement his fellowship funding with a separate fellowship from the Loomis Foundation, which awarded him $465 a year. John soon had his Ph.D. in physics, and in 1922, he became an instructor at Yale.

While at Mount Allison, John met Flora Curtis, a native of Newfoundland. She was a pretty woman with a kind demeanor and graceful features. She was a music major who sang and played piano, and she was the daughter of a leading clergyman and educator in Newfoundland. Their courtship was interrupted by John's odyssey to America and the war, but the couple reunited once John had secured his position at Yale and finally had a means to support a family. John went back to Nova Scotia and married Flora. By that time, she had become a member of the Music Department faculty of Mount Allison and was recognized for the quality of her voice, one of the finest in Nova Scotia. The couple returned to Connecticut, and on September 18, 1922, Flora gave birth to a son. They named him John, and to distinguish son from father, John Jr. was called Johnny. A year later, Leigh Curtis Foster was born.

John senior did his graduate research at Yale on a phenomenon discovered by the German physicist Johannes Stark in 1913. This was a new and exciting discovery at the time; it had won Stark the Nobel Prize in 1919, just one year before John's arrival at Yale. John's work led to the discovery of two different forms of the element helium, which won him acclaim from two of the world's leading physicists, Niels Bohr and Werner Heisenberg.

John's demeanor, good humor, high intellect, and superior teaching skills made him a well-respected and popular instructor. Among the new graduate students who arrived at Yale in 1924 was a young physicist from South Dakota who had arrived by way of the University of Chicago. His name was Ernest Lawrence. Lawrence, who aspired to be an experimentalist, was naturally drawn to John, one of the more outstanding experimentalists at the university. The two physicists began a friendship that would last a lifetime. Within a year, John was offered a position at McGill University in Montreal as an assistant professor of physics; his career was making a meteoric rise and it took him back to Canada.

Once at McGill, John Sr. continued his research in atomic physics. He arranged for the Physics Department to purchase the equipment necessary for him to continue his research into the Stark effect, and to enable him to take on graduate students of his own. John's natural talent as a teacher quickly emerged, and he gave several series of lectures on physics on Tuesday evenings in the winter months. He was a major contributor to the Juvenile Extension Lectures given in the MacDonald Physics Building at the University.

By 1926 John had been promoted to Associate Professor and was honored with an International Education Board fellowship. He used the fellowship to attend Niels Bohr's institute in Copenhagen. That same summer, Bohr also enlisted the theoretical physicist Werner Heisenberg, most famously known for his "Uncertainty Principle," to be the guest institute lecturer. Heisenberg would receive the Nobel Prize in 1932. Bohr's letter of invitation to John reflects well how important he regarded John's research:

> …The Stark effect is a subject which has acquired very great interest during the latest development of the quantum theory. I am enclosing a paper of Dr. Pauli which contains some important new points of view and also a small note by Takamine and Werner

> [Heisenberg] dealing with the measurements of the intensity of the Stark effect components in helium. … I shall therefore be very interested if you would write me some further particulars as regards the strength of the field.

His stay in Copenhagen gave John the opportunity to publish his most important single paper, and it won him international recognition and prestige for his contributions to quantum theory. Newspaper reporters often referred to John as Canada's most renowned physicist. He became a Fellow of the Royal Society of Canada in 1929, and a Sterling Fellow of Yale in 1930. It was also in 1930 that he was awarded the Levy Medal of the Franklin Institute, and he became a visiting Fellow to Ohio State University the next year. His accolades continued for the rest of his life: a singular accomplishment for any British Commonwealth physicist, he became a Fellow of the Royal Society of London in 1935. Foster Crater, a meteoric crater on the Moon, is named after him.[2]

Chapter 2

Montreal

When John Sr. accepted the appointment to McGill's physics faculty, he moved his family to Westmount, which is still an affluent suburb of the city of Montreal. Johnny Foster, born at Yale University, was only two years old when the family arrived in Canada. He and his younger brother Curtis were about to start a new phase of their lives – Montreal beckoned.

Their neighborhood was about one mile southwest of McGill University along the Rue Sherbrooke. It was an ideal place for Johnny and his brother Curtis to grow up. Johnny grew up a tinker with a natural curiosity about gadgets, especially electrical ones, and he had an incurable desire to know how they worked. He and his friend, Sam Tilden, both loved to build communication devices, starting with two tin cans connected to a taut string. At one point, Johnny found a cache of tunable condensers, or capacitors, and he fitted them into a circuit and plugged the result into the electrical outlet in the wall to make a radio. He had used high-frequency condensers, which could not pass audible frequencies, but he was learning, and more importantly, he managed not to electrocute himself in the process.

John Sr. encouraged his son to study science by allowing him entry into a physics department laboratory in the basement of MacDonald Hall at the university. To Johnny, it was like letting him loose in Santa's workshop. Johnny learned to make glass bulbs; he used blowtorches to heat Pyrex and blow his own glass tubes, and to use wax to seal a vacuum. The basement laboratory was an initiation of sorts for Johnny into the world of experimental physics. It was there that he learned techniques to make basic laboratory instruments and where he acquired the personal qualities that were essential for an experimentalist: patience, inventiveness, attention to detail, and curiosity.

But a physics laboratory was not Johnny's only love; it wasn't even his first love. He was an athlete, growing up with a body that was lithe and agile. Near Johnny's neighborhood was a small hill at the Parc du Mont-Royal on which a ski jump apparatus had been built. Any kid growing up in that neighborhood was drawn to that ski jump like a child being drawn by the Pied Piper, and Johnny was no exception. He started jumping off of a small slope next to the ski jump and developed his skills until, by high school, he was ready for the main ski jump itself. When he entered Westmount High School, he joined their ski jump team and grew his passion for ski jumping.

At the insistence of his mother and father, Johnny enrolled in a dance school, primarily to gain poise and posture in societal functions. Johnny learned how to properly hold a lady in a dance, just as young ladies learned how to follow their dance partner's lead. One of the girls was a superior dancer, she was Barbara Anne Boyd Wickes – everyone called her Bobbie – a tall brunette who was an only daughter of a prominent Montreal family. Her father, Mike Wickes, was an insurance agent with a company called Sun Life Insurance, headquartered in Montreal. There was something about her that Johnny found attractive, and before long he and Bobbie were going out on dates. Their budding romance was interrupted when Bobbie and her family moved to Binghamton, New York, just as Johnny and his family were leaving for Cambridge, Massachusetts.

Johnny acquired a nickname in high school – Mechanic. He spent a good part of his time working on the family car, even to the point of rebuilding parts of the drive train. That was

the state of affairs when Johnny was rebuilding the family car's transmission; Nobel laureate Niels Bohr had arrived from Copenhagen and John Sr. stepped into the garage and asked Johnny to drive him to pick up Dr. Bohr at the main train station. Johnny stood there with the top of the transmission sitting on the floor of the garage. There was no time to put things back together again, so Johnny told his father to get into the car; he started up the car and put it in reverse by applying a long-handled screw driver onto the transmission gears. They made it to the train station and met Dr. Bohr, who got into the car and got to enjoy his ride back to the Fosters' home with Johnny applying the screwdriver to change gears in the transmission.

At the age of 18, Johnny entered McGill University, majoring in physics. By his own admission, he was not a good physics student. He found it hard to concentrate solely on physics, and instead divided his time with two other passions: gymnastics and ski jumping. He continued to physically develop and, by his late teenage years, he had the body and talents of an Olympic athlete, and the looks of a Hollywood movie star. He joined the University's gymnastics squad and excelled in parallel bars and the high bar. A gymnastics meet against the Massachusetts Institute of Technology (MIT) typified his performance – Johnny led McGill in the high bar and parallel bars, beating out his competitors.

In 1929, Norwegian immigrants to Montreal had founded the Viking Ski Club and built a ski jumping hill at *Côte des Neiges*. It soon became the site for an annual ski jumping competition to determine a city champion, and Johnny, a natural competitor, was ready to test his mettle in the city championships. On January 8, 1939, he climbed up the ski jump tower at *Côte des Neiges* that had been built the previous summer. It was higher than the older tower and the greater height allowed skiers to start further up the chute. That morning, ski jumping records were broken, and there were spectacular crashes. But Johnny survived competing in the first citywide competition, and although he did not win, he performed well, soaring high above the crowd of one thousand who had come to watch.

For members of McGill's ski team, there was a higher hill on the other side of Montreal with a larger ski jump. This served as the University's athletic arena for the ski jumping event. Johnny became a leading jumper on the team, breaking records and helping to make McGill a regional powerhouse. It was the spring of 1942.

The war in Europe had been going on for two years. Johnny listened to British Broadcast Company (BBC) newscasts depicting the Battle of Britain, where the Spitfire and Hurricane fighter planes of the Royal Air Force held off the bombers and Messerschmitt fighters of Germany's Luftwaffe. Johnny imagined himself as a fighter pilot protecting the British homeland in dogfights against German invaders. The summer of 1941 saw the Germans invade the Soviet Union, and the war greatly expanded. Then the Japanese Navy struck Pearl Harbor on December 7, 1941, and the United States too was at war. Johnny felt a strong, irresistible tug to join the fighting. One evening, he spoke to his father in the family living room and told him he wanted to enlist in the Royal Canadian Air Force.

But that dream was not to be. John Sr.'s friend from Yale, Ernest Lawrence, had recruited him to join a laboratory that Lawrence had helped to create in Cambridge, Massachusetts: the MIT Radiation Laboratory, which was devoted to developing radar to support the allies in World War II. John had previously been a consultant with MIT on microwave radar, so his skills were badly needed. The next day, John Sr. announced to the family that they were leaving Montreal and heading for Cambridge.

Chapter 3

World War II

Lawrence had been asked by the American government to create a laboratory to develop an advanced radar capability that was based on a recent British invention, the magnetron. Lawrence accepted the challenge and established a laboratory at the Massachusetts Institute of Technology to develop the radar. He would need good physicists to do the work, and so he recruited them from across the country, and from Canada and Great Britain too. John Sr.'s renown in radio research from the First World War, made him a prime candidate for Lawrence to contact. So, the family moved to Massachusetts and settled down. The migration of the Fosters had come full circle, from Boston to Nova Scotia and back again.

Before settling into the MIT Radiation Laboratory, John Sr. arranged for Curtis to get a position with a research laboratory run by the Navy, and he got Johnny a position with Harvard University's Radio Research Laboratory, where Johnny served with a team of scientists as a technician to design and develop a radar receiver in the 1000- to 3000- Megahertz range. In an ironic twist, while John Sr. worked on developing radar technology for military use, Johnny worked on developing technologies to defeat radar signals from detecting objects.

Johnny's athletic prowess had not affected his curiosity with electrical gadgets. Still without a college degree, he dove into his Harvard assignment and began work with a team of technicians to develop a radar receiver. Within a year, they had developed a receiver that was turned over to Motorola for production. To get around Cambridge, Johnny needed transportation for himself, so with savings from his salary, he purchased a British manufactured Triumph motorcycle that a dealer had assembled from bits and parts. Then Johnny went to visit Bobbie.

She was still living with her family to Binghamton, New York, so the trip from Cambridge was about 350 miles. He set out on a Saturday morning and drove west through cold and icy weather. This was before there were interstate highways, so the journey took him all day. When he arrived at Bobbie's house, he suspected he had sprained his lower back as he dismounted from the motorcycle and felt an intense pain in the small of his back. Helped into the house, Johnny, who was not in a physical condition to be good company, convalesced through the night and all through Sunday. Despite the pain, he had rekindled a warm relationship with the girl he had met in Montreal. On Monday, he returned to Cambridge; ready or not, he had to get back to his research.

Scientists were needed in the war theater to advise servicemen on how to best use new types of electronic equipment. Johnny wanted to be part of the war effort, so after one year at Harvard, he volunteered to be a technical advisor to the US Army Air Force. He would bring his understanding of radar that he had picked up from his father.

Getting to a theater of war was a major challenge. To reach his assignment, he would have to sail across an Atlantic Ocean filled with prowling German U-boats. He was assigned onto a Liberty Ship, which he boarded in New York, and set off with a large convoy of supply ships. Along the way, his ship's Sperry inertial navigational system, in essence a large gyroscope, stopped functioning. Without the gyroscope, the ship could no longer keep in line with other ships in the convoy as they made their precisely timed turns at night or in fog, and as a result it risked colliding with another vessel. So, the convoy continued on, and Johnny's

ship was left to fend for itself in the middle of the ocean.

The captain heard he had a scientist on board, so he summoned Johnny and asked him to fix the Sperry instrument. With help from the ship's radioman, Johnny read the set's manual and inspected the machine, but he could not detect anything wrong. However, after juggling with the set along with a maintenance crewmember, it started working again. Whether he deserved it or not, Johnny was an instant hero. Still alone in the middle of the Atlantic, the ship increased speed and rejoined the convoy. They safely passed through the Strait of Gibraltar and then headed southeast to make their first landing at the port of Oran in Algeria.

There were many wretched looking refugees camped out along the waterfront, lying along the docks and in the city streets, and for the first time Johnny saw some of the absolute misery that had been caused by the earlier fighting in Africa. It took only a short time to unload cargo from the freighter, and it then set sail again, this time to the northeast to dock in Naples, Italy. Johnny disembarked; he had reached his assigned theater of war. He checked in at a local Army headquarters and caught transportation to the headquarters of 15th Army Air Force at its main base in Foggia.

When he arrived at an assigned airbase, which was home to the 38th Reconnaissance Squadron, Johnny received a cold welcome. He reported to a young officer who was rude, and he felt uncomfortable. Whether the young officer was simply arrogant or resented having to deal with a civilian, Johnny couldn't tell, but the lieutenant made Johnny's first meeting as uncomfortable as he could; he even kicked Johnny's ankles, making it look like an accident. He later staged a fight between Johnny and another officer, and he did it in front of a Ph.D. visitor from England. Johnny bore the lieutenant's insults and concentrated on doing his job.

Once ensconced into the reconnaissance squadron, Johnny moved into his assigned quarters, which was a tent, and he reflected on what he had to do. He was 21 years old, with no college degree, and he had to win the respect of officers and men and get them to trust his judgment on how best to use some of the fairly sophisticated equipment they were issued. The men he was serving were young – many were teenagers – and, they had one of the most dangerous assignments in World War II. Based on his experiences in Harvard, and his natural-born instincts with technical gadgets, he focused his attention towards radar.

German anti-aircraft units had been using radar effectively to spot and shoot down American bombers for the past two years. They used a radar set that was called a Würzburg unit to do the spotting. It had been built by the German technical firm Telefunken. Johnny went to his squadron commander and asked if he could obtain an actual German Würzburg radar unit. To his surprise, the commander provided a captured set one week later. Johnny was assigned an assistant, Army Air Force Technical Sergeant Burrell, to help him with his work, and Johnny and Burrell figured out all the ins and outs of the set.

