Chapter 10

The Fork in the Road

Autonetics 1955 –1959

After his decade of accomplishment (1944–1954), Walt had firmly secured his place in the history of control theory. The publication of his textbook coincided with those of many other books of the time, all of which dedicated extensive sections to the root-locus method of design. On the home front, two significant events made 1954 a milestone year in his life.

Randy, Gary, Nancy, and Greg at 9728 El Venado Drive (c. 1954)

First, in March, Arline gave birth to their fourth and last child, a son, Gary. Then, in August, the family moved from their modest two-bedroom home on a tenth of an acre, on Maple Street in uptown Whittier, to a custom-designed five-bedroom home on a half-acre in East Whittier, California.

In 1954, the *Brown v. Board of Education* Supreme Court decision began dismantling racial segregation in schools, signaling the rise of the Civil Rights Movement. Television shaped American households with wholesome family shows like *Father Knows Best* and *Lassie*, while *The Adventures of Ozzie and Harriet* portrayed idealized suburban life. Color TV technology was advancing, setting the stage for new entertainment experiences, and Walt Disney broke ground for Disneyland, symbolizing postwar optimism. This combination of social shifts and cultural milestones marked 1954 as a transformative year in modern history.

The year 1954 marks a personal transition as well. I turned seven in 1954. Up to this point, I have no firsthand memories of the events described in this book. That changed in 1954. Thus, it is now appropriate for me to continue this narrative in first person, rather than third.

Walt at Work: Attracting Engineering Talent

As far as I know, Dad never recruited directly for North American Aviation. He did not have to. His reputation made him an asset in attracting talented engineers. Sam Carlson even made working for Walt a condition of accepting North American's offer. Carlson later led divisions at Autonetics, Ford Aeronutronic, and Rockwell Microelectronics—an exceptional career that gives particular weight to his high regard for Walt. In 1999 he wrote:

> *Walt Evans was the reason I went to work at North American after graduate work at Purdue University. I had learned of Walt's work in servomechanisms and had read his published papers. When Ray Hamada was recruiting for North American Aviation at Purdue shortly before I completed my graduate studies, I told him I would like to work at North American if I could work with Walt Evans.*

I reported to work in September 1952, in Walt's group. After about six or eight months, Walt Evans launched me on my management career by appointing me supervisor of the Instrumentation Unit.

He was a great person to work for. I have never known anyone more brilliant or of higher personal integrity than Walt Evans.

All of us who worked with him learned so much: pride in technical excellence, respect for absolute integrity, and satisfaction in accomplishing extremely challenging goals through dedicated individual and team efforts. I am thankful for those lessons. They were important to me throughout my career and are still today.

Walt at Work: Exuberant

Walt and Arline, Fred and Mona Eyestone, John and Miriam Moore, and Jesse and Dorothy Bowman were pictured at a company-sponsored dinner. Walt could be quite animated at such events. One of Walt's direct reports was George Anderson. He and his wife hosted an annual Christmas party at their Whittier home. A spouse of one of Walt's colleagues took Mom aside as the evening wore on and said to her, "Don't you think Walt has had enough to drink, dear?" Neither he nor Mom drank, and he had not had a drop of alcohol. He was simply exuberant.

Aerophysics Lab Management Party (c. 1950)

Walt at Work: High-Spirited

Walt's exuberance was not confined to Christmas parties. Working with Walt, as it turns out, was not always what you might expect, as these anecdotes contributed by George Klees and Bob Cannon reveal.

> *Engineers and supervisors worked at desks in a large open area. Group leaders had offices enclosed by partitions only about six feet high. Walt Evans had a unique, zany sense of humor. Walt liked to stir things up once in a while to make sure the engineers were awake. On one occasion he came out of his office and started walking across the tops of the engineers' desks, spouting Shakespeare or some such thing. That certainly woke up any would-be sleepers.*
>
> *Another time he was walking toward his office with someone when he said, loud enough for most of the room to hear, "I think I will take a short cut to my office." He stepped onto a desk and climbed over the wall when all he had to do was walk around the corner and open the door.*

Bob Cannon recalled a similar occasion when Walt's high spirits took over.

