Dedicated to the memory of Robert C. Crawford, beloved husband, lifelong teacher, constant mentor, lover of life. Photo courtesy of Natalie Crawford.
Foreword

Natalie W. Crawford embodies the values, virtues, and effectiveness of RAND research. In the studies she authored in the ten years that she led RAND Project AIR FORCE and in her role over the decades as member and then co-chair of the Air Force Scientific Advisory Board (SAB), Natalie has set an unsurpassed standard of objectivity and impact.

Beyond this 50-plus-year record of programmatic accomplishment, Natalie’s mentorship of researchers at RAND, in industry, and in the Air Force is equally notable. One example among many: Thirty years ago, there were few XX chromosome sets among senior RAND people. That it is so different now owes a great deal to Natalie and a few others. Her talent for institution-building—whether team building within RAND; in science, technology, engineering, and mathematics (STEM) programs; or the Air Force SAB—has left an admirable legacy.

RAND has grown a great deal in size and diversity of program and staff, international footprint, and public visibility since I first encountered it 65 years ago. And there are now many more organizations that profess to provide analytic examination of issues of public policy. But if RAND can continue to produce and persuade as Natalie has done, its future is bright.

Harold Brown
Secretary of Defense, 1977–1981
Natalie W. Crawford’s career at the RAND Corporation spans some five decades, during which she has advanced from new analyst to the director of RAND Project AIR FORCE to RAND Senior Fellow. What follows are the observations of those she has touched along the way, and there are many. More than 60 people from RAND, industry, academia, and family participated in interviews, so Every Day Is a School Day is predominately an oral history.

The idea for this project belongs to RAND’s Bill Welser, who learned that I had conducted two oral history interviews with Natalie in 2011 in my previous position as the director of Air Force history. I had planned one more interview with Natalie, but I retired before we could arrange it. Bill contacted me and asked if I would finish the interview as a RAND project. I immediately agreed, but there has been some mission creep as we realized that there is much to learn from her life and career, and having an interview on file in the deep recesses of the Internet is probably not the best way to communicate her story.

I have known Natalie for more than 40 years as a colleague and friend, and I freely admit on the first page of this work that I view her through an affectionate prism. I am not alone; like others, I maintain a deep respect for Natalie’s fierce objectivity and selfless motivations. As she once told a colleague, “It’s not the applause; it’s the work that counts.”

Natalie’s girlhood years of working on the family farm and always having jobs in town developed an ironclad work ethic that can be characterized best by one phrase—unassailable integrity with an unshakable thirst for excellence. During her early years at RAND, she deep-
ened and honed her technical competency, especially in the area of fighter tactics and weapons. By most accounts, Natalie was an exceptionally quick learner who sought new ways to analyze data and often taught herself important skills. Ultimately, she matured into leadership roles at RAND, so she broadened her experiences into most of the Air Force missions. She never waited for the experience to come to her; she went after it.

Throughout these pages, readers will see that Natalie is tough, tenacious, analytical, and especially persistent, sometimes nearly to a fault. Yet, whenever an interviewee describes her demanding side, there is always a softening comment to follow concerning her motivations. It is clear that personal ambition has never made Natalie tick; she always wants the best product for RAND and the Air Force and the nation. Even those with whom she has butted heads—and there have been some over the decades—quickly point out that, after the smoke clears, each still holds her in high regard because her motivation is for the nation, and RAND Project AIR FORCE is a vital tool that contributes to national strength. A couple of interviewees remarked that her blood runs Air Force blue. It is an affectionate metaphor as far as it goes, because, at her core, she is a patriot deeply committed to national security.

Of Natalie’s many talents, perhaps the most striking is her ability to maintain relationships over decades. The list of senior officials at RAND, in the Air Force, the U.S. Defense Department, industry, and academia who cite long and productive associations with Natalie is impressive. One interviewee commented that Natalie’s “Rolodex is infinite.” In many cases, she has maintained both a professional and a personal association, but it is clear that she is ever mindful of a demarcation between her work as an analyst and her role as a friend. She can be brutally direct without offending those with whom she has deep personal ties. U.S. Air Force Gen Richard B. Myers, a former chairman of the Joint Chiefs of Staff, met Natalie when he was a young instructor pilot in the Fighter Weapons School at Nellis Air Force Base in Nevada. Their personal and professional relationship became deep over the span of three decades as she presented RAND work to him but also came to know his family very well. Myers, who counts her as a friend,
said of Natalie’s professional objectivity: “She could tell you your baby was ugly, and you’d say thank you.”

Natalie is more than an objective thinker and patriot; she is a researcher, leader, honest broker, problem-solver, team builder, friend, and volunteer. She believes every day is a school day that presents opportunities to learn and teach. What follows in these chapters is our attempt to show how she has played all those roles with great success, and how she passed on that knowledge to others. The goal for this study is for the reader, after finishing it, to put it down and think, “Yes, today was a school day.”

C. R. Anderegg, Springfield, Virginia
July 2, 2017

RAND Project AIR FORCE

RAND Project AIR FORCE (PAF), a division of the RAND Corporation, is the U.S. Air Force’s federally funded research and development center for studies and analyses. PAF provides the Air Force with independent analyses of policy alternatives affecting the development, employment, combat readiness, and support of current and future air, space, and cyber forces. Research is conducted in four programs: Force Modernization and Employment; Manpower, Personnel, and Training; Resource Management; and Strategy and Doctrine. The work presented here was prepared under contract FA7014-16-D-1000.

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Early Years

Childhood in Boonville, Indiana

Boonville, population 6,200, is in the southwest corner of Indiana, ten miles north of the Kentucky border and 17 miles southwest of President Abraham Lincoln’s boyhood home. The seat of Warrick County, Boonville’s population, as in many American small towns, has been in a slight decline over the past three decades. Nonetheless, it boasts recreational lakes, solid schools, a desire to host new industry, and a rich heritage. Boonville is named for a somewhat distant cousin of Daniel Boone, Ratliff Boon, who served five terms in Congress in the 19th century, and whom President Andrew Jackson touted as “the faithful among the faithless.”

Among Boonville’s monuments are two that say much about small Midwestern towns in general and of Boonville in particular. Of course, one monument honors Lincoln and tells not of his political successes but of his frequent visits to Boonville as a young man to borrow books and study law. The other monument is a tribute to John Hemenway, “who through hard work, practical genius, and American opportunity, rose to positions of high honor and responsibility in both houses of Congress” (City of Boonville, undated). Such were the ideals of the 19th century and the mid-20th century, when Natalie Wilson was born in Evansville, a short distance from Boonville.

Natalie is the first of two daughters born to John and Dorothea Huthsteiner Wilson, followed two years later by her sister, Sandra. The
family shared a home with Natalie’s paternal grandmother during the sisters’ grade school years, and the school was a short walk away, with an equally short walk to their maternal grandmother’s home. The grandmothers, both widowed early in life, were dominant forces in Natalie’s development, especially instilling in her the value of hard work and education. Her paternal grandmother was a third-grade teacher who read Shakespeare plays to Natalie and her sister, and Natalie became an avid reader, usually alone in her room.

Education was an important family value. Natalie’s mother, Dorothea, was a well-educated woman, having earned a degree in teaching and later a degree in laboratory technology. As a young woman, Dorothea traveled to Europe. Although her father (a member of the regional Federal Reserve Board) was wealthy, Dorothea earned extra money as a seamstress making dresses for college classmates, a moneymaking talent she continued after her father died young. Furthermore, Natalie’s maternal grandmother taught etiquette and cooking, so Natalie and Sandra were expected to write proper thank-you notes at appropriate times. Natalie’s father attended Indiana University for
Natalie, left, and her sister, Sandra. Photo courtesy of Natalie Crawford.
two years, but after a fire destroyed his dormitory room, his clothing, and his books, he could not afford to continue on his mother’s teaching salary.¹ His school from then on was the school of life, taking every opportunity to learn and improve his abilities. He became an operator of a large shovel at the Sunlight Coal Company mine, north of Boonville, providing a good living for the family.