They started it up and discovered that it was capable of operating with several wavelengths, so if anything interfered with one operating wavelength, the radar crew could switch to alternate wavelengths to regain a signal. Johnny measured how long it would take an experienced operator to readjust the radar. They were also able to judge its range. That told Johnny how much time the German air defense system had to react. Johnny then asked for an opportunity to brief the air crews, and he was able to visit the local B24 bomber groups.

At each local air base, he asked to speak with the bomber group commander. Johnny wanted to understand the kind of tactics the Americans were using, which would lead him to

understand the kind of tactics the Germans were using to react. He explained to the local commander that he and Sergeant Burrell had brought receivers and jammers commonly used by the B24 bomber crews, and he wanted to review the Americans' standard operating procedures after they returned from missions.

To counter the German radar, American bombers were equipped with jamming units that transmitted noise modulated signals at the same wavelengths used by the enemy. The idea was for the jamming set to drown out radar signals emitted by the German radars. Johnny found that the B24 crews turned on their radar jamming sets immediately after the engines were started and they stayed on for taxiing, takeoff, and during the entire flights to their targets on the other side of the Austrian Alps in Germany. Once over the border, they also dropped aluminum chaff into the air. The aluminum strips reflected radar signals into many directions, so that the bomber formations looked like a blizzard on German radar screens, making it difficult for the Germans to track the direction the aircraft were heading.

With these tactics, the pilots hoped to confuse the German air defense units about what targets the bomber formations were heading for. Unfortunately, by taking these countermeasures early in the mission, these tools of deception were not blinding German radar units; instead, as Johnny was about to reveal to American crews, the early deployment of American countermeasures allowed more time for German technicians to circumvent those countermeasures. Despite the American tactics, or perhaps because of them, the German gunners were prepared to engage the bombers in route and as they reached their designated targets, and many American crews were shot down. As Johnny saw it, the bomber crews were giving notice to German listening posts that they were on their way – they were warning the enemy of imminent attack.

Johnny formed a picture in his mind of the problem and a way to solve it. Jamming and dropping aluminum chaff were tactics that could disrupt German radar signals, but they had to be used sparingly and as late as possible so to limit the amount of time the Germans had to react. It was becoming clear that American tactics had to change; and the quicker the tactics changed, the more American crews would survive. It would take courage for a pilot to allow German radar stations to track his aircraft without responding, but that was in fact the best way to survive, and it fell to Johnny to convince the bomber pilots that it was so.

To get his message out, Johnny loaded up receivers, jammers, and radar sets into a van and took off for the towns of Lucera, Celone, and Amendola to brief aircrews of the 301st, 463rd, and 97th Bomb Groups of the 5th Bomber Wing. Then he delivered his message to the 454th, 456th and 459th Bomber Groups of the 304th Bomber Wing at Cerignola and finished up with the 49th Bomber Wing. He told the crews to hold off turning on their jammers until just before they reached their release points, which were located close to the targets.

Many bomber crews took his advice, and they started to see their odds for survival increased. That's all it took for more pilots to join in, as they began to recognize that the ideas coming from the twenty-one-year-old civilian advisor were working. It didn't take long until Johnny's tactics became the standard operating procedure for the entire 15th Army Air Force.

Johnny's love of flying had not died away since he had listened to descriptions of aerial dogfights in the Battle of Britain on BBC radio two years earlier in Montreal. On several nights, after debriefing air crews returning from bombing raids to learn how well the anti-radar tactics worked, Johnny passed rows of parked P-38 Lightning fighter planes. He sometimes climbed into the cockpit of one of the fighters and imagined himself in a dogfight

with a German fighter, his boyhood dream of being a fighter pilot not forgotten.

After the German surrender, Johnny was asked to join a small team to visit an integrated anti-aircraft site on a mountaintop in the Italian Alps, which had radar, optical range finders, and guns. When he arrived there, Johnny looked over a battery of 88-mm guns that had fired at Allied aircraft; the guns had white rings painted around their barrels, one ring for each aircraft downed by the gun. There were German officers present, and an interpreter was available to allow Johnny to have a conversation with them. When it was discovered that the visitors were from 15th Army Air Force, a German officer told Johnny that the 15th had changed tactics that year, which made it harder for them to shoot down bombers, and he wondered why the 8th Army Air Force had not done the same thing. In fact, casualties in the 15th Army Air Force had dropped in half after it had adopted Johnny's tactics. Johnny looked back at the rings on the guns and felt pain at the loss of so many airmen, but he was gratified to know that he had made a difference.

The base commander at Foggia recommended Johnny receive a Silver Star Medal, the military's third highest-ranking medal. But orders arrived for air units to return to the United States, so there was little time to process the paperwork for an award and it did not happen. But he did get one reward. With the war over, Johnny prepared to transfer back to America. The adjutant general of the 15th Army Air Force arranged for Johnny to travel back as a VIP, with the equivalent rank of lieutenant colonel, on a Sikorsky flying boat. He actually had a bed and he did not have to sit on a bench facing inward towards the center of the airplane fuselage.

Chapter 4

Berkeley

Johnny was soon attending classes again at McGill, restarting his sophomore year. His passion for motorcycles had not suffered during his time overseas, and when he returned to Montreal, he used savings from his work at Harvard to purchase a Vincent HRD motorcycle for $600 from a Montreal dealer. Vincent motorcycles were top-of-the-line machines that were the British equivalent of America's Harley Davidsons.

There was a change in Johnny's demeanor though that his family and friends could see. He was more mature, a veteran returned from a theater of war. He had seen the ravages of war – countless American fighting men who never returned from missions and those who came back with grievous wounds. He had to choose a lifelong career for himself; his studies in physics were no longer something to be done when he managed his time away from athletics. He had to give purpose to his life.

He enrolled in another course of experimental physics, and just as he had three years earlier, he excelled as an experimentalist. He was introduced to the world of digital computers and became mesmerized by how much information could be stored on a rotating metallic drum. Captivated by its motion, he sat and watched as data came from the drum and was captured and printed onto a sheet of paper. He discussed what he had seen with one of his professors, and the exchange strengthened his natural curiosity to explore science.

That same professor had been a football player, and he coached the varsity football team that was being put back together at the end of the war. Johnny tried out for the team, went to the practices, and won a spot as a running back. His first play at his first college football game was a run around left end. He received the handoff from the quarterback and was hit hard on his right thigh bone by an opposing lineman, but he still managed to pass the ball to a receiver. Johnny had a bad bruise; he realized his football career at McGill University was problematic.

He did however, continue to excel in gymnastics and ski jumping. A highlight in his jumping career occurred in February 1946 at an intercollegiate ski competition, the Dartmouth Carnival, hosted by Dartmouth College in Hanover, New Hampshire. Johnny was invited to compete. His girlfriend Bobbie joined him for the weekend. Universities from across the United States and Canada competed, making it a kind of North American collegiate championship. Johnny's event was the 40-meter ski jump. A February 11th sports page article of the *Gazette Montreal* set the emotion of the competition:

> Hanover, N.H. February 10. – After 22 years McGill regained the throne of North American intercollegiate skiing here this weekend with a display of snow power that overwhelmed ten other universities at Dartmouth's spectacular winter carnival.
>
> It was touch and go all weekend for Coach Harry Pangamn's six Redmen, but in the final reckoning yesterday Dartmouth, McGill's old winter rival, was left behind by more than 15 points. …The meet was really captured yesterday when McGill's dynamic Karre Olsen sped home first in the eight-mile cross country and John Foster led a galaxy of jumping stars on the 40-meter chute here. Leaning high and smoothly, Foster chalked up a total of 207.5 points for the individual jumping honors.

The day after winning the championship at Dartmouth, Johnny was invited to compete at Lake Placid, New York. The ski-jump chute at Lake Placid was larger than anything Johnny

had competed in before. A good jump at Montreal or Dartmouth would cover 140 to 150 feet in the air. At Lake Placid, jumpers covered well over 200 feet. Johnny joined the competition; on his second try, he jumped a winning distance in the air, but on the flat surface at the bottom he fell sideways, and the judges counted it as a fall, disqualifying the jump.

Then it was back to Montreal, which held a jumping exhibition at *Côte des Neiges* on a Saturday morning. It had rained the night before, which made the ski jump chute and runway icy. That made the descent down the chute deceptively fast, and treacherous. The bad conditions made many of the competitors think twice about jumping and only 14 of the original 25 entries took part in the competition. Participants trampled the ice on the chute and at the landing area to break it up. Since Johnny had just won the championship at Dartmouth, he was chosen to be the first to jump. It was an honor.

He started down the chute and the ice made him go fast, much faster than he had experienced before. His strong legs catapulted him up at the take off point and he soared aloft down the hill. That's when he noticed that his left harness had fallen off. He approached the icy surface speeding by below him, and then he struck the ground. It was not pretty; he landed on his one ski and immediately crashed, bruising his rib cage and getting cuts and bruises on any part of his skin unlucky enough to be exposed. The groans from the crowd drowned out the sound of the crash. The competition officials met and cancelled the rest of the contest.

It was the end of the ski season, and the gymnastics season was about to begin. Johnny was captain of McGill University's gymnastics team. The team did well, and several members, including Johnny, were being considered to represent Canada in the gymnastics competition at the summer Olympics to be held in London in 1948. Unfortunately, it was not to be. Budgetary constraints limited participation to only 80 events, and Canada chose not to compete in gymnastics that year.

After graduating from McGill, Johnny proposed marriage to Bobbie, and she accepted. They had been dating since they were both in high school. At the wedding, Bobbie's father Mike was feeling very ill. Mike was being as gracious as he could, but he wasn't feeling well enough to give a toast. So, at the last moment, John Sr. stood up and gave a very impromptu, but well-performed speech honoring the young couple. The next morning, Johnny stepped out of the hotel where he and Bobbie had spent their wedding night, and he saw his father walk by. His physicist father was up early; keeping an eye out for his son, making sure everything went well for the wedding couple to depart Montreal.

Johnny had been just as concerned for his father. Before the wedding, he had persuaded his father to sell off the old family Dodge, and to buy a Chrysler Air Flow from a neighbor who had it sitting in his garage for a few years. John Sr. was a great experimentalist, but he was not the mechanic Johnny was. Johnny went about refurbishing the Chrysler, reshaping its tires, which were still good, and lubricating the engine, transmission, and differential with a change of oil. He took the car out for a long shakedown cruise and noticed that the oil pressure gauge had been giving a low reading. A closer examination determined that roller bearing inserts were worn down and needed to be replaced. So, Johnny jacked the car up, removed the oil pan. He inserted shims in back of the worn bearings. He didn't have fancy tools used by professional shop mechanics, like a micrometer, to measure how loose the bearings were, so he made an educated guess, and inserted shim thicknesses accordingly. He put the car back together, and the oil pressure came back to normal.

For their honeymoon, Johnny and Bobbie drove in the Chrysler to Mount Washington, New

Hampshire. It was late in the winter, so they brought their skies along. At the time, Mount Washington was not as developed as it is today. There were no chair lifts to the top. If you wanted to go skiing, you had to hike up a trail and then ski back down along the trail, or you could venture through the trees skiing on unpacked trails. It was a great athletic challenge, just what Johnny craved. He made several runs, and then he decided to go off and try out a pathway that was not being used very much.

At the top of his climb, he found the kind of trail that he enjoyed skiing on – a trail that had not been used. While skiing down the slope he encountered a crevasse that cut diagonally across the surface of the trail. As he approached the crevasse he realized there was no time to stop. He had a split second to react as he jumped over the gap. Making it safely to the bottom of that ski run, anyone else might have judged that they had pressed their luck enough for one day. It was time to head back, sit by a fireplace at an inn, and talk about the close call to those sitting nearby. But Johnny's natural stores of adrenalin were running high and he was not done yet.

The next day, after guns had been used to trigger avalanches, Johnny took a chair lift up the main slope. As he started his run down the slope, he crossed over a snow-covered ridge and managed to trigger off an avalanche. He schussed ahead of the snow cascading down the mountain. He kept his nerve, and his balance, and outrode the avalanche. That was it. He had his fill of excitement and called it a day. The next morning, the honeymoon had ended and he and Bobbie headed back to the apartment they rented in Montreal on University Avenue.

* * *

He graduated from McGill on May 26, 1948, with second honors in mathematics and physics; at the graduation ceremony he received the Wicksteed Trophy for being best gymnast. The student athlete who had won laurels in two intercollegiate sports was also an energetic physicist. Like his father before him, Johnny had become a student of the atom and its nucleus. The atomic age had arrived with the detonation of an atomic blast over the sands of Alamogordo, New Mexico and then jolted the world with two blasts in Japan that ended World War II. Many associated atomic energy as something released by a bomb, but to Johnny it represented a new form of energy with a promise of providing electricity for an entire country. Canada's part in that world was the Chalk River Nuclear Laboratories.

John Sr. helped arrange for his son to work during summer months out at Chalk River, which was a good four-hour drive from Montreal. Johnny made the trip on his Vincent. He became acquainted with the plant layout, and he soon took on more and more technical duties. The British physicist, and Nobel laureate, Sir John Cockcroft, was the director of the laboratory. Since Canada did not have a ready population of nuclear physicists at the time, several key positions at the plant were filled by British scientists, and Johnny was assigned to assist an English physicist, Bernard Kinsey.

One of Johnny's first assignments was to join a team of scientists to inspect the plant. They went around and checked the reactor before its scheduled startup and found nothing unusual to report. Following the inspection, the reactor's control rods were slowly withdrawn, but it did not go critical. Why? Johnny and the rest of the team were sent underneath the reactor once more. This time they discovered that light water had been left in the water lines at the bottom of the reactor. The coolant in the water lines was supposed to be pure heavy water, which is composed of water molecules made from the hydrogen isotope deuterium. The pipes had not been drained properly.

A new, and expensive, shipment of heavy water was ordered and placed into the reactor, and the plant engineers were finally able to bring the reactor up to a critical state. Heavy water reactors could be made to be relatively small, which held great attraction to the US Navy, which wanted to use nuclear reactors in submarine propulsion systems. A Navy team led by Lieutenant Jimmy Carter visited the plant to learn more about the Canadian reactor. Carter would serve for a short while aboard nuclear submarines, and later became Governor of Georgia and the 39th President of the United States.

John Sr. had earned Ernest Lawrence's thanks for the role he played in supporting radar research at the MIT Radiation Laboratory during the war. Lawrence returned the favor and arranged for McGill University to get the first cyclotron, Lawrence's Nobel Prize-winning invention, to go outside the United States. After Johnny had worked a year out at the Chalk River Plant, it wasn't difficult for John Sr. to arrange to have his son accepted at Lawrence's Berkeley laboratory.

Ironically, Johnny felt his grades did not meet Berkeley's standards, even though he had graduated from McGill with honors. It really shouldn't have mattered to anyone that his father worked hard on his son's behalf: Johnny deserved it. He had participated and made contributions in radar research at Harvard, and his service to the Army Air Forces in Italy was exceptional. And despite his own claims that he was a poor student, Johnny would prove to be an exceptional scientist. Regardless of his own self-doubt, he became a graduate student at the University of California and worked as a technician for Lawrence at the UC Radiation Laboratory.