> *Walt always loved a technical argument and he loved to win. I can still hear him as he points to a genius pad totally covered with scratches, saying, 'There's no chance for any error here!'*
>
> *The center of discussion in our office would be a huge pad of blank paper called a genius pad in the center of the table, which was between our desks, and there was also a chair in the doorway for guests. One day, Walt and a guest were going at it hot and heavy, both talking at once, both furiously writing equations on the genius pad. Suddenly, Walt reached over and broke the other guy's pencil.*
>
> *And then he said, 'Now! As I was saying.'*
>
> *On another occasion, when a good argument was going on in the next office, I saw Walt fidgeting. He listened and he stood it as long as he could. Finally, he climbed up on his desk, went over the partition, and joined the argument.*

Walt at Work: Mentally Agile

Walt leapt not only over physical barriers such as partition walls; his mind also leapt to the answers to technical problems. Chief engineer Jeff Schmidt and co-worker George Klees shared their thoughts in emails:

> *Walt was a walking engineer's handbook. You could ask him anything from heat transfer to hydraulics. He would pull a few fundamental constants from memory, apply a few conversion factors, do some math in his head while telling you what he was doing, and come up with an answer. (Jeff Schmidt)*

> *We were testing an inertial guidance system. Fuel to the turbine was controlled by a valve with a hydraulically driven piston-and-spring* assembly. *Small changes would cause instability which had to be corrected. Walt thought the valve might be the cause, so it was disassembled. He picked up the piston, hefted it in his hand, and estimated its weight. He compressed the spring between his fingers and estimated its spring rate. Then he slid the piston back and forth in the valve and estimated its friction. He looked up at the ceiling for a bit and stated the combination's natural frequency and damping rate. I took the parts into the lab, carefully weighed the piston, measured the spring rate and piston friction, and calculated the values. To my amazement, the numbers were within 5 percent of Walt's. (George Klees.)*

Walt at Work: A Caring Manager

Hal Engebretson admired Walt as a manager.

> *I came to work at NAA in 1954. My group leader was Walt Evans. There is certainly no question that Walt was an outstanding technical talent. I also respect him as an outstanding manager of people. When I started to work, it became obvious that if you worked in Walt's group, he supported you. The message was that one did not have to worry about trying to do a good job—if you did your best, Walt would support you. That attitude resulted in some very good people developing to do very good work.*

George Klees recalled another occasion when Walt's concern for his colleagues became apparent.

> *A few of us were running tests in the loft of Building One in Downey, right under the sawtooth metal roof, without a hint of insulation. It was a particularly hot day; the temperature seemed as though it must have been at least 130 degrees.*
>
> *Walt came up to see how the tests were going and was appalled. He immediately called the fire department to have someone hose down the roof. I guess they did not want to do it, and an argument ensued. I don't know what Walt threatened them with, but he won: within 15 minutes a fireman was hosing down the roof. Soon the temperature was much more reasonable, thanks to Walt.*

Finally, George shared this account of how he got his job at North American Aviation after an initial dismissal by another group leader.

> Walt *was not hung up on how many degrees you had and gave people a chance to prove themselves. Between my junior and senior years at UCLA, I took a summer drafting job at North American Aviation in El Segundo. My GI Bill had run out, I had started a family, and I had lost my part-time machinist job. I bought an RCA tube manual, built a Heath kit vacuum-tube voltmeter, and put together a power supply copied from one of the designs I had worked on. I experimented with different tubes until I thought I understood enough to do basic circuit design.*
>
> *I asked a development group leader whether I could transfer into one of his units. "What the heck makes you think you could contribute anything to my organization?" I then met with Walt. He seemed interested that I had been studying circuit development at home. He called in the supervisor of the Power Supply Unit, and after a discussion I had a job as a circuit development engineer in that unit. This set my career in the direction I had hoped for, where it continued for the next 30 years. I have always been thankful to Walt for the opportunity.*

John R. Moore, Engineering Executive Extraordinaire

In the late 1950s, I remember asking Dad what he did at work. I also remember his response: "I am one of 100 engineers trying to keep Johnny Moore an honest man." It was the first, but hardly the last time, I heard Moore's name. He seemed to me god-like, and, in a way, he was.

In those heady days of the 1950s, beyond being a consummate engineer and recruiter, Johnny Moore was also the best marketing executive at North American Aviation. His frequent trips to Washington, supported by outstanding technical work in California, led to rapid growth of the Aerophysics Lab. Moore counted on his engineers in California to deliver on the bold promises he made in Washington—especially those associated with the Navaho program and the Polaris submarine fleet.

Within a remarkable ten years, he and his engineers accomplished several technological firsts.[31] The X-10 test drone became the first turbojet-powered vehicle to exceed Mach 2 and the first aircraft to fly a complete mission under inertial (computer) guidance. Later, the G-26 ramjet-powered vehicle became the first jet aircraft to reach Mach 3 and an altitude of 77,000 feet.

The accomplishments of the Aerophysics Lab laid the groundwork for dramatic growth in inertial guidance technology. This technology evolved through multiple generations, from XN-1 to XN-6. The XN-1 was the first inertial guidance system to be tested in an airplane. (See Chapter 6.)