In this extended family, it was expected that Natalie and Sandra would do well in school and attend college. There were important values in the family: behave yourself; be young ladies; graduate college; and have ambitions and dreams. Most importantly, their parents taught them to live by the Golden Rule. When a reporter once asked Wilbur Wright what advice he would give a young man, Wright replied, “… pick out a good father and mother, and begin life in Ohio” (McCullough, 2015). Substitute Indiana for Ohio, and the meaning is unchanged.

As Natalie approached her teen years, her parents bought a farm on the south side of Boonville, where they built a house and farmed corn and chickens. Natalie had farm chores, and sometimes also took on her sister’s chores when Sandra had a serious bout with rheumatic fever. Sandra recalls hours of tedious work with flats of 200 chicks each, dipping each of their beaks into food and water to orient the fledglings. She also recalls that her stronger, older sister could heft and carry heavy bags of food. Farming is hard work, but it seems that Natalie never shied away from it.

When John L. Lewis, president of United Mine Workers, called a nationwide strike and essentially shut down all of the mines, her father bought a dry cleaning shop in Boonville where Natalie worked as a clerk after school. Her parents owned and operated the dry cleaning business until moving to California. Everyone in the family had jobs, and as Sandra noted, “[there are] good hard workers from the Midwest.”

¹ Except where noted, the entirety of information in this work was gleaned from interviews with Natalie Crawford on various dates; her sister, Sandra Pittman, on February 24, 2015; and her lifelong friend, Gretchen Powers, on March 27, 2015.
Natalie summarized her family and early years by saying,

My mother was a businesswoman in every sense of the word and partner with my father when they built our house on the farm and when they owned the dry cleaning business. They shared in every decision and when appropriate brought Sandra and me into decision making. We had a very strong family. We had very strong role models in our parents, grandmothers and a great-grandmother on mother’s side who lived to be in her 90s (Crawford, 2017b).

Natalie’s parents and sister regularly attended the local Presbyterian church, which was ministered by the same man who had married her parents, but the minister moved to a new location. When they found the new minister to be not as good, they switched to the Methodist church Natalie’s paternal grandmother attended. A disagreement there with a Sunday school teacher gave an indication of the questioning mind that Natalie had as a young person and would stay with her for a lifetime. The teacher proclaimed that the only prayers that counted were the ones prayed in church. Natalie asked him, “If I pray under a tree, will God hear it?” to which the teacher responded, “No.” Not seeing any logical or theological reason why that should be so, Natalie stopped attending that Sunday school.

As Natalie progressed into high school, lifelong friend Gretchen Powers recalls that Natalie was an excellent student, and Natalie had an early taste of success in the tenth grade when she finished in first place in a geometry competition. Math and its related subjects were always “easy” for her, and Natalie recalls enjoying it “like a puzzle.” Beyond schoolwork, Gretchen recalls the young Natalie as trustworthy, a friend who would never betray a confidence.

Gretchen and Natalie were very active outside school, and they thrived in the small-town atmosphere in which they could walk to most places and where most people knew their faces and names. She and Gretchen were in a singing group that performed often in Boonville at churches, for the Masons, Lions Clubs, and others. The high school had a strong music program with a teacher that demanded high standards, and they both were members of the Order of the Rainbow,
an affiliate of the Masonic Lodge. Gretchen recalls Natalie as “very energetic” with a wonderfully strong family that instilled Midwestern values. In Boonville, adult friends of parents were like aunts and uncles, and Gretchen’s mother was one of those surrogate aunts. Natalie fondly recalls her 13th birthday when Gretchen’s mother gave Natalie a surprise birthday party that included a sleepover.

**Move to Santa Monica**

However, graduation with her class of about 125 at Boonville High School was not to be. The summer before Natalie’s junior year in high school, her father moved his family to Santa Monica, California, on the promise of a job there. However, shortly after they arrived, he learned that the job was not available. Her parents had sold everything to finance the move, and her father pursued various lines of work to support his family over the next several years. The sisters never asked their parents for money; they earned their own through a series of jobs. Natalie worked at a small department store for “about a dollar an hour.” In her senior year, she took chest X-rays of incoming patients at Saint John’s Hospital in Santa Monica.

Moving from small Boonville to Santa Monica and a new school certainly had its difficulties, but Natalie used her love of and talent for math by excelling and taking college algebra as a senior, which was the highest math course offered at the school. The teacher demanded high standards—nothing new to Natalie—and held the students accountable for their work—also nothing new to her. She recalls that he “never spoon fed us, and he was really preparing us for college work.” He posted all grades for everyone to see, so that each knew her or his standing in the class. In her words, “If you were a competitor and good at the math, and if you thrived on that combination, you were in for an enjoyable time.” It was in this class that she realized that she not only had a love of math, but also “loved the competition. I knew that the mathematics and the discipline that I learned in that class would help me be a good, maybe great, problem-solver.” The class, she recalls, was “like lighting a fire” (Crawford, 2015). Natalie graduated with
honors from Santa Monica High School, but she was not eligible to be the class valedictorian because she had not attended the school for four years. Nonetheless, it was in high school that she fell in love with mathematics.

**Studies at UCLA**

Fulfilling their family’s expectations and their own desires, Natalie went to college, as did her sister, Sandra, who went on to teach grade school and kindergarten for 36 years. Natalie enrolled in UCLA as a mathematics major during years in which only 5 percent to 7 percent of women attended four-year colleges (National Center for Education Statistics, 1993) and a mere 15 percent of those women majored in such male-dominated fields as mathematics (Goldin, 2004). She chose UCLA for two reasons. Her high school math teacher had recommended it, and it was inexpensive. In those years, there was no tuition at UCLA for state residents, and Natalie further reduced costs by living at home. She recalls that her only expenses were a student fee of about $65 per semester that covered athletic events and a student health plan. Beyond that was the cost of books, and she had received a scholarship from the UCLA Alumni Association.

Her course work was loaded with mathematics and physics, but she recalls taking great pleasure and interest in anthropology courses taught by the head of the department. She opines that the department head might have recruited her had she not loved math so because his lectures were so interesting and challenging. She also recalls a political science course that focused on shaping public opinion. Natalie says she has discussed points from that political science course for many years.

Natalie worked several part-time jobs as she progressed through college. One job that would prove very valuable to her was at UCLA's...
Institute of Geophysics doing computer analysis for the graduate students. It was a job where she could use her love for math while she learned the basics of the nascent computing world. However, the only computer available to the institute was one mainframe shared by all of UCLA, and that meant waiting in line, especially if the first run revealed errors in the coding. The institute’s director secured a grant to buy its own Bendix G15 computer on which to solve complex problems. From the computer’s instruction manual, Natalie taught herself how to write the code to solve the problems and to compile the data in the right format (Crawford, 2015).

Joining RAND

When Natalie and her family arrived in Santa Monica, they stayed in a motel while her parents looked for a home. A professor from Purdue University in Indiana who was working at the nearby RAND offices for the summer was also staying at the motel. The commonality of being from Indiana cemented a friendship between her family and the professor. Impressed with Natalie’s passion for math, the professor suggested she work at RAND after college. His encouragement convinced Natalie that when she “grew up” she would work at RAND. She recalls that her instincts told her it would be a perfect fit. In fact, the professor arranged for her to take a tour of RAND; after that, her mind was made up.