In June 1949, Johnny and his new bride set out from Montreal to start a new life in Berkeley, California. They took all their possessions and traveled on the Vincent. The trip started out well enough, they had made it as far as Ohio when Johnny noticed that the motorcycle was making strange noises from its real axle. Bobbie's weight and the added weight of saddlebags had stressed the hub of the rear wheel, and it had to be replaced. They stayed with relatives living nearby and then went to a local motorcycle repair shop and ordered the replacement wheel. After a week's stay, they were off again.

They enjoyed the sights of Chicago, Illinois, traveled through Nebraska, and then headed into Colorado and the Rockies. Next, they crossed great American deserts in Utah and Nevada until they finally arrived in northern California. Once they reached Berkeley, they found an apartment and moved in. Two years later, Susan, their first child, was born. There followed the birth of their first son, Bruce, in 1952.

Soon after settling down in Berkeley, Johnny went off to meet with Ernest Lawrence and report to work at the UC Radiation Laboratory, or as it was better known, the Rad Lab. The next morning, he found out that he would be joining a group of experimentalists led by Luis Alvarez. Alvarez was one of the nation's leading experimental physicists – he would eventually win the Nobel Prize. It was a good match; Alvarez was the kind of physicist who could give Johnny a chance to expand his technical skills.

Alvarez took an immediate liking to Johnny, and he invited his new graduate student to join him at golf. Johnny broke 100 his first time out. Inevitably, when two physicists join in any endeavor, something technical has to come out of it. Alvarez worked on an invention that would train a golfer how to properly hit a ball, so that it would go straight. The golfer addressed the ball with his iron or wood club, and then a strobe light was triggered as the club passed over the ball. The flashes of the strobe light remained in the golfer's eyes for a second

or two, so he was able to tell whether the club face was open or closed, how fast the club head was moving, etc. It was the beginning of the training aids that pro shops use. Alvarez sent a prototype for President Eisenhower to practice on.

* * *

At the time Johnny joined Alvarez's group, they were making improvements to a Cockcroft-Walton particle accelerator. Lawrence had recently returned from a trip to Los Alamos and Washington to encourage the government to pursue what is called thermonuclear research, that is, research to develop a hydrogen bomb. He had become extremely concerned about America's safety after the Soviet Union had detonated an atomic bomb in August 1949. To get the Rad Lab involved, he had asked Alvarez to take over a program in Livermore, California called the Mass Test Accelerator (MTA), which had as its aim to accelerate deuterium ions (the nuclei of an isotope of hydrogen) into a metal plate to produce neutrons, which in turn would produce the element tritium. Tritium was useful for thermonuclear research. The accelerator being built by Alvarez was big, and it would require an enormous vacuum. To evacuate a large volume of air, Lawrence invented a scheme for an ion pump, essentially a vacuum pump, and he asked Johnny to develop the scheme into a real machine.

The ion pump pictured by Lawrence was a complicated device, nevertheless, Johnny set up laboratory space in a Berkeley campus building and started working – it was a challenge. A key component to the pump was that part of it that produced a cloud of electrons that were placed in a "trap," which was used to ionize the atoms in the volume to be evacuated. There were problems with Lawrence's original design, and Johnny recognized the design flaw and thought about ways to fix it. One night in his impromptu laboratory room, it was 10:30pm, Johnny was setting up yet another experimental run for the device when he heard someone approach him. He turned around, and it was Lawrence with his wife Molly. The professor bent down and asked Johnny what he was doing. Johnny explained how he was planning to fix a problem with the ion pump, and Lawrence could see that what Johnny was planning to do made sense.

It was Lawrence's habit to routinely walk around his Rad Lab to observe what was going on; it was an act that Johnny called "keeping his feet to the ground." He drew a lesson from the professor, and Nobel laureate, about how to properly run a complex laboratory, a lesson he would remember later in life when he would be running his own large operations. Johnny resolved then and there that he would always keep his feet to the ground.

The long hours of work continued, but Johnny slowly made progress as he made it clear that Lawrence would have to modify the ion pump design on his patent. Alvarez observed the research and he was impressed with Johnny's work; the modifications discovered by Johnny were sophisticated enough that he suggested to Johnny that he make his work on the ion pump his PhD thesis – which Johnny did. After building an ion pump that successfully ran for several days, Johnny defended his thesis and was awarded a Ph.D. in Physics from the University of California. In 1952, Johnny presented his work on the ion pump at an annual meeting of the American Physical Society. Ironically, the size of the MTA made it impractical to use the ion pump, so it wasn't used as originally intended and Johnny's makeshift laboratory in Berkeley was dismantled. In any case, the MTA was also dismantled when special nuclear materials became more available, so the need to produce them no longer justified constructing the accelerator.

Johnny's natural ability to recognize a technical problem, and his skills for making whatever tools were needed to fix the problem, were becoming more and more evident to Lawrence and Alvarez. They tapped him to solve more difficult problems as they cropped up. Eventually, Johnny was assigned to a team that was operating a synchrotron, an advanced accelerator invented by the physicist Edwin McMillan.

Overcoming obstacles was one of Johnny's traits; as he rode his Vincent motorcycle to the Radiation Laboratory gate, he saw Lawrence standing there. Lawrence stopped Johnny and asked him who owned "that motorcycle" he was riding.

"Well, it's mine," Johnny said.

"How long have you owned it?"

"For a few years," Johnny said.

"How many miles have you driven motorcycles?"

"About 100,000 miles."

Lawrence gave an exasperated glance at his graduate student and said in an authoritative voice, "Well, you've already gone through too many mean free paths[*] for your own safety. Get rid of it." And with that, Johnny's adventures on motorcycles ended.

[*] In physics, a mean free path is the average distance an object will travel before it collides with something.

Chapter 5

The Hectoton Group

In the summer of 1952, there was a big movement afoot at the University of California Radiation Laboratory. Ernest Lawrence was about to expand the laboratory by adding to it a new site in Livermore, California. That was where the MTA had been located. The Livermore site was about to become a nuclear weapons design laboratory, the second in the nation.

The idea that an alternative site for designing nuclear weapons was needed had its beginning three years earlier, when the Soviet Union had tested its first atom bomb. Lawrence wondered if America fully understood how dangerous the world had become, and he was not convinced that the government was responding vigorously enough to the new Soviet nuclear threat. Lawrence asked one of his Rad Lab physicists, Herb York, to lead the new laboratory, and Edward Teller joined in the role of leading scientist. A Theoretical Division (T Division) was created, headed by Teller, which was responsible for providing the theoretical physics support needed for the design of warheads. Harold Brown led the Megaton Group, composed of physicists who designed thermonuclear weapons – hydrogen bombs. Art Biehl led another group of physicists who designed small fission weapons – atomic bombs.

Johnny was recruited into the new laboratory to be a physicist in the Sherwood Project. His work on ion vacuum pumps could benefit the program. Project Sherwood was separate from the weapons work; it concentrated on nuclear physics research with the object of creating energy from nuclear fusion interactions. Sherwood was led by Dick Post, an exemplary physicist who became an expert in using magnetic fields to contain plasmas of ions that were the fuel for nuclear fusion.

Johnny and his family moved into a modest home just east of downtown Livermore, off of the two-lane road that connected Livermore to the Laboratory, East Avenue. Livermore at the time was a dusty cowboy town located about forty miles southeast of Berkeley. It's biggest event of the year was the Livermore Rodeo, held in June in a specially built corral located away from the downtown area in the western part of town. They lived on Stanford Way, a few houses away from the home of Stirling and Rose Colgate. Stirling Colgate was another member of Project Sherwood and it didn't take long for the Fosters and the Colgates to become good friends. Within a year of moving to Livermore, Johnny and Bobbie had a new baby boy, Scott. Bobbie was a caring mother completely devoted to her children.

Johnny was just as much a doting father, but he had to spend long hours at work trying to get his career started. For the next year, he 'fiddled' with physics experiments to support Dick Post and his project. But after six months, he grew weary of the research. Although the ultimate source of energy they were seeking was nuclear fusion, the majority of the problems they faced had more to do with the laws of electromagnetism in a new branch of science called plasma physics. Johnny's experiences had been in the world of quantum physics, where he had studied the atomic nucleus. Project Sherwood just wasn't his cup of tea.

To get himself to another position, he approached a member of Herb York's staff, a physicist by the name of Jim Carothers, and told him that he felt ill suited to the work at Sherwood; he wanted to be more productive to the Laboratory. The timing was good, for there was a need to replace Art Biehl in the small weapons group. Biehl was a talented physicist, but he was leaving to seek a job in Los Angeles. It is likely that York conferred with Lawrence and

Alvarez for a replacement, for he asked Johnny if he would be willing to take over Biehl's group.

* * *

Johnny's new job was to assemble a group of young physicists to design advanced fission weapons. The Laboratory had just completed testing two atomic bombs at the Nevada Proving Ground, they were called the Hydride Shots, and both devices were 'fizzles' – they had failed. Johnny would have to lead his small band of disheartened physicists to get past the two failures and make them innovative. Besides testing his leadership abilities, Johnny was taking on a huge technological challenge. Designing, developing, and testing an atomic device is a monumental task, but Johnny had to additionally make sure that the atomic device his group produced was different than anything yet tested. The only precedent they had to work from was the string of atomic tests conducted by Los Alamos over the previous eight years. They had a lot to learn.

And Johnny had a lot more to think about. A primary purpose for creating the laboratory in Livermore was to conduct thermonuclear research – to develop a thermonuclear weapon. A thermonuclear warhead is composed of two parts: a primary and a secondary. Johnny was responsible for developing the primary, a fission device, an atomic bomb. The function of the primary is to radiatively compress the secondary, a hydrogen bomb, which releases about a thousand times more energy than the atomic bomb. But the Laboratory was new and had yet to develop a secondary, so Johnny concentrated on making an effective atomic device that would stand alone on its own merits.

Edward Teller provided overall guidance to the Laboratory's nuclear weapons program. The fission devices that had already been developed at Los Alamos used enriched uranium and/or plutonium as an atomic fuel. At Livermore, Teller had pushed to develop a hydride atomic device that used a different type of nuclear fuel – uranium deuteride[*]. The challenge facing Johnny was that the Laboratory's two failures had been uranium deuteride devices and Teller was adamant to test yet another uranium deuteride device. Johnny had to evaluate the wisdom of doing that; most important, he had to come up with a design that would work – the Laboratory could ill afford another failure. With the organizational changes taking shape, Herb York named Johnny's group the Livermore Hectoton Group, the Greek language prefix hecto- meaning one hundred – the group designing secondaries was led by Harold Brown and called the Livermore Megaton Group.

Much of the effort to design an atomic device relied on using a computer program, or code, to guide the designers. The group's computer code support came from Bob LeLevier and Chuck Leith. Leith was a real computer pioneer. He had written out the Laboratory's first codes on one of the world's first computers, the UNIVAC. The physicist Jim Wilson, who was a distinguished graduate from UC Berkeley and a member of T Division, was yet another code developer, and became Johnny's technical leader.

In 1954, in a series of nuclear tests called Operation Castle, the Laboratory had once again fielded a shot that failed. This was a test of a Megaton Group secondary. It was the third successive nuclear test failure of the Laboratory. There were powerful men in Washington,

[*] Uranium-deuteride is a molecule composed of uranium and deuterium. Deuterium is an isotope of hydrogen. Instead of just a proton in its nucleus like common hydrogen, deuterium has one proton and one neutron in its nucleus.

DC who wanted to see the new Laboratory in Livermore shut down. The stress of the failure had its effects on Lawrence and Teller, and they both suffered from attacks of colitis and had to be hospitalized. Herb York came down with Valley Fever and had to remain at home in bed rest. That meant that the future of the nuclear weapons program at the Laboratory rested squarely on the shoulders of Johnny Foster and Harold Brown.

* * *

Soon after he took over the Hectoton Group in July 1953, Johnny had to formulate a strategy of what to do. He recognized he had to get his physicists past the recent failures. He had a straightforward philosophy: "Take a big enough step so that things get a little radical. Don't look so far ahead that you really don't know what you are talking about. But, don't look so close in the future that you are just putting existing pieces together." Because of the Laboratory's two fizzles, the Hydride Shots, there would be little tolerance for any more failures. He could have duplicated a device from Los Alamos that had already worked, but that was not Johnny's nature.

Johnny was especially interested in designing a weapon for the Army, which during the Korean War, had experienced massive "human wave" attacks of Chinese soldiers – assaults that had almost destroyed Eighth Army. The Chinese Army attacked with large, closely packed formations that overwhelmed American defenses. Chastened, the Army wanted a nuclear artillery shell that would deter any nation from using those tactics again on a battlefield.

Showing remarkable resolve for a young physicist starting his career, he would not go down the Hydride trail again, despite getting monthly suggestions from Teller to test yet another uranium deuteride advice. After some thought, he decided to explore two thrust areas that were given the names Gun and Geode. Atomic weapon designs like the Gun or the Geode had not been attempted before; despite its name, the Gun was not a gun assembly weapon. So, developing either concept into an atomic device would be a challenge.

The Geode concept had been proposed a year earlier by Art Biehl and Ernie Martinelli; it went to the heart of designing a small fissionable device, but it required computational and diagnostic tools that did not yet exist. Developing the Geode required experience that Hectoton designers did not have. Johnny sorely wished to pursue the idea, but there was not enough time to develop the Geode before the next series of tests in 1955, Operation Teapot. He did not know it, but a team of Los Alamos engineers and technicians had developed a diagnostic technique called a pin dome that could measure how a device imploded. Johnny later claimed that if he had known about the pin dome earlier, he would have used it to design and test a Geode device.

Instead, he focused his energies on the Gun device, which was given the nickname Cleo. The Cleo was a tactical weapon, suitable for the Army, and it promised to be one of the smallest atomic devices yet developed. The Cleo concept required multidimensional modeling to fully understand its workings, and Jim Wilson performed Cleo calculations on new codes that he wrote. But even with Wilson's talents, multidimensional computer codes were primitive affairs in 1954. So, Johnny relied on experiments that were called hydro-tests. In a hydro-test, a model of a device was built that included high explosives. After an explosion, data from diagnostic devices were examined to see how the model responded.

A model of the Cleo was manufactured on a lathe after tracing its shape on a template, which

was a metal sheet cut into a prescribed shape. The lathes cut shapes to within a tolerance of two to three thousandths of an inch. That level of accuracy had been good enough when manufacturing the earliest weapons of the Manhattan Project, but Johnny would need the tolerances reduced much lower.

He made it a practice to visit Los Alamos once, or even twice, a month and he met with his New Mexico counterpart, Theoretical Division Leader Carson Mark, a physicist from Canada. It was a good, quiet form of collaboration that benefited both laboratories. Through Mark's intercession, Johnny got hydro-testing support from Max MacDougal, the Los Alamos Laboratory's GMX-6 Division Leader. Johnny supplemented the hydro-tests done at Los Alamos with hydro-tests conducted at the Nevada Test Site, in a program he called Operation Tea-Leaf.