> *The guidance and control computer for the Navaho was completely digital, with a rotating disc, nonvolatile memory. It made its first flight in 1955 as the first transistorized digital computer with a rotating disc memory ever flown.* [31]

The Navaho program is one of the least-known, yet most important early missile programs in the United States. The project achieved advancements in every discipline of engineering and electronics. It introduced the airborne digital computer, modular electronic circuitry, and the first fully inertial navigation system. James Gibson wrote an excellent reference. [30]

Autonetics

In 1955, North American Aviation restructured its MACE (Missile and Control Equipment) division, which focused on guided missile systems and control equipment. The name was a contraction of *Autonavigator* and *Cybernetics*. This restructuring led to the creation of Autonetics, a division specializing in avionics, guidance, and control systems. As general manager, John Moore then led a division of more than 7,000 people.

In September 1957, Walt received a bonus check from his boss, Fred Eyestone. Afterward, he sent Fred a three-page, typewritten letter. It contained a confession, tactfully worded pushback to management's goals, and several constructive suggestions. Walt liked Fred. He and Arline played bridge with Fred and Mona Eyestone. A reading of this letter is as good a way as I know to understand how Walt approached his work.

Fred Eyestone awarded Walt a bonus in 1957

Dear Fred, *September 30, 1957*

Receiving today's bonus check reminded me how much our work has contributed to the company's success. It also prompted me to reflect on the challenges we've faced—especially in reducing costs while maintaining high engineering standards. Discussions at work are often too rushed to go into detail, so I'm taking this opportunity to outline my thoughts….Some policies—like component detail specifications—were meant to improve planning but have become bureaucratic obstacles instead. We need better coordination between design and production…I believe we often see different sides of the same problem, which is why I wanted to clarify my perspective. Our work has proven that sound engineering, rather than shortcuts, leads to real cost savings and technical success. I hope this letter helps move us toward better solutions.

Sincerely, Walt Evans

USS *Nautilus*—90° North: August 3, 1958

Autonetics continued to expand, securing ambitious contracts for equipping the Navy's Polaris submarine fleet and the Air Force's Minuteman missile silos. In 1958, the XN-6 navigator, originally developed for the Navaho, would guide the Navy's first nuclear submarine, the USS *Nautilus*, to the North Pole.

When I interviewed John Moore in 2003, he said he was proud of his, and the company's, foresight to design the XN-6 inertial navigation system so that it would fit through the U.S. Navy's standard submarine hatch. In "Legacies Left by Former North American Aviation Experts and Executives," he wrote:

> *In the early 1950s, our gyro engineers came up with a paired, reversing gyro design which automatically canceled almost all of the error torques dependent upon the gyro angular momentum vector. This six-gyro stable platform, in which three gyros performed the h function while the other three were reversing their angular momentum vectors, provided a concept which seemed to meet the Navaho accuracy requirements without depending upon a star tracker called 'NAVAN' [North American Vehicle Auto Navigator].*
>
> *Tom Curtis was the project engineer on the NAVAN, which was selected as the guidance system for the Navaho missile. This concept had so much promise that we recognized its potential application as an inertial navigator for submarines. Accordingly, we established as one design criterion that the stabilized platform and associated guidance electronics had to be small enough to pass through a submarine hatch.* [19]

Tom Curtis aboard Nautilus Submarine

An Engineering Experience of a Lifetime

For the young engineers, the development of six inertial navigators, culminating in the XN-6 guiding USS *Nautilus* to the North Pole, would prove to be among the most rewarding years of their careers. Nothing that came afterward could hold a candle to their pride in belonging to the team that achieved remarkable technological advances from 1948 to 1958. Such would be the case in the decade that followed for engineers who launched their careers in response to John F. Kennedy's statement: "I believe that this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the moon and returning him safely to earth." For engineers at NAA, the North Pole was a goal not unlike the moon.

The Glory Days

In 1987, Bob Cannon—whose illustrious career after 1958 included service as chief scientist of the Air Force and as chair of Caltech's Division of Engineering and Applied Science and Stanford's Department of Aeronautics and Astronautics—remembered working for Walt Evans during the "glory days."

> *[In] no period in my life did I learn real engineering more rapidly, or more deeply, or with more enjoyment. It was in those days that Walt led the development of the inertial platforms for the [XN-1 to -6] guidance systems. Evans saw the new problems coming and his agile mind made giant leaps over details to the key to the good answer.* [3]

Chief Engineer Jeff Schmidt expressed what many undoubtedly thought:

> *Many of us can claim a minor role in winning the Cold War but Walt took the black art out of servo analysis. He made it into an understandable procedure for college students worldwide. To top things off he had a great sense of humor.*

Technological Successes Changed the Corporate Culture

The Aerophysics Lab's entrepreneurial culture, which encouraged individual accomplishments, gradually gave way to a more bureaucratic culture. John Moore admitted in his memoir that mistakes were made:

> *Autonetics had gone from a nadir of 5,400 people at the beginning of 1958 to a requirement for rapid growth. It soon became clear that for the buildup these new programs required, the original Autonetics organization structure was totally inadequate. Accordingly, in 1959, Autonetics was reorganized along product lines. However, I made the mistake of effecting this organization without first changing the existing organization's operating policies, procedures, specified authorities, and responsibilities to relate to the new organization…the division escaped meltdown only because of the dedication, skills, and stamina of its key people.* [19]

One consequence was a loss of talent. Some engineers went to other companies, and others struck out on their own, most notably Henry Singleton who founded Teledyne, becoming a multimillionaire.