After receiving her degree in mathematics from UCLA, she immediately sent a letter to RAND. Although she does not recall the exact details, she paraphrases the intent by saying with probable impatience, “Well, here I am. I’m yours. I’ve been waiting for this all my life!” RAND responded with, “We do not hire trainees.” Meanwhile she had been babysitting for a man who was the general counsel at North American Aviation, and he had suggested that she could work there after graduation. She applied, and the company took her on as a computer programmer. It was interesting work, but it was not RAND, which she viewed as the perfect job in which to apply her love of mathematics. So when a neighbor, who worked at RAND, approached her
parents about an opening in his office for a computer programmer, Natalie applied and was hired (Crawford, 2011).
Beginnings at RAND

Getting Up to Speed

When Natalie started at RAND in 1964, it was organized “like a university” with an aeronautics/astronautics department, math department, physics department, economics department, planetary sciences, and other similar ones. She went for an interview in the armament group of the aeronautics/astronautics department and recalls being terrified that interviewers would ask her to derive a differential equation or some equally challenging math task. However, the interviewer presented a different narrative to her as he described the kind of work the department did, much of which was Air Force work. She recalls thinking that the only thing she knew about the Air Force was that it had airplanes. Nonetheless, she found everything he told her to be “fascinating, just fascinating,” although she also admits to not understanding much of his jargon. Late in the interview, he asked her whether she had any objections to working on “this kind of thing.” Nonplussed, she answered no, why should she? He explained that there were people who did not want anything to do with weaponry. She replied that it did not bother her and said, “in a perfect world, we wouldn’t have to work on these things; but it is not a perfect world, so we should work to be best!” He hired her into the armament group of the aeronautics/astronautics department.

Natalie recalls that she and five men comprised the armament group. The others had extensive experience in military weaponry from
such places as the Navy’s China Lake and the Army’s Picatinny arsenal. More importantly, she found them to be “fabulous teachers,” who took the young inexperienced woman under their collective wings. Her first job was to write the code for an anti-aircraft attrition model that would calculate the likelihood of ground fire downing a particular aircraft under particular conditions. Natalie confesses to not even knowing the meaning of the word “attrition” at first, but she threw all of her energy into the project, determined to learn everything there was to learn. Her project leader tutored her at his table by drawing out the model’s specifics on large white sheets of butcher paper. Ultimately, the Air Force used the model she and her team developed to compare projected attrition rates of two front-line Air Force fighters, the F-100 and F-4, and a new fighter in consideration for duty in Vietnam, the F-5 (Crawford, 2011).

Shortly thereafter, the group included Natalie in a continuing study of weapon effects. In those days, the Air Force did not procure its own non-nuclear weapons because the Army and Navy were in charge of procuring those kinds of weapons for the Defense Depart-
ment. Furthermore, there were no computerized weapon effect models that could predict lethality given various delivery options, such as a dive delivery or a level delivery from various altitudes. Nor was there adequate data to describe the vulnerable areas of a target, the engine in a truck, for instance, versus the soft, inconsequential surrounding components. Picatinny Arsenal had developed a model to predict weapon effects called the Full Spray model. The data that populated the model came from arena tests in which the ordnance being evaluated, such as a bomb, was placed in an arena surrounded by witness panels. When the bomb detonated, an accurate accounting of each fragment’s parameters (velocity, weight, and other factors) could be measured. Natalie recalls being thrilled to do this kind of analysis, as it opened a new intellectual world to her. Today, all of those factors are accounted for in the Joint Munitions Effectiveness Manual (JMEM) and tables specific to the delivery aircraft, but Natalie learned it from rough data computed and compiled on blackboards and butcher paper and eventually by talking with pilots who used these weapons in combat, testing, and training. All of this is to say that she rapidly advanced her knowledge to become a technical expert in a field where there were few experts. “[Today’s weaponeers] have no idea how those numbers came about, but I learned all of that,” Natalie says.

Over time, Natalie broadened her expertise within the armament group that gave her opportunities to learn aircraft avionics, aircraft survivability, and weapons effects. “I’ve done more things [later on], but never with the depth that I did in the early years of my career,” Natalie says.

**Thinking Like a Fighter Pilot**

Natalie’s early years at RAND were during the height of the war in Vietnam, and then later the Cold War as the U.S. military focused its attention more closely on the Warsaw Pact’s threat to NATO in Europe. As she deepened her technical expertise, Natalie started to learn about the men who flew the aircraft and dropped the weapons and their tactics. She learned from the Air Force experience in Vietnam
that the fighters’ high speed made it very difficult to spot small camouflaged targets, and that problem would continue within the context of a European war. “I concluded that the most significant thing I could do in my career would be to do something that mattered to [fighter pilots] and that had credibility with them. [But] I had no credibility with them. Who was I? I was nobody,” she says. Perhaps she had no credibility, but she had ideas and deep technical expertise in weapons of the day. She continues,

But I had this idea, which in those days was technologically infeasible, but the idea was that you’d have a weapon on the airplane, put a strap-down inertial guidance unit on it … integrated into the fire control system … the pilot [would] have a helmet-mounted sight to which a laser was slaved, which was technologically impossible in those days; [the helmet] would have been too heavy … . You see the target … you mark the target through the sight with the laser which marks its position relative to you—your inertial position … that goes into the weapon’s inertial position; the weapon comes off and flies over [to the target].

Convinced that this was a good idea, Natalie studied every fighter manual in detail from its basic description to the operation of complex weapons systems and weapons capabilities. She recalls driving her car at 50 mph and trying to translate the compression of reaction time to 500 mph. Having studied this idea as much as possible, she determined that the only way to gain a true appreciation of the problem was to fly in a fighter. She “worked up [her] courage,” and wrote a letter directly to the commanding general of Tactical Air Command (TAC), who had the responsibility for all fighter operations in the continental United States, explained the concept to him, and asked to discuss her ideas with someone who could determine whether her ideas were reasonable. “In those days, this took a lot of courage on my part,” she says. Although she does not recall asking directly for a flight, the general

1 Interview with Natalie Crawford, December 7, 2011. Although Crawford does not claim to have invented any of the components, these capabilities exist today to some degree in a variety of aircraft and systems.
responded by offering her two flights, one in the F-111D and one in the F-4E (Crawford, 2011).

**Flying in the F-111**

Natalie went to fly in the F-111D at Cannon Air Force Base (AFB), New Mexico, in 1975. The swing-wing F-111, initially developed as a joint Air Force/Navy fighter, proved to be too heavy in that role, so the Navy never bought any and the Air Force used it as a medium bomber—a role to which it was ideally suited. The jet was at the forefront of computerized weapon deliveries, as well as integrated analog computer interfaces between its other avionics systems. However, such innovations were difficult to keep in working order, so TAC determined that Natalie might be able to offer insight. TAC also offered a ride to give her experience in how the computer systems worked. Like most Cold War aircraft, the F-111 was built with low-altitude penetration capabilities, most notably its ability to fly very low and fast using its on-board terrain-following radar (TFR) to hug the valleys, slopes, and mountains. The TFR interfaced with the autopilot so that the jet flew itself at low altitude through any weather conditions, day or night. The cockpit had two seats side-by-side with the pilot on the left and the weapons operator on the right. The pilot could select the aggressiveness of the TFR by opting for one of three rides—soft, medium, or hard. A hard ride was like being on the steepest roller coaster and not often used in training. Natalie’s pilot, Capt Victor Grahn, recalls that Natalie immediately said she wanted to experience everything the F-111 could do, including the hard ride. They flew a low-level route at 500 feet and 520 knots to a gunnery range where Natalie could see the computerized deliveries at work, including both non-nuclear and nuclear weapons attacks (Grahn, 2015). She recalls that the F-111 was a special airplane because it was the only one in the Air Force inventory that could combine low-altitude penetration with very high speed and carry a large array of ordnance. She was thrilled with the ride, and she had her first taste of delving into computerized weapons interfaces that would evolve rapidly over the next decades.
Natalie with Victor Grahn in the F-111D and ready for her first of many fighter missions. Photo courtesy of Natalie Crawford.
Nellis and the Fighter Weapons School