The Hectoton Group made strides towards coming up with a design for the Cleo. Some of the hydro-tests revealed flaws in design features and these were immediately corrected, and then the newer Cleo was tested again. The physicists were truly professional men who were diligent about their work as they carefully made modifications to the device and recorded their progress. By the spring of 1955, just a few months before they were scheduled to conduct an actual atomic test, they had completed their design work.

But then, York told Johnny that the Laboratory had instituted a new review process, which was called a pre-mortem. In it, a committee of physicists who were not directly involved with the design process was formed, and they were to examine the design of the Cleo. The premise of a pre-mortem was that the device would not work and the pre-mortem team provided explanations why. It was up to Johnny to counter their objections and defend the design decisions made by him and his group. After a couple of weeks of examination, the committee arrived at a conclusion that the design for the Cleo was correct, although recent tests at Los Alamos persuaded them to suggest that a small amount of plutonium be added to the device – and that's what Johnny did.

In the course of designing the Cleo, if there was a doubt, even a small doubt, about any design feature, it was usual to add a small amount of plutonium to the fuel as a kind of insurance against failure. By the time the Cleo reached its final design, there was enough plutonium inside it to cause a worry that it could go critical when it was assembled on top of its tower at the test site. The object of the worry was the presence of the assembly technician's hands and body. When the technician bolted in the last bolts for the assembly, there was a fear that neutrons emitted by the Cleo could reflect off the hands of the technician and go back into the device. Could that cause the Cleo to go close to critical? If it did it could cause a release of radiation that would be harmful to anyone close to the device.

Myron Knapp was the assembly engineer for the Cleo; he held the responsibility of making sure the Cleo's assembly procedure was safe. Inside a blockhouse, two parts of the Cleo were placed onto two conveyor belts that remotely joined the two parts into one assembly. To model the hands of a technician, Knapp used petty cash to purchase 10 pounds of short ribs from Kelly's butcher shop in downtown Livermore, across First Street from the Donut Wheel bakery. Knapp wrapped the ribs around each of the two parts of the Cleo. The subcritical assembly machine was activated, and the two parts of the Cleo moved closer and closer; then the Cleo was joined together. To everyone's relief, the Cleo remained sub-critical and that night Knapp's pet dog enjoyed a large meal of short ribs.

For its transport to the Nevada Test Site, the Cleo was constructed in two parts, and each part

was placed into a reinforced Samsonite suitcase. Walt Arnold, the mechanical engineer responsible for putting the Cleo together at Nevada, was assisted by a young man named Tommy, a summer intern from San Jose State College. Arnold ordered Tommy to manhandle the hefty suitcases out of the Laboratory's assembly building and put them into the back of a "woody" station wagon. Then Arnold gave Tommy an Army issue .45cal pistol and told him he was to guard the suitcases and not let them get out of his sight.

Once at the Test Site, the station wagon was placed in the middle of a small convoy that delivered the suitcases to a final assembly building. A few days later, the Cleo was hoisted up a tower by a team of Sandia engineers called bomb hoisters. The bomb was raised through a floor panel and into a cab atop the tower, and then the assembly team mounted it to the floor. The assembly crew finished after midnight, then the arming team climbed up the tower, and armed the Cleo.

Early the next morning, a firing switch was released that ignited the Cleo's high explosives. There followed an extremely bright flash of light and an atomic explosion. The Cleo had worked; the first warhead from the Laboratory to do so. Someone, apparently, had leaked information out about how the device had been delivered to the tower. *Time* magazine wrote a story about a new type of nuclear weapon that could fit inside a suitcase.

Johnny could not contain his happiness over the successful event and was bursting to spread news of the results. He phoned Lawrence, who was still in Berkeley, to let him know the good news. After he hung up the phone, Johnny realized he had just committed a gaffe in protocol by calling up the boss directly rather than going through Herb York. He found York and told him what he had done and apologized for his impertinence. York simply smiled.

When Lawrence arrived at the Test Site, he met with York, Johnny, Brown, and Teller. They escorted him down to the conference room to give him a recap of the results of the Cleo test. Then they all took a walk around the large parking lot outside the command post. Lawrence opened a discussion by asking, "Why do we need small diameter nuclear weapons?" Teller responded that they were needed for nuclear artillery, which had been identified as a need for the Army. Then Lawrence asked, "Where do we go from here?" They all knew the answer to Lawrence's question: their goal, their overriding focus, was going to be to make weapons smaller.

Chapter 6

B Division

A year before the successful test of the Cleo, Johnny joined with Harold Brown and wrote a memorandum addressed to the Laboratory's scientists – they announced they were going to strike out in new directions. That memorandum marked a significant event for the Laboratory. From then on, the Laboratory would not suffer through a humiliating failure in a nuclear test. The weapon designs that followed would have a profound effect on the Cold War.

It was 1956: time to plan another year's set of nuclear tests. Operation Redwing would be conducted in the Pacific Ocean in the Marshall Islands – at the Bikini and Eniwetok atolls. The Cleo was ill-suited to be used as an artillery shell, and it used more of the valuable plutonium fuel than did other atomic devices of comparable size. It was a good start, but Johnny would have to do better.

Johnny's thoughts went back to the Geode design that he had reluctantly abandoned the year before. He held biweekly meetings of his group where physicists gave progress reports on research they were doing. At one meeting, Morris Scharff gave a progress report on work that looked promising – it shared many characteristics with the Geode. Johnny organized his team to pursue the idea further.

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The Atomic Energy Commission (AEC) was the government agency responsible for managing the nuclear weapons complex of the United States, and among other things, it provided the Laboratory with its budget. The successful tests of 1955 had proven that the Laboratory was fully capable of designing nuclear weapons. In recognition of that status, funds were allocated to create a high-explosives testing facility capable of supporting hydro-tests called Site 300. A hydro-test exposed a model of an atomic device to high explosives and observed how the device responded. The Hectoton Group would no longer have to travel to New Mexico or Nevada to conduct a hydro-test. Now they could accomplish the same thing in a facility located 15 or so miles from the Laboratory.

To conduct a hydro-test, the designers first had to make a model of their device to act as a surrogate. The model was made from non-fissionable materials, which usually meant using depleted uranium, also called D38. This was the residue of natural uranium that remained after the isotope uranium-235 had been mostly removed from it, so it was predominantly composed of the isotope uranium-238. The device model, with its high explosives, was placed on a stand surrounded by intricate diagnostic equipment used to measure if the model correctly responded to the high-explosive detonation.

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For the tests of 1956, Johnny organized the Hectoton Group into three teams; each team was responsible for designing an atomic device that deviated from the other devices in some way. He instituted a protocol that named each new device after a bird, and the three devices were called the Swan, the Swallow, and the Swift. They were radically different from the Cleo. Johnny's goal was to get maximum performance from a minimum of material. The designs were radical enough that Johnny felt obliged to describe the physics that made them work in a report sent to AEC headquarters in Washington.

The design for the Swan was based on computer calculations, which were used to build a model of it for hydro-testing. Models of the Swan went through hydro-tests at Site 300 and small changes were made, and then the new model was tested again. Finally, they began to see satisfactory results.

The Swallow came the closest to resembling a nuclear artillery shell. The Swallow's design had to be strong enough to withstand the high torque and acceleration it would experience after being fired from an artillery tube. So, just like the Swan team, the Swallow team drew up an initial design from calculations and then built a model that could be hydro-tested.

The hydro-tests began to reveal flaws in the Swallow's design. Johnny wrote a report that went to AEC headquarters that accurately described the problems. He was as truthful about the tests as possible, and he didn't hold back any discouraging news that might negatively reflect on him and his group. Finally, in January 1956, the hydro-tests began to come in with encouraging results. It looked like the Swallow would be a successful design.

The smallest device was the Swift. The Swift team was led by an Air Force captain named Jasper Welch, who would eventually rise to the rank of major general. The Swift team began to see difficulties as soon as they started to conduct hydro-tests. Time was getting short, and if they had any hopes of getting their device tested, they had to complete their design within a few months. Welch had his team working overtime for months and they were just able to complete their device.

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With the coming of summer 1956, Johnny moved his entire group to Eniwetok. They were on edge to see their devices tested after so many months of preparation. Taking everyone in his organization to the Pacific Proving Grounds was not usual practice, but Johnny wanted all his physicists to share the experience. He wanted each of them to feel that they were an important part of the entire effort.

They were assigned a set of barracks – there were three classes of barracks to choose from. The VIP barracks contained one-man rooms furnished with a single double bunk in each room. The semi-VIP rooms had two double bunkbeds and were to be occupied by four men. Finally, the lowest class of barracks contained four double bunkbeds for eight individuals. Johnny had been assigned a VIP room, but he wanted to be close to his team leaders, and so he moved them into his room and the adjoining room. That was not all right with organizers and there was a bureaucratic tussle. Choosing to be with his men, Johnny gave up the bureaucratic squabble and moved himself and his duffle bag into one of the eight-man rooms.

There were huge clams living inside the atoll, and Johnny wanted to take home a large clam shell. He spotted a huge clam lodged under a rock off Parry Island, so he secured a rope and tied it to a large inner tube. His idea was to wrap the rope around the clam and then float it ashore. He dove down and groped around the shell, looking for a way to fashion the cord around the monster clam. In the process, he brushed his arms against the razor-sharp coral, which caused him to bleed.

When he came to the surface for air, Johnny noticed several sharks circling in the lagoon a hundred yards away, and he was concerned lest his bleeding attract them. A Hectoton physicist named Larry Germain, who always wore a pair of thick glasses, was treading water nearby, and Johnny asked him to watch out for the sharks and warn him if they began to get closer. Assured of a watchman on the surface, he dove down again and continued working to get the

rope around the clam.

When he resurfaced, there was no Germain, and Johnny noticed that the sharks were coming closer. He swam back to shore, and spotted Germain lying on the beach. When he asked Germain why he had left his post, the bespectacled physicist responded, "Well, I thought about what you said about there being sharks in the water, and I decided to get out of there."

It was time to test the devices, starting with the Swift. It was tested atop a 200-foot tower. It gave a low yield, about one-fourth of what had been expected. This was not an encouraging start. Its exceedingly small size had caused unforeseen complications to dominate the Swift's performance. Hopefully, this was not a bad omen; they would have to wait and see how the other designs worked.

That opportunity came two weeks later, with the test of the Swallow atop a 300-foot tower. The mediocre performance of the Swift made the mood tense. At midmorning, the detonation switch in the control bunker was activated and the tower became bathed in light, and then consumed in an explosion. There was no need for fretting, for the Swallow performed well, rendering a yield greater than had been predicted. The Army had wanted a tactical nuclear device, and it looked like they may now have one.

Next it was the Swan's turn. When test day arrived, the same controls that had detonated the Swallow now triggered the Swan, which lit up the South Pacific sky and gave a yield in the upper part of its predicted range of values, which was gratifying. This was the mothership of their atomic designs – the main hope for the Hectoton Group – and it had performed well.

During their time on Eniwetok, Johnny assembled his physicists into a Quonset hut. They sat together before a blackboard in their shorts and shirtless, a tropical breeze moving through two doors on either side of the hut, with no distractions. This was Johnny's way of getting his entire group involved with the business of designing a new warhead. Jim Wilson threw out an idea and sketched it on the blackboard. Wally Birnbaum looked at Wilson's sketch and offered a novel way to use a detonation shockwave, and others in the group chimed in with other ideas. They were all experts by this time, having participated in scores of hydro-tests. They had reached a stage of expertise where they did not need a computer code to tell them how the model drawn up on the blackboard would react to a high explosive shockwave.

As they went through their discussions, day after day, an idea for a fission bomb smaller and lighter than any other device developed up to that time took form. At a meeting held back in Livermore in August 1956, Johnny announced, "A study named Robin has been started on a different method of implosion. It aims to achieve a device characterized by light weight, ruggedness, and moderate efficiency."

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The procedure to conduct a hydro-test was slow and cumbersome, and miscommunications led to heated arguments. York's solution to the problem was to integrate several groups into a single unit, which he called B Division, and he appointed Johnny to lead it. It was a complex job, as Johnny himself testified:

> Now let me tell you about something: the job of doing what became B Division. I was thinking about this primary. How do we get this to compress a secondary, or anything else? So, we did some experiments. The first thing I tried was to just take the hydrodynamic energy from the explosion of this thing to implode that thing. Which shows you how much total ignorance and no calculational capability I had. But I did have Jim Wilson, who could put a code to work.

Johnny was an invigorating leader, as B Division physicists were about to learn. He held a weekly meeting of the division in an auditorium that was hot and stuffy. It was difficult to stay awake at these meetings. One physicist, Ray Brandey, was always falling asleep until rather abruptly, Johnny lit a firecracker from his cigar and threw it under Ray's chair.

Another meeting was held every Friday afternoon in Johnny's office. Engineers and shop managers attended, and the status of each experiment was discussed. The engineers were expected to design, and the shops to build, all kinds of odd parts, to unheard of tolerances, in almost zero time. It is no wonder the engineers and shop people called the meeting the "Inquisition" or "Foster's Friday Frolics."

The Fosters of Stanford Way were getting used to life in Livermore. The kids, Susan, Bruce, and Scott, were growing up quickly and adjusting to the warm and invigorating climate that Livermore had to offer. Soon another son would join the family as well. Ian, who preferred to be called John, became a vigorous young toddler enjoying the rich sunshine and Mediterranean climate of the Livermore Valley.

Being neighbors with Stirling and Rose Colgate had its rewards and challenges. Colgate enjoyed an inheritance from his family estate, that which came with the toothpaste industry. Soon after they settled in Livermore, Stirling had a swimming pool emplaced in the family's backyard. Johnny decided he had to get a swimming pool for his family as well, but he didn't have enough cash ready to hire a company to emplace it. He would have to be creative with his finances and his engineering skills.

He contracted to have a hole dug and to have the pool tiled, then he put in reinforcing mesh, plumbing and then sidewalks with the help of his B Division physicists. Payback to the volunteers came with pool parties for everyone in the division. Edwin McMillan was a frequent guest, and the soon-to-be Nobel laureate derived pleasure in throwing Isotope, the family cat, into the pool time and time again. Isotope must have enjoyed the relief from the afternoon sun, for he kept going back to McMillan.

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The summer of 1957 was arriving with a new series of nuclear tests, Operation Plumbbob, and Johnny organized his newly formed Robin team. By this time, B Division physicists were veterans of hundreds of hydro-tests, so they had a natural feeling of what they were after. They were also able to use codes developed by Jim Wilson and other code developers who had progressed quite a bit since the Hectoton days. They had a feeling that the project they were working on would be very important to the country, and they were right.