The Fork in the Road

The rapid growth of Autonetics was a mixed blessing for Walt. In January 1959, he applied for a promotion to become assistant section chief. Despite Fred Eyestone's support, he did not get the job. He found himself at the fork in the road. In college Walt had followed Roy Glasgow's advice: "*to prove myself as an engineer first and worry about the vice-presidency later*." His father's "vice president" title at Wagner Electric may, in the back of his mind, have been a standard against which he compared himself. It is a force field for a son. I have felt its power. After a second setback, he decided to escape the force field. At the age of 39, halfway through his career, he decided to look for a work environment in which he would be allowed to do technical work full-time. Full stop.

Too many colleagues admired him as a manager for him to achieve that goal at North American. He would have to look elsewhere. He reached out to Bob Cannon, now a professor at Stanford, to advise him on options in the Bay Area. Cannon responded with four possibilities: Lawrence Livermore Labs, Stanford Research Institute (SRI), Lockheed Missiles and Space Division in Sunnyvale, and Stanford. Walt and Arline flew to Palo Alto on July 22. Meanwhile, Walt explored his options near Whittier.

Ultimately, he chose a company he believed would offer interesting technical problems, a first-class engineering staff, and a location within commuting distance. He chose Ford Aeronutronic in Newport Beach, CA.

Walt's Last Week at Autonetics: In His Own Words

In his last week at Autonetics, Walt wrote several letters, including the following one to Bob Moore that reveals one thing on his mind.

To: R. E. Moore *August 1959*

The attached memo reminds me of some thoughts which might be well expressed at this time. Several people, on returning from trips, have been surprised at how frequently my name is known at universities. It is due almost completely to the popularity of servo as a subject and the novelty of root locus as a method.

I am always leery of anyone who is too enthusiastic about the method because it suggests that they are not aware of the whole problem. They might also be subject to being 'fad happy' without really thinking about the problems themselves and the many possible solutions. Some clues on the adoption of root locus can be gained from the growth of Spirule sales to the present figure of about five thousand Spirules per year. My present problem is that bookstores receive them at $2.10 and mark them up, typically to $3.50, and in one case to $3.95. Arline and I use the approach of notifying the bookstore of our direct sale figure of $3 and likewise notifying the professor involved. We guarantee the bookstore the return privilege in case they are caught with an overstock.

Profit to myself runs about $1,000 to $2,000 and my main interest is to provide a useful gadget rather than make a killing. The prospect of students being forced to buy something they don't want at prices they figure are too high worries me. So, if you pick up any information along this line, I would be glad to hear it.

Walt Evans

Two Leaders at North American Aviation During the 1950s

No single individual had a more profound influence on the career of Walt Evans than John R. Moore. The men met at Washington University in St. Louis in 1937 upon Moore's graduation and Dad's matriculation. Dad followed Moore to Schenectady in 1941, to Washington University in 1946, and to North American Aviation in 1948. Washington University's McKelvey School of Engineering awarded John R. Moore and Walter R. Evans its Engineering Alumni Achievement Awards in 1988 and 1990.

John Moore on Walt Evans:

> *Walt was one of my best friends, and I brought him from GE to Washington University and from Washington University to North American Aviation. One of Walt's major characteristics was his sense of humor.*

Walt Evans on John Moore:

> *John Moore was the key driving force behind the North American Aviation team which developed and manufactured inertial guidance equipment from 1948 through his presidency of the Autonetics Division in the 1960s. This guidance equipment, used in the Minuteman and Polaris Missiles, achieves an accuracy of a fraction of a mile based upon acceleration measurement and computing alone. John's leadership covered recruiting, error analysis, sales as well as management. He was selected executive vice-president of North American Aviation just before the Rockwell merger, which led to Rockwell's taking over the management of the company, … John is now a vice-president of McDonnell Douglas. However, the team which he formed still dominates the Electronics Group of Rockwell International.*

In short, John Moore was the consummate engineering executive and Walt Evans was among his brilliant engineers. Their contributions to the development and deployment of strategic weapons delivery systems helped the United States defeat the Soviet Union in the Cold War.