A month later, she went to Nellis AFB just outside Las Vegas, Nevada, for her flight in the F-4 and another opportunity to discuss her ideas. In 1975, the two-seat F-4 Phantom II was the primary Air Force multi-role fighter at bases across the United States and around the world. The F-4 Fighter Weapons School (FWS), founded in 1949, conducted the fighter weapons instructor course at Nellis, a course that some referred to as “a Ph.D.” in fighter weapons, tactics, and employment. Three classes a year, each comprised of 15 pilot front-seaters and ten weapons system operator back-seaters, came to Nellis for nearly four months of intensive weapons and tactics training, both in the classroom and in the air. No nut or bolt was too small to understand, and no tactic too common to go unexplored. After graduation, the participants returned to their squadrons as squadron weapons and tactics officers with the expectation that they would be the top experts in their units. TAC handpicked instructors for the FWS from those who had excelled both as students in the FWS and in their tours of duty back at the squadrons; therefore, the instructors at Nellis were the best of the best. In those years, all had one combat tour in Vietnam and many had two or more tours. These combat veterans demanded excellence in the classroom and in the air from their students.2

Into this environment, the young Natalie walked with some trepidation but eager to learn. She recalls approaching the base and seeing the fighters in the landing pattern: “It was so amazing to me.” When she arrived at the squadron for her meeting with the instructors, she was shown into what served as the lounge—a small room with a refrigerator, a soda machine, and a couch. She recalls not being scared, but she was anxious to “pass the test” as someone who knew about weapons and their potential for improvement. In retrospect, Natalie says she thinks that having the meeting in the lounge area foretold the meeting not lasting very long. “It ended up being more or less a peer-to-peer conversation.” The instructors could tell that she had worked very hard

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to understand their challenges. And most of all, they could tell that she really cared about what they did and how it could be improved. In fact, one of the weapons that most interested her was the AGM-65A Maverick, and her visit coincided with the tactics phase of the weapons school that emphasized Maverick employment. She had studied Maverick in detail and saw it as a positive contributor to the problem of killing Soviet armored targets (Wong, 2015). Beyond her ideas, though, she views this meeting as a watershed moment in her life that established lifelong friendships based on mutual understanding and respect and fostered relationships that she would nurture for decades to come. One instructor was then–Capt Dick Myers, who would eventually rise to the nation’s highest military rank as the Chairman of the Joint Chiefs of Staff. Myers says he remembers how “she threw herself into [our mission],” and that she had a “very analytical professional [approach]” (Myers, 2015). Another, then–Capt John Jumper, who would rise to the highest rank in the Air Force as the Air Force Chief of Staff, remarked that Natalie “bridges time from the weapons school … [and] she probably sees it as the most significant time in her career” (Jumper, 2014).

As she prepared for the F-4 flight, she discovered quickly that they were not pulling any punches with her; she was scheduled to fly in the F-4 back seat on a mission that was the graduation exercise for the current class. It was a full-blown tactics mission complete with simulated surface-to-air missile (SAM) systems trying to “shoot down” her flight, as well as “enemy” fighters defending the target area. Her job was to operate the AGM-65 Maverick missile system from the back seat. The Maverick was one of the highest-tech weapons of its day; it had a television camera in the nose of the missile that presented a black and white picture in the cockpit. The operator, usually the back-seater, could control a tracking “gate” that was a centroid tracker by moving it over the target, commanding “lock-on,” and then firing the missile, which would track to the target. In her previous studies of tracking systems, Natalie had advocated strongly for exactly this kind of centroid tracker in the Maverick (Wong, 2015). It is a very accurate missile and easily capable of destroying armored vehicles, even the most heavily armored tanks. Natalie’s pilot that day was then–Capt Doug Melson, a double-tour combat veteran who would later become a col-
onel in charge of one of Nellis AFB’s most important divisions. He recalls that the mission was flown at very low altitudes to fly under the SAM radars, and that they flew at very high speeds. On this day, they were trying to “kill” trucks in a convoy, so one of the challenges was to determine in a 4-inch-by-4-inch television screen which trucks had already been hit and which were still “alive.” Such target discrimination issues would be important later when Natalie did studies on the next generations of the Maverick missile. It was common to give back seat rides, but they were almost always conducted at altitudes and airspeeds not so demanding, and it was also common for the uninitiated to become airsick, but Melson recalls Natalie being alert and engaged throughout this very demanding tactics mission. He also recalls that it was the first time he had ever flown with a woman (Melson, 2015).

Then–Capt Ron Keys was in the other instructor position in the flight. Keys, who would progress through the ranks to become the general commanding TAC’s successor, Air Combat Command, says, “If she could climb into the back seat and operate a Maverick, then she wins with me [because] she was right in there amongst us.” He recalls what he saw as her best characteristic: “She could listen.”

And then she would ask the most “innocent” questions that went to the heart of the matter. Although some in the Air Force viewed the Nellis AFB instructors as mavericks or wild-eyed radicals, Keys found Natalie to be respectful of their desire for excellence and their desire to improve. One area in which she took interest was the instructors’ work to quantify the effect of different training methods by demanding documentation and specific values applied to training events (Keys, 2015).

Although it is a cliché to say that those instructors were a band of brothers, they had seen combat, and they had seen friends die in combat. Such a bond breeds a familiarity, which when combined with aggressive competitiveness, often results in “jabbing” or teasing. It did not take Natalie long to pick up on that part of the fighter pilot culture. On the mission with Melson, one of the “enemy” aircraft, an F-15 flown by the F-15 weapons school commander, never seeing Melson’s jet, flew right in front of them trying to attack an F-4 ahead. Melson lined up on the F-15 but let Natalie call the shot that “killed” the F-15. In the mission debrief, he had Natalie relate how the kill had hap-
pened, which was likely the first time anyone on the mission had ever heard a woman do so. Natalie laughingly stated, “[E]very time I saw [the F-15 commander] after that, I would remind him of that ‘terrible day’!”

She experienced more of the post-Vietnam fighter pilot culture soon when she learned that the instructors not only worked hard, they played hard. The next day was the graduating class’s golf tourney, and the rules were unusual. They played in five-man teams of four golfers and one designated drinker. When the teams turned in their scores,

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3 The first female fighter pilot in the Air Force would not come along for another 20 years.
they subtracted one stroke from the score for every ten empty beer cans they had. Natalie recalls one golf cart with an IV bag filled with a clear liquid hanging from the frame from which the “golfer” dispensed to his teammates. Minor injuries on the course were not uncommon. When recalling her trip back to Santa Monica, Natalie says, “When I got on that airliner I had this … strangest thing; I thought there must be an aura about me. Does everybody realize what I’ve just done?”

Natalie went on to fly in other aircraft, such as the F-15, F-15E, EF-111, F-16, OV-10, C-17, F-105, and an A-7, while visiting many Air Force installations as part of her learning process over the next four decades. However, that first visit to Nellis was special. “That was graduation day for me. It established years of lifelong learning for me. All of the people I met there were great teachers and have remained great teachers … and become personal friends. I would not give up any of it for anything,” Natalie says.
During her first ten years at RAND, Natalie became a weapons expert in the armament group by learning from everyone possible. Her weapons expertise expanded into aircraft survivability and especially into defense suppression—attacks on automatic anti-aircraft (AAA) and SAM sites, both directly and electronically. She was an avid participant of developing a way to collect data on weapons and estimate their effects, which ultimately became the JMEM and is still in use today.