B Division physicists prepared models of the Robin from computer calculations and then took them out to Site 300 for hydro-testing. They quickly converged onto a design that was a marvel to study. There were originally two versions of the Robin, Robin A and Robin B. The first A version used enriched uranium as its nuclear fuel, and it was cumbersome. The second version, Robin B, had a plutonium pit and when it was tested, it performed exquisitely. The Robin B was a true descendent to the original Geode concept. It was light and rugged, and it gave a significant yield. When the Robin B team was done, the device could be carried by one man. The Fat Man, America's first atomic device, was five feet in diameter and had weighed several tons.

The Robin never showed up in America's nuclear stockpile; that was not its legacy. It was much more important than that. It became the foundation upon which to build warheads for

the future. It was the ultimate fission weapon, the prototype used to build the country's modern stockpile.

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Soon after the nuclear tests in Operation Redwing had concluded in 1956, the US Navy held a conference in Woods Hole, Massachusetts. The conference center was located along the Cape Cod coastline near the Nobsque Lighthouse, and so the meeting became known as the Nobska Conference. The Chief of Naval Operations, Admiral Arleigh Burke, had originally called the conference together to discuss threats posed by Soviet submarines that were patrolling along the coast of America.

Burke also had an idea to give the United States the ability to strike the Soviet Union with a missile launched from a submerged submarine. President Eisenhower had instituted a defensive strategy called Massive Retaliation that relied on nuclear weapons to deter the Soviets from aggressive action, like an invasion of Western Europe. Studies had shown however, that air bases that contained practically all of the nation's nuclear deterrent force could be destroyed by a surprise attack. So, our nuclear deterrent was built on sand and lacked credibility – there was concern that the vulnerability of our nuclear forces could cause a pre-emptive surprise attack against them.

Burke suggested using a submerged submarine to launch nuclear-tipped missiles – it would bring credibility to our nuclear deterrence. However, thermonuclear warheads were monstrous affairs that could only be carried by large bombers. A missile launched from a submarine was small and could only carry warheads that were significantly smaller than any that existed.

Prominent scientists had been invited to attend the Nobska Conference, and representing Livermore were Johnny and Edward Teller. In the course of discussions about Burke's Fleet Ballistic Missile idea, Teller rose from his seat and stated that the Laboratory in Livermore could design a thermonuclear warhead small enough to fit inside a Polaris missile, and they could do it within four years. The contingent from Los Alamos told Admiral Burke that such a warhead did not exist, and it would take more than five years to design and develop. Burke accepted Teller's proposal and awarded a Navy contract to the Livermore Laboratory to produce a thermonuclear warhead for the Polaris Submarine.

The Laboratory was up to the task, and in the next series of nuclear tests in 1957, the physicists of Johnny's B Division and Harold Brown's A Division successfully tested the smallest thermonuclear warhead then existing. It weighed much less than previous warheads that each weighed over a ton, and the size and weight made it a very suitable candidate for deployment on Navy submarine-launched missiles. The USS Washington, the nation's first Polaris submarine, was launched in 1960 loaded with 16 Polaris missiles, each carrying the Laboratory warhead.

Chapter 7

Lab Director

When Herb York was putting together his plans to organize the Laboratory in 1952, he expected individuals taking leadership positions to stay in those positions for only two or three years. After that, he expected them to move on. He included himself – he thought he would be Laboratory director for only a few years. In 1956, he talked about leaving the Laboratory with Lawrence, but Lawrence got him to hold on. York became a member of several committees serving in Washington, DC, and he became acquainted with the Secretary of Defense, who asked York to bring more scientific discipline to the Defense Department. That fit in well with his wishes for change and by the middle of 1958, York accepted a position in the Pentagon to establish and run the Advanced Research Projects Agency (ARPA).

In anticipation of the change, a reorganization of the Laboratory's top positions was made. Johnny and Harold Brown became associate directors for nuclear weapons research. It meant that Johnny would be responsible for more than the activities of his B Division. He would be overseeing physicists, chemists, engineers, and technicians who performed the necessary tasks of producing nuclear devices that would be tested, and for diagnosing how well those devices performed.

With York's departure, Lawrence came up with a plan of succession for Laboratory director. Edward Teller was asked to become the temporary director and Mark Mills, the T Division leader, was asked to become Teller's deputy. The plan was to have Mills become Laboratory director once his appointment could be approved by the Regents of the University of California and by the Commissioners of the AEC. As the new deputy director, Mills went out to the Pacific Proving Grounds to see the Laboratory's preparations for a nuclear test at Eniwetok Atoll. While on a helicopter flight between islands of the atoll, his helicopter crashed into the sea and Mills drowned. He had been a popular leader among his charges in T Division, and his untimely death was taken hard.

Teller then became the next Laboratory director. He appointed Brown to be his deputy, and Johnny was appointed to be associate director of the entire Laboratory's weapons program. This was a period when the Laboratory had to ensure that it met its obligations to the Navy with a warhead for the Polaris. The Air Force had also expressed an interest in developing a new solid-fueled missile, Minuteman; they would need a warhead for it, and they eyed the small warhead that the Laboratory had just designed for the Navy. Responsibility for making sure the Laboratory met its obligations fell on Johnny's shoulders. There was little doubt about how competent he was, or that the Laboratory would succeed.

Then an event occurred that touched Johnny greatly. Lawrence was in Geneva, Switzerland, serving as a member of an American team that met with Soviet scientists to discuss a nuclear test ban. After a few weeks at the job, he began to experience stomach pains that reminded him and his wife of his previous bouts with colitis. The couple flew back to Berkeley and Lawrence was admitted into a hospital and underwent surgery. A few weeks later he died. It was a terrible blow to everyone at the Laboratory; they had lost their founder and the man who gave so much innovative spirit to the institution. In recognition of his services, the University of California Board of Regents renamed his laboratory the Lawrence Radiation Laboratory.

There followed a period when the Eisenhower Administration became deeply engaged with the Soviet Union to negotiate a cessation of nuclear testing. Members of Congress needed more information about the ramifications that a test ban could have. The Senate Armed Services Committee wanted to know more about the technical issues involved with nuclear testing, and the AEC chairman wanted a Laboratory expert to testify. When Teller received a request to provide an expert witness to appear before the Senate Armed Services Committee, he sent Johnny.

That's when Johnny first met a man who would soon become an important part of his life, John Fitzgerald Kennedy. He referred to the meeting as the time "he got me." Bill MacMillan, a RAND analyst and a consultant to the Laboratory, joined Johnny for the flight, and they discussed the upcoming testimony. Then McMillan wrote a draft statement and presented it to Johnny to have for the next morning.

Johnny had limited experience addressing committees of Congress; he nervously fidgeted with papers in the committee room as he prepared to read his statement. Among the members at the committee hearing was a Massachusetts Senator named Kennedy, who was known for his ability to concentrate on a speaker, seldom interrupting until the speaker had made all his points. His rapt attention and unblinking gaze could be unnerving.

Johnny stood to give his briefing, and he said that the views he was about to present were technical and not political. At the end of his presentation, Senator Kennedy asked a question. Kennedy said he understood that Foster was giving a technical briefing, but he wondered whether Johnny had made a few political judgments. Johnny told the Senator that no, he had limited himself to technical advice only. Then Kennedy picked up the paper McMillan had written and read aloud a sentence that dealt with the need for continued testing, and said, "Doesn't that sound political to you?" Johnny thought about it and said, "Yes sir, it does." With that, Johnny's mind went blank; he sat down and kept quiet for the rest of the meeting.

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Teller was a renowned theoretical physicist, but leading a large laboratory was not one of his fortes, and so after 18 months as Laboratory director, he stepped down, and Harold Brown was asked to replace him. Brown was sitting in his new position for only eight months, when he got a call from Herb York, who had left his position as the first director of ARPA to become the first Director for Defense Research and Engineering (DDR&E). York wanted to continue with a career in academia; he had just accepted an offer to be the Chancellor of the University of California, San Diego, and he asked Brown to take over his position at the Pentagon. Brown readily accepted the offer, and within a year of his appointment as Director of the Lawrence Radiation Laboratory (Livermore), he departed for Washington. In 1961, Johnny was asked to replace him as Laboratory director.

In November 1958, the United States and the Soviet Union had entered into a treaty to ban nuclear testing. So, when Johnny started his duties as the director, Laboratory scientists and engineers had not conducted a nuclear test for two years, during which no new nuclear warheads had been designed or developed. The warhead for the Polaris had been a success and had been deployed in Polaris submarines, starting with the USS Washington in 1960. That great success was soon followed by the Air Force contracting with the Laboratory to develop a warhead for the Minuteman missile.

Although the warhead for the Minuteman would be similar to that of the Polaris,

modifications would still have to be made for it to perform in a different type of missile compartment. Without nuclear testing, one could not assume the performance of a new warhead would be desirable. An extraordinary amount of care was needed in the warhead's final development stages, and it occupied much of Johnny's attention.

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Johnny's love for his growing family was also taking hold, and his interests went beyond the Laboratory to the environment in which they lived. The city of Livermore was growing, and with the growth, it was changing its culture. New businesses were opening up, supported with a burgeoning population that had come with the creation of the Laboratory. The saloons, plain restaurants, and antique stores that were the mainstays of downtown Livermore for decades were being supplemented with car dealerships, flower stores, furniture stores, and more upscale restaurants. Schools were being built to handle the influx of youngsters from newly settled families, and several members of the Laboratory took up a campaign to locate a hospital near the center of town to provide better health services.

Johnny got involved; he became chairman of the board for the Livermore Recreation and Park District, sitting in on meetings to decide how the city ought to expend funds to build parks, to support outdoor events, and to create recreational facilities needed to exploit Livermore's welcoming climate. He used that indomitable spirit of his to make his community a better place to live, and he enjoyed watching his children grow up to be teenagers. His new found celebrity as Laboratory director also brought out a yearning to move out of the house on Stanford Way. The Fosters purchased a lot in Castlewood, an exclusive development in the nearby town of Pleasanton. They hired an architect and had a dreamhouse built on their newly acquired property. Johnny finally got to see Bobbie and his kids benefit from the hard work that had given him such a successful career.

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John F. Kennedy was elected to be the 35th President of the United States in November 1960; he was inaugurated the following January. Events around the world began to conspire against the relatively quiet routine that the Laboratory had settled into. American intelligence agencies had detected activities within the Soviet Union that suggested they were preparing to resume nuclear testing once more. The Chief Commissioner of the AEC, Glenn Seaborg, issued a warning for the agency's nuclear design laboratories to be prepared to conduct nuclear tests should the president so order. Johnny prepared for the worst.

He established a six-workday schedule that would bring the Lab up to full form in the shortest amount of time. Lab employees who had retired during the testing moratorium felt a surge of patriotism and returned to the positions they held when the Lab had been involved in testing two years earlier. Johnny began to plan what the Lab should do if testing was reinstated – what types of devices made the most sense for the country facing a highly aggressive Soviet Union? Then the Soviets abrogated the nuclear test ban by conducting forty-five nuclear tests in a sixty-day period. Many of the tests were over a megaton. The President ordered the Laboratory to immediately conduct a test.

There was only two weeks to respond to the President's order, nevertheless, the Laboratory prepared for an underground nuclear test in the Nevada Test Site, in an event called Antler. A nuclear weapon, one designed by Johnny's B Division, was randomly chosen from the nation's nuclear stockpile and sent to the Test Site to be tested. The test was meant to signal

Soviet Premier Nikita Khrushchev that the United States would not be intimidated. The Antler device performed just the way it had been designed to do.

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The Soviet Union maintained a huge army in Eastern Europe that was poised to launch itself against the democracies of Western Europe, especially West Germany. Its 96 divisions consisted mostly of armored forces and mechanized infantry – tanks and soldiers mounted in armored vehicles. B Division physicists came up with an idea for a weapon that could be used against Soviets tanks in an invasion. Their idea was to attack Soviet tank crews without destroying the surrounding West German countryside by detonating the weapon at a high altitude. The weapon was called an enhanced radiation warhead because it could release more radiation, especially neutrons, aimed at tankers while having a reduced blast. It would deter the Soviet Union from launching an armored attack against the West. Johnny decided that the enhanced radiation warhead qualified as a valid weapon to test in the new operations.

The RAND Corporation, a so-called "think tank" headquartered in Santa Monica, California, is used by the Department of Defense for studies related to national security. From its earliest days, analysts from RAND visited the Laboratory to observe how the country's nuclear weapons research was progressing, and true to form, a RAND analyst named Sam Cohen visited Johnny to ask what was new. Johnny described the enhanced radiation weapon they were testing, and Cohen exclaimed, "You've invented the neutron bomb!"

Cohen went back to his office in Santa Monica and wrote up a report in which he described what he had heard about the new weapon, and he claimed that he had invented it. The weapon underwent development over the years until it was ready to be deployed with NATO troops. The sobriquet 'neutron bomb' stuck and was used by news media to identify the weapon to an American public skittish about any connotations to radiation. Criticism came from members of Congress, and a debate about deploying the weapon continued until President Carter cancelled the program.

There were other programs that needed attention, and Johnny had to arrange to test those devices too. A Plowshare Program for the peaceful use of nuclear explosives had emerged in the late 1950s, and serious thought was given to using nuclear explosives to make large excavations to build canals or deep-sea ports. Now there were opportunities to see if the concepts would work, and several tests were conducted in Nevada and New Mexico to develop a thermonuclear device that would have little radioactivity after detonation. The culmination of Plowshare came with an event called Sedan, in which a nuclear device exploded and created a crater that was 320 feet deep and 1,280 feet in diameter. For comparison, the crater was at least as large as UC Berkeley's football stadium.

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The 1950s saw the Soviet Union increase its nuclear strength, and the Soviet leader, Nikita Khrushchev, was not hesitant to use it to further his political goals. He even told democratic countries in western Europe that he had rockets carrying super bombs that could reach their capitals. Khrushchev was obsessed with West Berlin. For years, Germans living in East Germany escaped from a Communist regime by infiltrating into West Berlin and sought political asylum. Khrushchev was adamant he would stem this hemorrhaging of humanity into the West, and he warned President Kennedy that the Red Army was going to occupy West Berlin. Kennedy was just as adamant that he would not surrender two and a half million

Germans to Communism.

The United States was the only power on Earth strong enough to resist the Soviet threat, and for that it relied on its nuclear forces. If Khrushchev followed through on his threat, what would prevent him from first dropping an atomic bomb on each of America's strategic air bases? With America's strategic deterrent gone, what would deter Khrushchev from an invasion? When Johnny and Harold Brown had collaborated to produce the smallest nuclear weapon in the world, they were able to give the Navy a warhead for the relatively small Polaris missile. With Polaris submarines, the country had a deterrent threat to the Soviet Union that was invulnerable to attack.

With the Polaris system, President Kennedy knew that Khrushchev could not conduct a surprise attack against the United States without suffering a retaliatory strike that would destroy his country. For that reason, Khrushchev would not risk an attack, and Kennedy used that knowledge to give him the resolve to face the Soviet threat. Khrushchev blinked at Kennedy's resolve, and the crisis over an invasion of West Berlin passed. The development of the Polaris warhead had helped to avoid a nuclear war between the Soviet Union and the United States.