By the late 1970s, Natalie’s work on weapons, weapon effects, and aircraft survivability blended perfectly with her experiences with fighter operations, fighter pilots, and especially the FWS at Nellis, so that her expertise was valued well beyond RAND. William P. Delaney, who has been associated with the MIT Lincoln Laboratory for more than half a century, and was highly placed in the Office of the Secretary of Defense (OSD), led a major study in the late 1970s of bombers and cruise missiles—and the study team included Natalie. “She was already well-known as an analyst with much experience,” he recalls. Furthermore, she was familiar to other study members. “She was a definite intellectual force on airpower and how the Air Force viewed [airpower].” Her work so impressed Delaney that, “If I needed anything from RAND, I called Natalie Crawford. She was a protégé of [retired Air Force Gen Glenn] Kent. If he was in the room you listened” (Delaney, 2015). Kent taught her, and she was a proponent of systems analysis and its language of defining a problem, focusing on the problem, and then deciding what to do.

Natalie recalls that her best mentor at RAND was Kent, whom she says was a “tremendous thinker, [a] great analytical mind [who was] able to criticize and praise, but always with an explanation. [He] made me think every time.” He taught her how to characterize a problem—how to turn it around and ask it in a different way. As an example, Natalie points to his reliance on “strategies to task” to explain the merit of a system or systems to support national strategies, in particular the airborne warning and control system (AWACS). When Congress directed that further development of the AWACS be discontinued, Kent was able to use these tactics to demonstrate its place in national military
strategy, whereas previous AWACS advocates had merely tried to “sell” it based on its advanced technology (Kent et al., 2008). Kent’s door was always open to Natalie, and she relied on him to give her another perspective of thorny issues in her portfolio (Crawford, 2011).

Natalie recalls that Kent mentored her in two ways: actively by teaching her and also by setting an example for her of how to be an analyst. She cites several skills he regularly used. He was a stickler for precise language, which he believed should be simple, direct, and unambiguous, and that it should convey exactly what was intended. He was also emphatic that arguments should be transparent. In any model or methodology he used, Kent wanted it to be the simplest so that the sensitivity of data could be clearly seen. “He harped and harped on … clarity and simplicity of the language, as well as the analysis,” Natalie says. He believed that an entire analysis could be torpedoed with a careless phrase that would allow antagonists to focus on the phrase rather than the body of the work. He lectured her to never give opponents an easy target. According to Natalie, another of Kent’s positive characteristics was that he never held a grudge. “[H]e could be … taking you to task over something that wasn’t precise or clear, and an hour later … that chapter was closed and you’re moving on to something else,” she says. It was never punitive to him, but the student always had to be corrected—and, to her, each event was a lesson. It’s how he mentored Natalie, and according to her, many, many others, one of whom was Dick Hillestad who recalls that Kent’s door was always open—an invitation to stop and chat often about his pure love of the mathematics of analysis (Hillestad, 2016). Natalie describes her admiration for Kent:

He was extremely clever in his ability to take complicated problems … and break them down into relatively simpler building blocks that could be addressed separately … and then you could begin to integrate them and the whole really was larger than the sum of the parts. It was a gift (Crawford, 2012).

Furthermore, Kent’s example of mentoring showed Natalie how to mentor, so she also made herself available to others.

Ted Wong, who early in his career at Hughes Aircraft Company was an analyst, describes Natalie as a strong proponent of systems
analysis long before it became commonplace: How effective are the components of a system? What is the payoff? (Wong, 2015).

In those years, Natalie was a member of a cadre that included Kent, Dennis Murray, and perhaps 50 others, who, according to Delaney, had the critical thinking skills and technical expertise to “argue logically” within the Defense Department about airpower, military acquisitions, and other military matters. This standing cadre could be counted on to have an opinion with solid rationale. It was a “collective intellectual body that was highly driven by patriotism.” The common currency among them was trust, a virtue Natalie had in spades. She was the “trusted Air Force kid,” according to Delaney, who said Natalie could always be trusted to be honest, and not always buy the party line. In many ways this environment was similar to the one that Natalie experienced at FWS—always questioning; always striving for excellence; always persistent. Delaney believes that Natalie’s close association with line pilots and their aircraft, including her flights, “made her rep.” In Delaney’s words, she was a “patriotic person trying to do the best for the nation” (Delaney, 2015).

“I can learn from everybody. I have to learn from everybody. Every day’s a school day … I hope that if I’m right about something, that I can actually teach somebody something. Much of what I know has taken me 40 years to learn,” Natalie says.
Natalie’s contributions to RAND and the Air Force as a researcher and analyst span six decades; it is impractical to relate all the projects on which she has worked. However, a few examples are meaningful. Sometimes her work directly impacted decisions, and sometimes it reinforced decisions.
Imaging Infrared Maverick

In the late 1970s, the Air Force brought the A-10 into its inventory. The main purpose of the design for the new jet was to kill tanks, specifically Soviet tanks, which the Warsaw Pact had facing NATO by the thousands. The aircraft’s centerpiece was a 30mm Gatling gun that could fire 4,000 dense depleted uranium bullets per minute, but it also had many survivability features, including a protective titanium tub protecting the pilot. It was not fast but very maneuverable at low altitude—in other words, it was meant to get down there and root around among them. The tank-killing Maverick was a perfect complement to add to the A-10.

The Maverick system that Natalie had flown at Nellis on the F-4E was limited to daytime use because of the internal television camera, which needed considerable ambient light to operate. The Air Force was searching for a system that would enable night employment of the Maverick, as it was a proven tank killer, and because, under the right circumstances, it was a fire-and-forget weapon that did not demand that the pilot overfly the target. Two improvements to the Maverick were under consideration: a laser-guided version that could track to a laser spot illuminated from either a ground or air position; and one that, instead of a television camera in the nose, had an Imaging Infrared (IIR) camera. The IIR camera system could see small temperature differentials, digitally analyze that signal, and present a black-and-white video image to the pilot who could then lock the tracking gate to the target, fire the missile, and escape. IIR technology was new; laser technology was established; therefore, there existed considerable doubt in the defense establishment of the efficacy of an IIR tracker. Such doubts were especially strong in the minds of some influential congressional staffers, who proposed funding cuts for IIR Maverick development in favor of a laser-guided version.

The Air Force devised a test to determine whether IIR Maverick could, in fact, distinguish live tanks from dead ones surrounded by the smoke, fire, and clutter of the battlefield. The Air Force conducted the test at Peason Ridge in Louisiana and included the new A-10 as one of the test aircraft. The test intended to make circumstances as difficult
as possible by putting armored targets in an attack formation, then
surrounding them with debris, fire, smoke, and muzzle flashes, all in
a high-humidity area because high humidity was predicted to reduce
the IIR’s ability to “see.” Two of the A-10 pilots, then–Capt Roger
Carleton and then–Capt Wally Moorhead, flew in the test because
they were the first two pilots in the Air Force to reach instructor status
in the new jet. The test missiles did not actually fire; they were flown
captive with recording devices that picked up the video from the mis-
sile and cockpit voice. The results were excellent. The test runs were
highly demanding, at night, low altitude and navigating by dead reck-
oning because the A-10 had no internal navigation system, so the lan-
guage on the tapes was more than a bit salty. Adding to the workload

She’s a national treasure.
—then–Capt Roger Carleton

was the announcement that a group from RAND, including a woman,
was going to look at the results, including the tapes. Moorhead sat at a
machine trying his best to edit their language, when he turned around
and saw Natalie, whose reaction was, “I don’t care about that; I just
want to know the results.” The team compiled all the results, and the
data showed them without question that IIR was far better than the
older television version, and that the pilots could, indeed, distinguish
the correct targets. The analysis went through the Air Force to the con-
gressional staffs, who immediately discounted the results by observ-
ing that the conditions in Louisiana hardly replicated those in Europe.
So the test was redone, this time at Baumholder, Germany, during the
winter. According to Moorhead, he and another pilot, then–Capt Al
Whitley, flew all the night attacks, and they flew nearly every night for
two months. Moorhead recalls that Natalie was there gathering infor-
mation during all of their mission debriefs (Moorhead, 2015). The “live”
targets for the test were Army armored units that had been told by their
commander to keep heat sources to a minimum, including space heat-
ers in their tanks. The commander violated his own rule by keeping his
tank heater on and his tank was “killed” the first night. No one outside the small community of experts knew that the heaters really did not matter; any small heat differential between a target and its background produced an image adequate to launch an IIR Maverick. Finally convinced, the staffers approved final development and production of the new missile. According to Carleton, “The data RAND extracted was convincing.” Ted Wong, who worked for the Maverick manufacturer, agreed (Wong, 2015). Carleton further related that the original concept of the Maverick was for it to be carried in clusters on three-rail launchers, which produced a very high drag. The A-10 pilots wanted a single-rail, much lower drag launcher. The RAND team’s analysis supported the concept, and the Air Force purchased the smaller rail (Carleton, 2014).

**Advanced Fighter-Bomber**

Natalie’s work sometimes drove decisions and sometimes reinforced them. Her work on an advanced fighter-bomber is an example of the latter. The Air Force in the early 1980s had been considering paths to take to the next fighter to replace the F-15, as well as a fighter-bomber replacement for the F-16. Gen Bob Russ, an air staff general in charge of fighter requirements, asked Steve Drezner, who was the director of Project AIR FORCE (PAF), to weigh in on whether RAND had inputs to the specifications for the new jets. Drezner asked Natalie to lead the team performing the analysis. She recalls the project as the “most fun and exciting project I ever worked [on] at RAND.” Her team members looked at every aspect of the new aircraft that they could imagine: performance, basing, sustainment, and acquisition strategies. They not only came up with those data, but they also concluded that it would be a better path to develop the fighter-bomber aircraft first, followed by the air superiority aircraft. She recalls that there were seven aircraft companies interested in competing for the contracts, and that all were doing their own analysis. Most of the industry teams visited RAND and shared their own analyses with the RAND team. Through these meetings a huge difference was discovered between their analy-
Researcher

ses and her team’s. The companies were focused on the fighter-bomber being able to fly high and fast, but her team’s analysis showed that high and fast would not be the best solution. Such an aircraft needed to be survivable, carry significant weaponry and sensors, as well as other equipment, all of which did not seem compatible with the high-and-fast model. Natalie recalls a conversation with Ben Rich, the famous director of Lockheed’s Skunkworks that had produced the U-2 and SR-71, and asking him, “What am I missing; I can’t make high-and-fast work!” Rich replied that he could not see that they were missing anything and left it at that. So Natalie and her team pressed on and completed their work and briefed the Air Force on their solution, which was a medium-altitude, subsonic aircraft with an IIR sensor and laser designator that could deliver precision laser-guided bombs. After Russ and his staff thanked them, they gave Natalie permission to brief her work to the competing contractors. The companies filled the large conference room at RAND, and Natalie told them that the fighter-bomber version should go first and that it should be a high-subsonic platform with high survivability, and they discussed range and payload, weapons, and other aspects. Natalie, still concerned that her analysis was at odds with the high-and-fast concept, asked Rich what he thought after the briefing. “He winked at me and said, ‘I think you got it just about right,’” she says. One year later, Natalie learned about the F-117 stealth fighter that Rich and Lockheed had already built for the Air Force. Knowing absolutely nothing about the heavily classified F-117 project, Natalie and her team had hit the nail on the head through the analysis of pure physics and operational requirements and an understanding of the tactical environment. Furthermore, they reinforced the efficacy of a decision already made. Had Natalie and her team backed down and submitted to the conventional wisdom of others’ analyses, their work would have been useless, perhaps even counterproductive (Crawford, 2012).
Tanker Analysis of Alternatives

Natalie’s deep involvement in research projects continued into her years as PAF leader—sometimes putting her, PAF, and RAND in the center of controversial programs, and none more so than the Air Force’s efforts to obtain a replacement aerial refueling tanker for the aging KC-135. The first of the C-135 family flew in 1956, with more than 800 eventually produced, and more than 400 of those were of the aerial refueling variety (“Boeing KC-135 Stratotanker,” undated). Although the aircraft was primarily assigned the mission of refueling nuclear bombers to provide the range to meet targets across the Soviet Union, the onset of the Vietnam War immediately proved that aerial refueling was beneficial to fighter aircraft en route to targets that normally would have been out of range. Over the next decades, aerial refueling, primarily from the KC-135, would become a key component of America’s global reach by forming “air bridges” to faraway theaters. Of course, this constant and large-scale use of the tanker fleet put heavy wear and tear on the airframes and engines. According to retired Gen Gregory “Speedy” Martin, one indicator of the failing fleet was a dramatic increase in time that the aircraft were in “depot maintenance,” which is a periodic and extensive tear-down and inspection process. He recalls that the planned and historic time for the depot maintenance for the KC-135 aircraft had been about seven months, but it had dramatically increased to 18 months because of extensive corrosion in wings and engine mounts. Because of the backlog, the Air Force reached a point where 176 KC-135 tankers were in the depot maintenance process—nearly half of the fleet (Martin, 2014).

The Air Force started to investigate ways to replace the KC-135 and settled on a plan to lease Boeing 767 tanker aircraft from its manufacturer; however, that plan ultimately failed. A senior acquisition official pleaded guilty to rigging the process, which torpedoed the leasing plan, but more importantly damaged the Air Force’s credibility with Congress (“The Rise and Fall of a Maverick,” 2004). Although an internal Air Force study indicated the 767 was the best option, the Defense Department (or OSD) determined that further study in the form of an analysis of alternatives (AoA) was needed (Kennedy, 2016). Upon hear-
ing that an AoA was under consideration, Natalie, who always “kept
[her] ear to the ground,” argued with senior Air Force officials that PAF
should have the task because PAF had the “advantage[s] of talent and
ability” (Crawford, 2016). Air Force officials agreed, and they agreed
to pay for the AoA, and the task went to PAF. Originally, OSD had
determined the AoA would take 18 months; however, not long after
PAF started, OSD directed the study to be complete in a year, then
further reduced the time to six months. Natalie knew that a proper
AoA was impossible in such a short time, but OSD was unrelenting,
even though Natalie told the overseers, “[if you] want it bad, [you] get
it bad” (Crawford, 2016). In an email to a senior Air Force general,
Natalie said, “This is not an AoA and should not be advertised as an
AoA. One could do an AoA in five months on only the most trivial of
topics. This is not a trivial topic.” She continued, “[The AoA] is going
to commit billions of dollars over several years … now a five-month
study. Totally nuts” (Sevastopulo, 2004).

The team worked seven days a week under intense pressure, finally
producing an oral report and a draft written report, and they included
a list of things they would have done if given more time. Natalie, at
the time the vice president of RAND for PAF, and her team leader,

I get paid to tell the truth, not to sell the story.
—Natalie Crawford

Michael Kennedy, asked the Air Force to meet with senior congress-
ional leaders to argue for extending the time for the AoA, but the
Air Force refused. However, congressional staffers who saw the study,
and its list of what could have been done given more time, requested
that PAF meet with them. The meeting was confrontational, with an
openly accusatory attitude that PAF had simply parroted what the Air
Force already wanted. Natalie bristled at what she called “impugning
the [Air Force] and RAND,” and told them she had worked for RAND
for 40 years and had not pulled a punch yet. Kennedy characterizes
her arguments as “leaving no doubt that we were independent and
objective.” Her arguments succeeded, and the staffers convinced their chairman to write a letter to the secretary of the Air Force supportive of extending the time for the AoA (Kennedy, 2016).