Six months after the crisis over Berlin, Kennedy flew out to Berkeley to receive an honorary degree from the University of California, and he took advantage of the event to thank the physicists of the Laboratory for their contributions to the defense of the country. The nuclear warheads that Kennedy had relied on when he faced Soviet threats had been designed by these very same scientists, and Kennedy wanted to thank them personally. As Director of the Laboratory, Johnny would be giving the President a briefing to show him the warheads that were part of the backbone of the nation's defensive posture.

Johnny stood before Kennedy for the second time in his life; remembering their first encounter in a Senate conference room three years earlier made him a bit nervous. Full-scale models of the Polaris and Minuteman warheads were placed on demonstration tables, and Johnny showed the President the strategic warheads. After that, Johnny planned to give a pitch for an idea he had conceived the year before concerning the security of tactical nuclear weapons. He had an idea about how to protect the weapons, and he initiated a program to design a sophisticated anti-theft system that came to be called the Permissive Action Link (PAL).

To demonstrate the PAL mechanism, Johnny had to enter a proper sequence of numbers into the demonstration nuclear device on the table. Just before the President arrived, a technician gave Johnny the number sequence; Johnny explained the PAL concept and Kennedy became animated with the demonstration and pulled up a chair and sat before the device. Then Johnny came to the point where he had to enter the proper sequence of numbers. As he stood there, he couldn't remember the number sequence. Somehow, he did not know how, he reached inside his mind and pressed a sequence of numbers on the PAL device. It worked!

The President liked the idea and agreed with Johnny's approach to solving the problem. Kennedy asked his Presidential Science Advisor, Jerome Wiesner, to look at the matter more deeply, and Wiesner replied on May 29, 1962, that the approach seemed to be a good idea and a timely solution to a national security need. On June 6, Kennedy issued National Security Memorandum No. 160, which directed the Department of Defense to install PAL systems into selected nuclear weapons, principally those in NATO.[3] On July 6, 1962, the *New York Times* reported, "President Kennedy asked Congress today for $23,300,000 to install electronic locks

on nuclear weapons in this country and abroad as a safeguard against accidental or unauthorized firings."[4]

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On the afternoon of March 23, 1962, an hour or so after he had met the Livermore scientists and received the briefing from Johnny, Kennedy stepped onto a platform at the campus of the University of California to receive an honorary degree. Secretary of Defense McNamara, an alumnus of the university, also received an honorary degree. Joining the President were seven Nobel Laureates, all of whom were Berkeley alumni. They included AEC Chairman Seaborg and Lawrence Radiation Laboratory Director McMillan. A crowd of 85,000 spectators came to the university's football stadium to watch the ceremony. After receiving his honorary degree, Kennedy told everyone assembled that the democratic world could look forward to the future with a new confidence.

Kennedy had come because he wanted to see the Livermore scientists who had given the country the Polaris and Minuteman warheads, and he had received briefings from those very same scientists that morning, and perhaps thinking back to the Berlin crisis of the previous year, Kennedy remarked, "I am forced to confront an uncomfortable truth. The New Frontier [his Administration's nickname] may well owe more to Berkeley than to Harvard."[5]

Chapter 8

The Director of Defense Research

During his time at Livermore, Johnny had occasionally been approached by individuals who wanted to coax him away from the Laboratory to take a lucrative position in private enterprise. When he was B Division leader, representatives from RAND tried to cajole him to join them in Santa Monica. As Laboratory director, large firms that had government contracts approached him, for he had a reputation of being a capable and honest scientist who had served Defense Department programs for a decade. But Johnny politely rebuffed all these invitations. He had become passionate with the work he had been doing for the past decade, and like his mentor Ernest Lawrence, he wanted to continue offering his services towards the defense of his nation.

Then in 1965, Harold Brown called Johnny and said, "Secretary McNamara would like you to replace me. I'm planning to be the Secretary of the Air Force." Johnny explained that he wasn't going to go to Washington. Brown said he understood Johnny's feelings, but now he was being asked by his government. Brown knew Johnny better than Johnny knew himself. Johnny realized then that he had to go.

With his decision to leave Livermore made, Johnny took steps to move with his family across the country. He had hoped to use funding provided by the Defense Department to pay for his family's travel expenses, but then he discovered that a law had just been passed that forbad the government to award travel costs associated with an appointment to the Department of Defense. Johnny hardly had enough money to move his family. Duane Sewell, who had been Johnny's deputy director, arranged to have the University of California help Johnny with his moving costs.

Chet Funkhauser, who served on the Laboratory headquarters staff, scheduled an early morning meeting in the main auditorium for Johnny to say farewell to the Laboratory's staff. Johnny stood erect on center stage and told them he was sorry that he was leaving, but he could hardly decline a call from the Secretary of Defense. Then the theme music from the popular movie *The Third Man* began to play in the background. Why? Well he was the third man in a row to leave the position of Laboratory director to pursue a post at the Pentagon. There was York, then Brown, and now Johnny.

Johnny needed to quickly sell his still new Castlewood house without taking a financial soaking. He got some badly needed help from Alfred Loomis, who had been a close friend of Lawrence, and whom Johnny had met during his time at the Rad Lab in Berkeley. Loomis was a bigger-than-life character who had made sage investments during the Great Depression of the 1930s, which had made him a very rich man. During World War II, Loomis had been placed in charge of radar research for the government, and it was he who had persuaded Lawrence to create the MIT Radiation Laboratory, the institution that had drawn Johnny and his father to Cambridge, Massachusetts, and had led to Johnny's being deployed to a combat zone in Italy.

Loomis told Johnny, "I'll buy your house and take it off your hands." Johnny needn't worry about having to quickly sell his property and losing a large sum of money; Loomis would give him a fair price. Johnny said, "Alfred, you don't need another house." That didn't matter, Loomis was adamant that Johnny not be disadvantaged because of his service to the nation.

The Fosters moved out of California and were soon settling into life in Falls Church, Virginia. They purchased a house on Lakeview Drive, at Lake Barcroft, which lay astride the Columbia Turnpike, and was situated about six miles from the Pentagon.

Their house was an ideal place for the kids to play in the summer and winter. A backyard swimming pool was convenient for them to swim and sail. Scott loved the outdoor life that the new neighborhood offered. He soon took over two of the family's small sailboats, a Sunfish and a Sailfish, and he became an excellent sailor. Susan was a natural athlete, and she excelled as a swimmer.

Johnny had been nominated to be DDR&E by President Lyndon B. Johnson, and his nomination had to be approved by the Senate. The nomination process was finished quickly and without controversy. Johnny then spent his first days at the Pentagon getting coached by Harold Brown. Brown's advice was short and concise, "Just make sure that the staff doesn't run off going to the Hill on their own."

Johnny's time was soon consumed with learning the ins and outs of his role as DDR&E and navigating his way through the Pentagon bureaucracy. President Johnson had taken steps to become much more militarily involved in the growing conflict in Vietnam, and Johnny wondered, "What are we doing about the war in Vietnam?" When he discussed it with Brown, he found that Brown still considered Vietnam as a war in its infancy, and it could be over soon, "That's going to be over long before we can get any research and development products to that effort."

Johnny met with Secretary of Defense McNamara for the first time as the new DDR&E, and as he entered the Secretary's office, Johnny's first question was, "What would you like me to do about the war in Vietnam?" In characteristic fashion, McNamara ticked off five things on his fingers. By the time Johnny left the office, he had trouble remembering all that the Secretary had spelled out, but he knew McNamara wanted to see research and development directed towards the war in Vietnam immediately. Johnny called meetings with the Service Chiefs and the Joint Chiefs of Staff and explained to them what he wanted to do; he said he was open to suggestions they thought would be helpful. He did the same thing with industry representatives, who often invited the DDR&E to give a talk about future weapons needs.

McNamara had made it a habit to meet with CEOs on a regular schedule from corporations supporting the military. With Johnny newly ensconced into office, McNamara invited him to give talks on military R&D requirements, and Johnny used these occasions to seek suggestions from industry. Johnny's attitude was that it was important to have people in his staff who had come from industry and knew how to get things done. Soon enough, the executives, including the president of Boeing, provided volunteers to join the DDR&E staff with the kind of expertise Johnny wanted. They came from firms like Boeing, Northrop, Grumman, and Lockheed, and indeed, the government benefited from their knowledge and drive.

Johnny was getting comfortable with his job. He already had a superb background in producing weapons for the government, and he was no slouch in understanding technical issues that arose with the introduction of sophisticated systems. He was also a natural leader who could organize professionals to solve complicated problems; he used his talents to put together a sizable staff of experts to analyze what weapons systems were needed and would best serve the interests of the country. They tackled the problems then facing the security of the United States: the war in Vietnam, nuclear deterrence, and dealing with a militarily resurgent Soviet Union.

* * *

Johnny felt his primary objective was to see what could be done to relieve the situation in Vietnam. One of the items that McNamara had ticked off on his fingers was that he wanted to break the lines of communications between North Vietnamese forces fighting in the South and the government in Hanoi. The main line of communication used by the Communists was the Ho Chi Minh Trail, which wound its way out of the North, through Laos and Cambodia, and into the mountainous regions of South Vietnam. Johnny thought he might find a choke point along the trail and seal it off. The Dong Ba Bridge was a good candidate since it was a major structure that allowed the Communists to get their military supplies over a large river. Its importance was recognized early, and it had been attacked often by American pilots. The North Vietnamese knew how valuable the bridge was, and they protected it with extensive anti-aircraft batteries, which led to the downing of many American fighter planes that had attempted to bomb the bridge.

Bill McLean was a member of the Naval Ordnance Test Station and he had an idea about taking out the Dong Ba Bridge. He came into Johnny's office and described a glide bomb: insert a movie camera into the nose of a bomb that relayed a picture of the target to a navigator in the back seat of the fighter-bomber that had dropped the bomb. In that way, the navigator could steer the glide bomb into the target. The accuracy of this system meant that the pilot could drop the bomb far from the target and the lethal anti-aircraft guns. McLean's idea struck Johnny as a way to strike the Dong Ba Bridge. As he had shown and would continue to show throughout his career, Johnny evaluated the initiative, acted on impulse, and took steps to make the initiative a viable program, and he did it. McLean's idea for a glide bomb became the predecessor for an entire series of "smart bomb" programs for decades to come.

Johnny felt he needed to have a knowledgeable and aggressive representative in Vietnam who could witness the war firsthand and could advise the American commander on technical opportunities that could provide science and engineering support. He found that individual in Dr. William G. McMillan, a chemistry professor at UCLA. McMillan had worked in the Manhattan Project during World War II, and after the war, he accepted a Guggenheim Fellowship to conduct research with Edward Teller at the University of Chicago. He later worked at RAND Corporation until settling down at UCLA. Johnny called Westmoreland and asked him if he would be willing to have a scientist in residence, and Westmoreland said he'd be delighted. In 1966, McMillan went to Vietnam to represent Johnny and to act as a scientific advisor to the commander of American forces, General William Westmoreland.

For the next two years, McMillan developed concepts for artillery and military reconnaissance, gave frequent advice to Westmoreland, and helped make American fighting men more effective. McMillan's conduit to the resources of DDR&E was Leonard Sullivan, a member of Johnny's staff. Johnny visited Vietnam himself and met Westmoreland on the island of Long Hai off the Vietnamese coast, but he relied heavily on McMillan to determine how the DDR&E could best support the military forces there. In 1968, McMillan contracted hepatitis and the disease forced him to return to UCLA, where he conducted more research to develop an antidote for it. Johnny felt McMillan had provided great service to the Army especially, even though he had been hardly recognized by newsmen or historians.

* * *

Johnny's experience with nuclear weapons gave him the potential to be beneficial to the nation by dealing with nuclear deterrence, and indeed, that was true. The 1960s were a tense period in the Cold War, and relations with Communist regimes reflected that. China had recently become a nuclear power and it had an aggressive program to develop missiles that could carry nuclear warheads across the globe – Mao Tse Tung's Cultural Revolution hardly eased tensions in the world. Most importantly for the moment, the United States needed a defense against an attack from the Soviet Union; Minuteman Missile silos needed to be protected against a surprise attack that could eradicate a major component of the country's nuclear counterforce.

Before becoming the DDR&E, Johnny had worked for a while as a consultant to the Defense Department's Advanced Research Program Agency (ARPA). One of his projects was to look at how to detect and defeat an incoming ballistic missile from the Soviet Union. Analysts had fretted about this almost from the moment the Soviets had launched Sputnik in October 1957; it was a problem that still absorbed Johnny as he pondered questions that needed to be answered. What are the indicators of a missile attack? Could you easily detect a Soviet missile with radar? If you could, what would be the radar cross-section of the sheath around the nose of the missile? How much warning time could you get? If you did see a missile attack coming, what was the prospect of intercepting the missiles? What kind of a warhead was necessary if the interceptor missed the missile by hundreds of feet? At a very high altitude, the interceptor's blast would not suffice, so it would have to emit enough radiation to functionally destroy the missile. An interceptor operating at lower altitudes would have to be different. So, what kind of interceptors were needed?

Responding to these questions eventually led to the Sprint and Spartan Programs. Defense officials wanted to build 15 sites throughout the country to deploy Spartan and Sprint missiles to defend the country against a Soviet attack. Paul Nitze, who was the Deputy Secretary of Defense, was asked by Congress to describe how America planned to defend itself against a missile attack and Nitze asked Johnny to assist him. Johnny agreed, and arranged to show a movie at a committee hearing. Nitze started off the hearing with a top-level briefing about the strategy and objectives for having an anti-ballistic missile system. He was an excellent briefer, having had much experience dealing with Congress during his time in Dean Acheson's State Department. When he was done, Johnny stood up and gave a description of this defensive system; he went to a screen in the front of the hearing room and talked about having 15 anti-ballistic sites around the United States. There would be two kinds of interceptors: A long-range missile, the Spartan, would get 10 to 15 minutes' warning before launching to intercept missiles in outer space; if the enemy missiles got past Spartan, there would be a short-range missile, the Sprint. They would both carry nuclear warheads.

Johnny then showed the committee a picture of the Spartan, and the missile launch looked fairly standard. It came out of the silo and went off to make its intercept. Then came a film clip of the Sprint missile, and it roared up and went quickly into the air. Then Johnny said, "What I showed you was in slow motion. Let me show you what's it like in real time." When they observed the film at real speed, everyone in the room was aghast, the missile disappeared in a flash. On the way out of the conference room, Nitze told Johnny that his briefing was the best support he'd ever had in testifying before Congress.

The country's nuclear deterrent posture was defined as a triad. It possessed three independent legs that backed up each other should one of the legs fail catastrophically. The most invulnerable leg of the triad was the nation's nuclear submarines armed with ballistic missiles.