In fact, the final AoA report often contradicted earlier internal Air Force findings. Martin recalls that the last time he saw the results, before moving to a new assignment, some of the findings favored other aircraft over the 767 under certain conditions. When he discussed it with Natalie, she replied, “I get paid to tell the truth, not to sell the story” (Martin, 2014). Kennedy recalls that they worked under incredible pressure to complete the AoA, and he relates an event that makes a point about Natalie’s leadership. Natalie had sent an email to a senior Air Force general in the Pentagon describing how the team was doing the work, the long hours they were putting in, and their commitment to providing the very best information they could. Not long after that, and coincidentally, a Senate committee requested all correspondence on the AoA, and ultimately that correspondence was released to the press—including Natalie’s email. Her team took great encouragement from her providing “top cover” and unrelenting support for their efforts (Kennedy, 2016).
An important part of the need for more time on the tanker AoA was a more in-depth sensitivity analysis. Analysis of data always requires that some assumptions be made: If X is constant then X + any number of data points = an answer. Once all those data points are computed, then, in order to have a full understanding of the problem, the analyst must ask, “what if I changed the constant X, and how does that influence the results?” Expressed another way, how sensitive are the results to changing assumptions? Natalie learned these techniques from her original RAND mentors in her early years doing weapon studies. She recalls being asked to examine an Army study that had concluded that Patriot missiles were a better defense of Western Europe than Air Force fighters, such as the F-16. As she peeled back the layers of the study, she discovered that under all conditions the Patriot was ascribed a 90-percent probability of killing its target. However, if the probability of success fluctuated, as would seem reasonable under differing conditions, the results changed considerably. Natalie relates that she learned these “tried and true” analytical techniques from her earliest mentors (Crawford, 2016). Kennedy takes her view a step further. He credits her with an ability to “cut straight to the heart of an issue. Comparable to Glenn Kent. It is an astonishing intellectual capacity to see the heart of a problem” (Kennedy, 2016).

A former chairman of the Joint Chiefs, Myers—who had met Natalie at Nellis when she was a young analyst—looked to Natalie for her “objective analysis” as a comparison to “contractor analysis.” He says she was “passionate” and understood the Air Force very well.” He trusted her (Myers, 2015).

Logistics

Junior military leaders will not get to be senior military leaders unless they learn early in their careers the importance of logistics, and Natalie gained an early appreciation for what former Air Force Chief of Staff Gen Larry Welch calls “non-glamorous logistics.” Welch was the commander of the first operational F-15A fighter wing in the Air Force in 1976, and the new jet, as with all new jets, had growing pains—
some of which were in logistics and maintenance. He wrestled with his assessment that “normal” maintenance practices were not working with the new jet. In discussions with a logistics expert whom he trusted, then–Col Leo Marquez,¹ he learned that Natalie Crawford at RAND had not only a special interest in logistics and maintenance but also considerable expertise, because she spent a lot of time visiting units and learning how they operated. He took Marquez’s advice and called on Natalie. He laughs when he recalls that Natalie had an “instant recognition” that the old paradigm of having technical expertise in workshops off the flight line—“back shops” in the jargon—did not provide

¹ Marquez was indeed an expert, as he attained three-star rank later in his career as the chief of all Air Force logistics and maintenance.
enough expertise on the flight line when a pilot reported a problem. She recommended “teams of experts” on the flight line to deal quickly and effectively with problems as they arose. Welch implemented her recommendations and saw improvement (Welch, 2015).

This was not the last time Welch would call on Natalie; a few years later, when he was the Ninth Air Force commander, he faced another thorny logistics problem. His command was responsible for formulating contingency plans to rapidly deploy, and one such contingency was to blunt any Soviet intrusion into northern Iran. Speed was vital because a possible Soviet invasion could move quickly over the short distance into Iran, but any U.S. forces had a long trip. U.S. ground forces absolutely could not move that quickly, so the job of first defenders, or first responders, fell to the Air Force. Welch asked Natalie to work the problem along with his planning staff. He recalls that her thinking, similar to her approach to the F-15 problems years earlier, saw solutions in nontraditional ways. Rather than deploy en masse, she and his planners proposed a “7-in-7” scheme that deployed seven squadrons over seven days with a tailored logistics package that provided just enough supplies to blunt an invasion until more forces could arrive. An important part of this plan was to pre-position supplies on ships, thus obviating the need for massive amounts of airlift to support the 7-in-7 scheme should the crisis arise. Welch used this example to show how he values Natalie’s drive to “always look for new solutions.” By the time Welch became vice chief of staff and then later chief of staff, he had gained a great respect for PAF’s work, which is most valuable when PAF concentrates on work the Air Force highly prioritizes (Welch, 2015).
Origins and Development of RAND Project AIR FORCE

Natalie became the director of PAF in 1997, a position she held until 2006. PAF was created in 1976 as a successor to Project RAND, which had its genesis in the visionary leadership of General of the Air Force Hap Arnold. Natalie related her view of the founding of Project RAND and PAF and their founding principles in a 2011 interview with the Air Force history office. She says that Arnold believed that there was a need for an organization that could independently and dispassionately research and analyze problems facing the future of military forces in America in a post–World War II world. Arnold, she said, envisioned a multidisciplinary organization that could understand that military problems were more than bombs and bullets, and that there were always economic, political, cultural, and financial stressors that significantly influenced military thinking. Arnold and others feared that the tremendous reduction in armed forces would also see a corresponding reduction in focus on military matters, and that the strong bonds between academic and military thinkers would “disperse.” Furthermore, Arnold foresaw the Air Force greatly improving its leveraging of technology with the clear example of the sophisticated B-29 and the atomic bomb already on the books. Project RAND was created to fulfill this vision. Any defense organization could contract work through RAND, but there was a need to focus on specific Air Force issues. Natalie says, “… [S]ome organization had to be thinking about
the future [of the] Air Force; what kind of equipment did it need, what kind of missions it might fly.” So the creation of PAF allowed the Air Force to fund its own projects and others could contract directly with RAND, which in Natalie’s words made for a “cleaner” arrangement.
Yet, according to her, the spirit of Arnold’s vision remains unchanged within PAF and all of RAND. Ultimately, PAF was designated a federally funded research and development center (FFRDC). The significance of the FFRDC is that there is an agreement wherein the sponsor (the one needing work done) agrees to supply all information required for the study and in return the sponsor gets independent, objective results. According to Natalie, “that’s very, very important.” It is an agreement based on trust. Funding for projects is straightforward. PAF, as an FFRDC, has a dollar ceiling each year—a “cap” on the total amount of money that may be allocated for RAND work. It also has a program element (PE) within the Air Force budget, but the PE is less than the ceiling, thus allowing the Air Force the flexibility to add studies—and the funds to pay for them—during the year up to the cap. Oversight for all PAF studies falls to the Air Force vice chief of staff, who chairs a steering group that selects the projects for the year, called a “research plan.” As add-on proposals occur, they are also approved through the vice chief of staff’s office, although full steering committee approval is not required (Crawford, 2011).