These submarines, called "boomers", constantly patrolled the oceans underwater; they surfaced infrequently during a six-month patrol. The nuclear reactors used to power the submarines, and the selection and training of the crews used to man the submarines, fell under the purview of Admiral Hyman Rickover.

Rickover had an unsurpassed passion with his submarines, and he could be ruthless with anyone he felt was a threat. Johnny's DDR&E staff looked into one of Rickover's schemes for improving the power plant of a submarine and judged the scheme to be not cost-effective. This would not do for the admiral, who had significant leverage with several members of Congress. Johnny became vilified for opposing the scheme and was portrayed as being technically backward and obstructionist.

A Congressional hearing was called to review the project and Rickover arranged for Johnny to be called before the Joint Committee on Atomic Energy (JCAE); he would have to testify about Rickover's proposal. A committee staff member, John Conway, called Johnny and said he wanted Johnny to jointly testify with Rickover and the Assistant Secretary of the Navy for R&D. Johnny obliged and told the committee he opposed Rickover's scheme because it would be costly and would not increase the security of the submarine. As Johnny spoke, Rickover wrote out notes that he handed to the staff of the JCAE; they used the notes to ask questions in response to anything Johnny said. This went on for about an hour.

It felt to Johnny like an ambush. Conway had warned him earlier, "Look, this is going to be very rough." This was Johnny's baptism of fire in dealing with Rickover before Congress, and as he was finding out, Rickover could be a nasty political enemy. Senator Margaret Chase Smith was so concerned about these political antics that she warned Defense Department officials that, "You've got to get rid of Admiral Rickover." As Rickover manipulated the committee to accept his scheme, he cast doubt on Johnny's reputation. In the end, Congress gave approval to fund the scheme and the Navy built a submarine called the Lipscomb, named after Congressman Lipscomb, that satisfied Rickover's desires. This was not the only battle that Johnny would lose to the submarine Navy.

Johnny had mixed feelings about Rickover. While he resented Rickover's heavy-handed tactics to achieve his goals, he admired the admiral's absolute devotion to his mission. On one occasion Rickover went out for a few days on a newly commissioned submarine to inspect the boat's performance. On his return, Rickover met with the submarine flotilla commander at the end of the cruise and as they drove away in a limousine Rickover related that he saw some problems with the submarine's performance. The commander noticed that Rickover appeared to be having a heart attack and he ordered the limousine driver to go to a hospital. Rickover was upset, he said, "Admiral, you're not listening to what I have to say. I've got some important things that the Navy needs to know and needs to do. And I want your attention." Rickover said the hospital could wait; the important thing for him was to get his message to the commander.

Rickover was not the only admiral that Johnny crossed: Admiral Moorer was the Chief of Naval Operations, the number one admiral in the Navy. Johnny was investigating operations in the Navy and became interested in learning if submarines carrying ballistic missiles could be detected by the Soviets. Moorer was not interested in exposing the Navy's sensitive operations to public viewing.

Johnny had created a little office called Net Technical Assessment. And one of the first things it did was to look at whether or not ballistic missile submarines were being followed. Admiral

Moorer was furious and came storming down to Johnny's office. He said, "You don't know what you're talking about. These submarines are safe and reliable and are not being followed. And that's it. That's all there is to it." Despite Moorer's tirade, Johnny gathered his Net Technical Assessment staff together and they approached the Navy's Special Projects Office (SPO), the office that provided the missiles that go on the submarines. Captain Levering Smith, director of SPO's missile programs, was given $20 million a year to develop advanced detection devices that could be mounted on a submarine to see whether or not it was being followed.

Johnny was good friends with Dave Heebner, a researcher at Hughes Aircraft, and Heebner had been interested in submarine issues, especially studying acoustic monitors that could be mounted in the nose of a submarine. Then he got an idea that if you used a cable with some sensors on it that stretched out behind a moving submarine, you could use the long length of the cable as an antenna to detect the long wavelength acoustic signals associated with a stalking submarine. Johnny was intrigued with Heebner's idea, but he found that the Navy didn't want it. They didn't want a submarine, especially an attack submarine, encumbered by a long line. Johnny persisted and arranged for a test of the idea. A submarine dragged a long line behind it, and the data indicated just what Heebner thought would happen. The Navy still didn't want to do it, but it was difficult to ignore this capability to let submarines know if they were being followed by Soviet submarines, and eventually Heebner's idea became an additional tool in the submarine Navy.

* * *

The 1960s were also a time when the Soviet Union used its preponderant military strength as a tool to further its political goals. Advances in Soviet military technology had to be met with reciprocal American advances. The Air Force wanted a fighter capable of matching Soviet MiGs that could go supersonic and yet land on short fields. It should feature a swing wing, which would be an asset for short runways. The Navy, which had to share the fighter with the Air Force, required it to land on a carrier, which meant that the aircraft had to have strong wings that could be folded and still be able to withstand hard landings. These service requirements were not necessarily compatible, so McNamara decided to start two fighter programs: The F-111A for the Air Force and the F-111B for the Navy.

One day, a test pilot for the F-111B from Patuxent, Maryland, arrived at Johnny's office. He explained to Johnny that the airplane was inappropriate as a naval aircraft. He said, "Dr. Foster, I've been flying this aircraft at Patuxent where we can check out the capability of the airplane. You cannot land a F-111 on an aircraft carrier deck." His point was that the power settings during landings required the aircraft to assume an attitude that interfered with the pilot's field of view. Johnny asked, "Why don't you raise the seat?" The test pilot said, "I've been through all that, obviously, and if I put my head up against the canopy, I can just see the carrier deck."

Johnny knew that the F-111 program was special to McNamara, so he had to inform the Defense Secretary about the pending problem with the F-111B. To do that he called up Colonel Bob Pursley, McNamara's military chief of staff. Pursley was an Air Force aviator who had flown over fifty combat missions over Korea. After explaining the problem over the phone, Pursley promised he would keep Johnny informed about what McNamara was thinking.

McNamara called Johnny back and said he had scheduled a set of "Icarus Meetings." These were held each Saturday morning for the next few months with the CEOs of Pratt & Whitney and General Dynamics; corporations that produced the engine and held the overall contract for the F111. McNamara also wanted the Secretary of the Navy present. General Dynamics proposed changing the flaps and performing other modifications to give the F-111B a lower angle of attack upon landing. It was a straightforward aerodynamics way to solve the problem, but a swept wing airplane is very complicated, and the costs for making those modifications would be high. Nevertheless, McNamara said, "Yes, go ahead and do it."

Unfortunately, it turned out the Navy had been supporting another new airplane, one proposed by Northrup Corporation. Johnny knew nothing about it even though as DDR&E, he was responsible to ensure that this new airplane would operate safely. When McNamara heard about the Navy's secret dealings with Northrup, he relieved the head of Naval aviation of his position.

Notwithstanding McNamara's wrath, the Navy continued to develop the new plane. It was tested at Patuxent where it lost control during an early test flight, and the plane's test pilot was killed in the accident. Johnny went to the Northrup works to see what happened. The pilot had reported trouble when he lost control, but there was no time to make corrections. Johnny examined a second model of the new airplane and deduced the problem had to do with the aircraft's hydraulic system. He requested the company's engineers inspect and remove the housing in the hydraulic lines and test the system again. It turned out that Johnny's intuition was correct, and they fixed the problem.

Finding out about a developmental program only after it had progressed to a point that it killed a test pilot was disquieting for Johnny. There were lives at stake, he was unaware of the design going into the aircraft, yet he was still responsible for the success of the program. Fortunately, he kept to his ethic learned years before from Lawrence to keep his feet to the ground.

Chapter 9

Life at the Pentagon

After he had first been appointed DDR&E, Johnny was sent to meet President Johnson. When he arrived at the White House, he entered the Oval Office and then went on through a door off to the left into a smaller adjacent office. There he saw Johnson lying on a couch looking through a few papers that turned out to be Johnny's resume. Johnson looked up and said, "Well, I'm reading about you, it looks to me like you're well-qualified for this job." Johnson then went on about how much money was being spent on Defense Department contracts at MIT, Harvard, and at the University of California. Johnson wanted Johnny to do something for him – he wanted to send contracts to Texas. Johnny responded, "I'll see what I can do about that."

Johnny went back to his office and told Brown about his meeting with the President. Brown, who was about to become the Secretary of the Air Force, said, "You should know that one of the people on your staff is Donald McArthur, and he is related to Lady Bird." Johnny thought that wasn't necessarily bad, it could be an asset. Thinking back to his meeting with the President, Johnny sought out McArthur and asked him to run a competition that would involve universities competing for Defense funding. Johnny knew their activities would be scrutinized by Congressional and government inspectors, since competing universities were apt to object to any competition they did not win. So, Johnny asked McArthur to work out the details and to make sure the competition would be fair. A few weeks later McArthur returned with a project called the Corporate Management Information System (CMIS).

With that, Johnny activated CMIS and employed it to select universities that would be receiving government contracts to conduct Defense Department research. He went through the results after the competition, and the University of Texas did win some funding. Why? Because over the last several years the University of Texas had attracted some of the very best scholars from other universities. Nevertheless, there were complaints about project CMIS, and McNamara canceled it. Johnny never really knew why.

* * *

Life at the Foster home on Lake Barcroft settled into a routine as the lake became a focal point for family activities. Neighbors down the road offered to give Johnny a monkey called Major as a household pet; Johnny accepted and Major soon became a regular feature in and out of the home. One day when Johnny was out on a Sunfish, the family's small two-man sailing boat, he put Major on his shoulder. The wind gusted up and the sailboat flipped over, and Johnny was suddenly under water trying to right the boat to get the sail up. That's when he thought, where's the monkey? Major was doing the Australian crawl beside the boat, so Johnny reached out and pulled Major up on the deck of the boat. It was too much adventure for the monkey, who climbed up the mast and screamed at the top of his lungs.

Throughout his career, Johnny and Bobbie worked as a team. Bobbie was the exuberant partner who jumped onto the back of a motorcycle driven by Johnny and traveled across the North American continent to arrive in Berkeley and begin a new life. She was an attentive

mother to Susan, Bruce, Scott, and John, making sure their schoolwork was complete, their chores were done, and that they made it to all their activities on time, all while her husband had to establish himself as a student, a scientist, and then as a high-ranking government official. Up until the Pentagon, her life remained fairly private, but then she was thrust into a position of public prominence. As the Pentagon's arbiter for granting major contracts, Johnny was a frequent guest speaker at receptions sponsored by those corporations that dealt with huge defense contracts; and Bobbie was a frequent guest too.

She also got engaged with her own public functions; she christened a US Navy vessel, a destroyer named the Tripp. The ship had been named after an engineer who was a friend to Alfred Loomis, the great amateur scientist and financier whom Johnny had first met at the Rad Lab in Berkeley. Tripp was being honored as the engineer who had developed the first transoceanic passenger plane, the flying boat.

There were other public affairs that demanded Bobbie's time. You could find her seated at the stands of the Kennedy Space Center to observe the launch of a rocket. There were frequent official receptions at the White House or at a corporate headquarters. Each guest was served a glass of champagne or wine, and a house servant was always waiting nearby with a tray, ready to refill anyone's glass that emptied. Bobbie was not fully equipped to handle this level of attention. Her father suffered from alcoholism, and Bobbie was susceptible to the same disease. She was being interposed between her comfortable world with her family, and a new world of high-society affairs.

* * *

Scott was maturing into a young man; in high school, he kept good grades but his senior year he missed enough classes that the principal told Johnny and Bobbie that he would not be able to graduate from J.E.B. Stuart High School in Virginia. Bobbie met with the principal and made a deal: let Scott take all of the final exams while he sat in the principal's office, and if he received a grade of A in each of his subjects, he would be permitted to graduate. The principal accepted the deal and Scott scored an A in each of his final exams, and he graduated with the rest of his class. Then he went to MIT. It was a time when student demonstrations against the war in Vietnam were running rampant. It may seem ironic, given that Johnny led the Defense Department's acquisition for new weapons, but Scott became a student demonstration leader on campus, once arranging it so that the president of the university couldn't get into his office. Scott was identified as the leading culprit and was disciplined, and he lost a year of his education. When it was time for Scott to graduate, Bobbie and Johnny attended the ceremony. Jerome Wiesner, who was the president of MIT and who had been President Kennedy's Science Advisor, presided over the ceremony, and Johnny knew him well. Johnny and Bobbie had been aware of Scott's political antics at school; as they shook hands with Wiesner he said, "I think we almost lost Scott."

* * *

Johnny's father had spent most of his time in World War I at Fort Monmouth, New Jersey, developing the means to remotely control an airplane – it was the advent of drones. John Sr. was doing revolutionary research that would have serious military consequences in years to come. There must be something in the Foster genes that attracted them to airplanes. It was John Sr.'s knowledge of using radio waves to direct aircraft led him to be invited to the MIT

Radiation Laboratory in World War II, where he applied that knowledge to developing radar technology. That experience also led Johnny to get involved with the military services.

Johnny's love for flying machines stayed with him throughout his life. On weekends, he especially enjoyed flying remote-controlled aircraft at nearby airfields, like Davisson Airfield in Fort Belvoir, Virginia. He was often accompanied by his youngest son John, and sometimes by David Packard, the Deputy Secretary of Defense, who was the co-founder of the Hewlett-Packard computer empire. Johnny and Packard had each purchased a model airplane, and they took Johnny's $100 model and Packard's $400 model out to fly. In a scene reminiscent of his grandfather's wartime research, son John was soon adroitly handling a remote-controlled model airplane.

Johnny sharing his father's fascination with remote-controlled aircraft had some significant consequences for the Defense Department. The Advanced Research Program Agency (ARPA) reported to the DDR&E, and Johnny went over to the ARPA offices to discuss model airplanes. Johnny felt sure that they could be useful. After an afternoon of talks, he persuaded ARPA program managers to start a program to research how inexpensive model airplanes could be used for reconnaissance by troops on the ground; he wanted the cost to be one hundred dollars for a daylight drone and one thousand dollars for a starlight drone. Johnny envisioned a platoon leader launching a model airplane to fly over a hill to get pictures of the other side.

ARPA let out a contract to Lockheed-Martin to develop the idea in a program called Akela. As so often happens, the idea grew and to Johnny's consternation, it seemed as though managers at ARPA had lost control of the program. Lockheed researchers kept adding capabilities to the model airplane until the price of the machine was one million dollars, a thousand times more expensive than the thousand dollars that Johnny had originally thought would be the cost of the model. Eventually Akela was cancelled, but small interest and derivative programs led to modern drones like the Predator.

Chapter 10

Nuclear Deterrence and Arms Control

Like his mentor Ernest Lawrence, Johnny has remained an avid disciple of seeing the country remain strong to deter attacks and to guarantee peace. But once engaged by the government to support efforts to negotiate with potential adversaries a means of mutually limiting nuclear weapons, Johnny threw his entire energy into seeing that the negotiations succeed. The high point of Johnny's involvement with arms control negotiations came when Melvin Laird became Secretary of Defense; the Secretary asked for Johnny's support with the Strategic Arms Limitation Talks (SALT) then being held with the Soviet Union.

Laird had been appointed by Richard Nixon, but before he accepted his nomination from the President, he insisted on three conditions: first, that he have direct access to the President; second, that he would serve for only one term of office; and third, that he would pick his own chief deputies at the Pentagon. Nixon agreed to Laird's terms, and Congress quickly confirmed Laird to lead the Defense Department. Laird was a very competent and energetic administrator. He selected people for his staff not based on their political parties or other affiliations, but by the way that Laird judged their competency. As soon as he became the Secretary of Defense, he asked Johnny to remain in his position as DDR&E.

Laird also chose an outstanding man to be his deputy, David Packard. Packard had been in government since World War II when he served as an administrative assistant to President Roosevelt. In the Truman Administration, he became the Director of Policy Planning for the Department of State, and then he was brought to the Pentagon by President Kennedy to be the Assistant Secretary of Defense for International Security Affairs. Later he became the Secretary of the Navy. Nitze relied heavily on Johnny as he spearheaded the Administration's drive to make SALT succeed.

SALT resulted in the first substantial arms control agreement between the two nuclear super powers, the United States and the Soviet Union. Laird needed help understanding all of the technical issues involved with keeping a nuclear deterrent credible. He wanted to be careful not to negotiate away something to the Soviets that could give the Soviet Union a distinct military advantage, especially in strategic arms. This was a balancing act in which you wanted nuclear arms reduced, but it had to be done in such a way that did not give an opening to your adversary that he could capitalize upon with aggressive military action – something that arms control talks were supposed to eliminate.

Laird prepared a memo that put Johnny in charge of a panel of experts who would evaluate initiatives being offered up in the negotiations. They were also tasked with coming up with their own initiatives to offer to the Soviets. Johnny, the former nuclear weapons designer, was well positioned to evaluate all aspects of the country's nuclear defenses – the backbone of the nation's defense.

During McNamara's tenure, in January 1972, the Defense Secretary asked Johnny to chair a program that looked into the whole nuclear targeting process. With his typical thoroughness, Johnny established a committee consisting of representatives from his staff, the office of Systems Analysis, and the Department of State. They studied and researched how the country formulated its strategic defenses so that they would deter any aggression directed against our society. The committee produced a report based on his findings that was important enough for

Congress to pass legislation that would require a similar report on the state of readiness of our nuclear deterrent every year.

The legislation also created a panel known as the Nuclear Weapons Council (NWC), which had the responsibility of overseeing the making of the report. The NWC initiated an annual review of US policy for plotting nuclear targets and so on, and Johnny did a superb job of managing the council's activities.

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Johnny's performance at the Pentagon was good enough to be noticed by many of the professionals who worked there. General Bob Pursley, the decorated veteran pilot from the Korean War was also the military chief of staff to three successive Secretaries of Defense – McNamara, Clifford, and Laird. Pursley had this to say about Johnny:

> In any event, I really tip my hat to Johnny because he was exposed to technical challenges and all sorts of things. They were bumps in the road that would have derailed a lot of people, but they didn't with Johnny. So, the scope of his work I would argue was wider than just the technical, and not just in negotiating and stuff like arms control. It was in evaluating the economic impacts, particularly in the Vietnam War, where it hit the political side of things. And the social atmosphere of the 1960s was explosive in and of itself, and the fact that Johnny could keep a team together and get them to work was outstanding. Johnny bumped into what you'd expect but what many people forget, the competition among the services, and using the technical roles and missions, Johnny flew through that like a flying virtuoso.
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> Laird had such great trust in Johnny. He would not have turned over to many people the responsibilities that he handed over to Johnny.

When Johnny had left the Pentagon in April 1973, Secretary Laird arranged for him to become a member of the President's Foreign Intelligence Analysis Board (PFIAB). The board had been created at the end of President Eisenhower's administration to address intelligence analysis failures in predicting the speed with which the Soviet Union had grown its nuclear arsenal. Presidential concerns were aggravated after the launch of Sputnik. There followed rumors of a "missile gap" that claimed the Soviet Union was about to overwhelm the United States with missiles capable of launching nuclear warheads at the United States. President Kennedy continued to appoint a PFIAB after the Cuban Bay of Pigs debacle. Kennedy wanted an independent review of the National Intelligence Estimate (NIE) issued by the CIA. It is an annual report that advises the President about threats to national security.

By 1975, there was a growing concern among influential American intellectuals that the NIE issued by the CIA was being compromised by political pressure from Congress. They felt the NIE was downplaying the growth of Soviet nuclear weapons in order to be more compatible with a desire for a world in which the United States and the Soviet Union shared the same values of détente. Consequently, the NIE reflected the political judgement of many in Congress that the Soviet Union's recent deployment of advanced nuclear warhead missile systems, as well as missile defense systems being deployed around Moscow, did not pose a threat to the country. The members of the PFIAB disagreed.

When the Director of the CIA, Jim Schlesinger, appeared before the Board, Johnny asked him if he would agree for a CIA team and an outside team to both be given the same relevant intelligence information. It would allow the Administration to compare both teams' reports to address five key national technological/military issues; Director Schlesinger declined. A couple years later Johnny put the same question to the next director, Jim Colby, and he

received the same answer. The next director of the CIA was George W. Bush, and when Johnny put the same question to him, he responded “that seems like an interesting idea.”

Two teams were formed, a Team A from the CIA and a Team B composed of knowledgeable experts who were not members of the CIA. Team B was led by Richard Pipes, who was then the director of Harvard's Russian Research Center. When the teams had completed their work, it became obvious how much they complemented benefited each other and the government as they briefed the PFIAB. The PFIAB voted unanimously in favor of the Team B report, which differed significantly from the CIA’s NIE. As might be expected, the CIA did not agree with Team B’s assessments.

Shortly thereafter President Ford retired and President Carter, on learning of the recommendations of the PFIAB, cancelled the Board. Johnny thought to himself, “In retrospect, I should have arranged for Team B to report to the Secretary of Defense Rumsfeld.” In what was becoming a far from rare occurrence for Johnny, he made contributions to national defense through his ability to understand technical issues and intercede to promote those issues he felt would keep America safe. Four years after Carter cancelled the board, President Reagan reconstituted the PFIAB, and Johnny was able to use his position on the committee to acquaint the President to a novel weapon being proposed for his Strategic Defense Initiative. He introduced Edward Teller and Lowell Wood and they briefed him on Brilliant Pebbles.

Chapter 11

The Corporate Life and Retirement

Johnny had been the DDR&E for three successive Secretaries of Defense, which is something of a record. It is such a sensitive job, handling decisions on how to spend billions of dollars, that it inevitably places the director into many controversial situations and potentially can make enemies. But although he earned the ire of executives from many Defense Department contracting corporations, Johnny held onto a reputation for acting fairly, and high government officials had to respect him for that, and so he stayed in his position throughout their tenures.

This does not mean that Johnny was not being continually sought to join corporations that had large stakes in the Defense budget. David Packard, the former Deputy Secretary of Defense, offered Johnny an opportunity to lead the National Aeronautics and Space Administration (NASA) when it was becoming clear that Johnny would be looking to leave the Pentagon. Johnny felt that aeronautics and space were not his areas of expertise, and so he turned down the invitation. Packard then followed with an offer of a position in his corporation; Johnny was grateful for that kind of an opportunity, but his whole adult life had been dedicated to national security and he loved his chosen vocation. Packard's company was breaking ground into pioneering electronics and computers and that too, was not a field that Johnny had any deep interests in.

That set Johnny to shopping around; he went to Boeing where he had interacted with Boeing executives numerous times, and he even had engineers from Boeing on his staff. His son John liked the idea of going to Boeing because there was a flying field for model airplanes. Johnny arranged a meeting with the president of Boeing, but after visiting around company headquarters, he began to see some of the intrigue and internal politics going on among the top members of the organization. He really didn't like that.

There followed approaches from other corporations, like Raytheon. Then he got a request from TRW to come and work on their energy program. He was smitten by the attention he was getting, and he liked the idea of working at TRW because it was about energy, and because the President had a war on energy at the time. He was going to do something about it and Johnny knew from experience that TRW was good at getting the money and brains needed to complete their projects. So, it seemed like a good fit and he was appointed the Officer for Science and Technology. He was given an executive office and a very talented administrator, June Halstead, was assigned to support him. June would stay as Johnny's administrator throughout his career with TRW, and she continued to aid him even in retirement.

When Johnny had arrived at TRW for an interview, he met with Simon Ramo, the man who had created the corporation, and the man who helped spark the creation of systems analysis. Ramo wanted Johnny to work on an idea to build a car that was much more efficient by using a small engine and battery power. When a driver stepped on the brake, the car would slow down by drawing the energy from the moving car and using it to charge the battery. TRW had produced a model car and they had approached the automobile manufacturers to market it. But the car industry of the time was not attracted to the idea because in its view, the market wasn't ready for it yet.

Nevertheless, there were other areas that TRW was investing is that got Johnny's attention;

the principal one being how to create new forms of fuel. The country was going through a period known as the OPEC Crisis, in which oil-rich countries, mostly in the Middle East, withheld oil shipments to Western nations. The supply of gasoline ran low and gas stations around the country experienced long lines of cars waiting to pump gas into their cars. Johnny agreed to help TRW build a strategy that would allow it to alleviate the energy issues of the country.

In April 1973, Johnny, Bobbie, and their youngest son John, moved from Virginia to Via Segovia Drive in Palos Verdes, California. The rest of the family stayed in the East, mostly to finish college. Their son Bruce got a job working on a Congressional staff, but later, he left his position and visited the family in California with his fiancée, and he stayed at the family home. After a while Johnny said to him, "You've got to get a job. When are you going to get a job?" Johnny asked a member of the energy council, who was from Southern Cal Edison, "My son needs a job, but he doesn't have a doctorate or anything, could you make any use of him?" The energy company executive said, "Sure, I'll take him," and Bruce went to work for him. Within a few weeks Bruce was employing some views he had about energy that he had gotten from his experience in Congress. He presented his investment ideas around the departments of Southern Cal Edison, and some of the ideas were deemed to have merit. When he retired from Edison he was a senior vice president. Bruce always kidded Johnny that he would retire first, and he did. He settled in the Florida Keys.

Sometimes a technology arises that benefits by using a particular isotope of an element; the problem was that separating isotopes in an element was historically an expensive operation. Johnny took advantage of his experiences with cyclotrons at Berkeley to see if TRW could develop a cheaper way to separate isotopes. His idea worked and it turned out to be a profitable business. The company sold isotopes that had commercial value, like those used for radiative therapy. Other exploits followed, like extruding oil from shale or sand. Johnny's history with the Defense Department came in handy as he made arguments to Defense officials that the oil extrusion could benefit the country by helping it to maintain a strategic oil reserve. In the end however, TRW didn't get a contract and the company's oil extrusion initiative was shut down.

The years of corporate social life was taking its toll on Bobbie. It began with the mandatory parties sponsored by corporations with Defense contracts that she attended while Johnny was the DDR&E. He had been a key Pentagon official for many years, and there were a multitude of parties, with ample opportunities to dine with wine. Bobbie had a final reckoning with her illness that made her susceptible to alcohol abuse.

Johnny got the call at work and he raced home. When he arrived, he found that Bobbie had collapsed on the road in front of their Palos Verdes home and he took her inside. On the way to the hospital, she fell into a coma that lasted for several months, until she died, and Johnny lost his lifelong partner and there followed several months of grieving. After a time, Johnny reconciled himself to his loss; he felt a need for companionship and started seeing an administrator named Francis Jean Schnell; everyone knew her as Franny. They married in 1978 with everyone from the family present.

Johnny moved to Cleveland, Ohio, where he got involved with an initiative to bring quality back into American manufacturing plants. The Japanese had come up with a process to produce cars that were a higher quality than American cars. So how did they do this? Johnny studied their practices, and TRW got into a joint operation with Japan. To help him with the initiative, Johnny hired an efficiency expert named Philip B. Crosby, a well-respected expert

in the field who had initiated the Zero Defects program at the Martin Company and had been the quality control manager of the Pershing missile program. He was the author of the business book, *Quality Is Free*.

Resentment grew within the complex of TRW plants over Johnny and his program. The pressure grew until the company president decided that he would take personal control over the quality program. So, Johnny went back to corporate headquarters on the west coast and thought about his next move. The company president was concerned over losing business to Lockheed and others. He blamed several managers in the company for the company's ills, and he began to sack them. Johnny defended the managers, but it was becoming clear to him that his value to the company was declining.

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Johnny's life in the corporate world came to an end, and he began to once again devote himself to the country's national security. His reputation, gained from years of devoted service to the government, was too great for him to, as General McArthur phrased it, "simply fade away." He was soon nominated to serve on a number of advisory committees, and he returned to overseeing intelligence affairs in the PFIAB. He was the man who had led a team to design the modern American stockpile of nuclear weapons; there were few others in the country who could match his accomplishments. It was Johnny who had laid out the Defense Department's basic premises about what capabilities needed to be protected in arms control negotiations.

It was natural then that he was asked to join a group that provided Congress with sage advice on how to best manage the nuclear force that gave the country the core of its national deterrence: The President's Nuclear Posture Review Committee. Johnny is an esteemed icon of defense strategy as he continues to be asked for his perspective on national affairs by a government badly in need of his talents. He now resides in California, and June Halstead still provides him with the administrative aid needed to participate in a spate of government committees.

Meanwhile, the Laboratory back in Livermore remains close to his heart. It's a reciprocal relationship, for Johnny is still treated as an icon there by the professionals who continue to service the nation with defense research. After all, it was during those trying years in the 1950s, when the United States entered the Cold War and had to face an emerging threat from world communism, that Johnny may have given the country his greatest gift: his ability to lead the way for the country to defend itself. For that we will always be in his debt.

In September 2015, the Laboratory created the John S. Foster, Jr. Medal to commemorate the exceptional and inspirational career of Dr. John S. Foster, Jr. The medal is bestowed annually by the Laboratory director to an individual who has demonstrated exceptional leadership in science, technology, and engineering or policy formulation in support of U.S. nuclear security. The medal is a fitting tribute to a man who is bigger than life, a man who has devoted most of his life to the defense of the country he loves.

[1] David Hackett Fischer, Albion's Seed, Oxford University Press, 1989, pp. 20-27.
[2] "John Stuart Foster, 1890-1964", Biographical Memoirs of Fellows of the Royal Society, 1966, Volume 12, pp. 146-161.
[3] National Security Memorandum No. 160, The White House, June 6, 1962.
[4] Jack Raymond, "US to Install Locks on Atom Weapons as Extra Safeguard," *New York Times*, July 6, 1962, p.1.
[5] Tom Wicker, "President on Coast Tour; Watches Atlas Launching," *New York Times*, March 24, 1962, p. 1.