PAF, in keeping with Arnold’s vision, casts a wide net when manning a study. A project manager is selected and then that manager selects the team by tapping the right disciplines based on the study requirements. Furthermore, project managers are encouraged to select participants from RAND’s other major office sites, so that no function is centralized in one office and as many offices as possible are offered an opportunity to broaden their knowledge base. When Natalie was in supervisory positions, she tried to put new hires on a 50/50 schedule—half of their work in their area of expertise and half in a new area. The project teams are multidisciplinary. Natalie recalls, “When I went to work at RAND … people said that they did multidisciplinary work, and I used to roll my eyes. But now I know it’s true because most problems are … so … complicated. There’s always a cost factor … and often a technical factor.” Keeping people with the right expertise at RAND is a requirement of its contract with the Air Force, and that is a difficult management problem. If the funding shrinks, particularly the core funding, then there is a danger that PAF cannot maintain the experts to fully staff projects or respond to additional projects requested.
by the Air Force that are above and beyond the annual research plan (Crawford, 2012).

Employing and retaining people with the right talent and skills are not merely factors that RAND, PAF, or Natalie tout as part of a desirable management process. They are required by Federal Acquisition Regulations that also lay out guidelines for long-term relationships between the FFRDC and its sponsor, in this case the Air Force. Some of the guidance includes long-term relationships that provide continuity to attract high-quality personnel who will maintain currency in their fields of expertise, preserve familiarity with the needs of the sponsor, and provide a quick response capability (U.S. Congress, Office of Technology Assessment, 1995).

**Revitalizing the Relationship**

After Natalie became the director of PAF, she had to expand her horizons considerably by developing relationships within parts of the Air Force where she had little experience. She recalls visiting every four-star and every significant three-star in the Air Force to understand their business better and, ultimately, become a better leader of PAF. At each visit, she first would ask them to “give me the landscape, the big things that are of concern to you.” Then she would tell them about RAND and PAF to give them an idea of what PAF could do, and she would make sure they understood that PAF worked for the whole Air Force, not just the air staff at the Pentagon. She was quick to point out, however, that PAF did not compete with the private sector. “We don’t do that,” Natalie says.

One consensus of strong leadership is the ability to provide the organization with resources to do the job, and often the most important resource is funding. When Natalie took over PAF in 1997, one of her immediate concerns was that there had been no correction for inflation in the PE, so there was a gap between the PE and what the work was actually costing (Crawford, 2012). The PE shortage also made it difficult to respond quickly to unplanned Air Force tasks of high priority. She recalls that the error was purely a math error because inflation
had not been added to RAND’s PE, and exacerbating the shortage was an Air Force reluctance to correct the error after the fact. Fortunately, PAF had been able to compensate for the difference by securing Air Force work beyond the funded annual research plan, but it was clear to Natalie and others that eventually the funding had to be stabilized on a more-current, adjusted-for-inflation scale (Crawford, 2012). Furthermore, PAF had been compensating by what Natalie calls, “doubling down,” by using skills not just within PAF but across RAND if and when they were compatible (Crawford, 2012). She notes that it would have been impossible to fund enough people within PAF alone to meet expertise needs, but doubling down had to reach a crisis point eventually. She did not see PAF as able to respond quickly to the Air Force if they expressed a critical immediate need for facts and data (Crawford, 2016). Furthermore, she did not see inconsistent funding to be consistent with OSD guidance that stated, “[The Department of Defense’s] FFRDCs maintain long-term capability in core competencies in domains that continue to be of great importance to the Department” (Under Secretary of the Defense, 2011).

Indeed, the record shows a steady decline in manpower assigned within PAF in the decade prior to Natalie assuming the leadership of PAF. That trend reversed in the ensuing years of her leadership, and by the end of her tenure the manpower available increased more than 20 percent (Moore, 2016). She was able to manage this turnaround combining two of her skills: management and relationships. On the management end, she recognized the value of below-threshold reprogramming, or “BTR” in budgeter lingo. Air Force agencies have the authority to reprogram, or “move” in lay terms, money from one program to another as long as the amount does not exceed a threshold set by law. Therefore, the agency has some flexibility to move money around in a budget that has already been authorized by Congress. Natalie saw BTR as a way to increase the numbers of the PAF cadre of experts because she also knew that Air Force agencies, such as the major commands (MAJCOMs), had work they individually wanted done but that did not “make the cut” in the Air Force’s annual study plan for RAND. Before this, PAF had never asked for increases in its PE. So she went on the road and talked to officers with whom she had established
a mutual condition of respect and asked them what they needed. “[PAF was good], but [other agencies outside the Pentagon] won’t think of you if they never see you,” Natalie says. She explained how PAF could do the work they needed if they could reprogram money from their own accounts to pay for it. “Sometimes I felt like I had a tin cup in my hand,” she says. Nonetheless, her use of BTR and her constant contact with major commanders coupled with the long history of success and high-quality results she brought attained her objective. She increased manpower available to do studies, while maintaining an experienced, diverse, and highly qualified workforce.

Exacerbating the funding problems was a continual pressure to reduce funding in all the FFRDCs following the end of the Cold War and certainly after the first Gulf war in 1991, Operation Desert Storm (an allied effort led by the United States to oust occupying Iraqi forces from Kuwait). According to Paul Kaminski, a former undersecretary of defense who was later on RAND’s board of directors, Defense Department support for RAND “waned in the early ’90s” (Kaminski, 2015). In fact, he recalls that the FFRDCs needed to be “saved.” Natalie, however, pressed hard for maintaining and stabilizing PAF funding. Kaminski recalls her remarkable access to Air Force senior leadership, and that she could talk directly to the chief of staff and vice chief of staff to show how RAND was contributing to the Air Force mission and national defense. He recalls that Natalie could point to many comprehensive studies, such as nuclear deterrence and bomber capabilities, that clearly had impacted the Air Force decision process. A former Air Force secretary, Mike Wynne, says that Natalie “gets a lot of the credit for making sure RAND was relevant” during tough budget years (Wynne, 2015).

Gen Ron Fogleman, a former Air Force chief of staff, described to Natalie his view of a waning relationship between PAF and the Air Force as similar to a long marriage: After a while, the couple can gravitate to taking each other for granted. In fact, he believed that FFRDCs, such as PAF, go through periods “without a lot of scrutiny” (Fogleman, 2015). Natalie agreed, and together they decided to take action. The chief established a policy that required a general officer be involved with each PAF project and report regularly to the chief of staff on the
projects. In Natalie’s words, “that was big; it showed the [Air Force] was involved.” According to Jim Thomson, who was president of RAND at the time, “she did a great job during the drawdown [of budgets in the 1990s]” of cementing PAF’s role for the Air Force (Thomson, 2015). Brent Bradley, who was director of PAF before Natalie, agrees, saying she did a “good job of getting the Air Force to commit resources [to PAF] after budget cuts after the end of the Cold War.” He attributes her success to good work done by PAF but also to the longstanding trust she had built and her “ability to be frank” (Bradley, 2014). She had an “extraordinary reputation” (Kaminski, 2015). One former vice chief of staff, retired Gen John Corley, recalls that she was a “fierce advocate for RAND,” who would argue that projects should be assigned to RAND purely for the skills there and not for less-important reasons. He adds that her arguments were credible because of a “long track record of integrity and skill” (Corley, 2015). Fogleman recalls that “her style was credible. Approachable. Very persistent” (Fogleman, 2015).
Friction

An important part of leadership is to provide resources: Two of the most important are manpower and funding. During her tenure as the leader of PAF, Natalie fought hard to secure funding for PAF in the Air Force budget, especially a consistent budget. Arguing about money is distasteful to most and can result in rancor between the participants, but Natalie never shied from arguing her case for PAF funding at the highest levels of the Air Force. Former Air Force chief of staff Gen Norton A. Schwartz recalls disagreements with Natalie over what he calls the RAND “stipend.” He thought that over time the funding for RAND had become untouchable, an “entitlement” in days when defense spending continued to decline. “In tight times, the RAND [funding] was off the table, and I had a different view than … Natalie,” Schwartz says. He thought that RAND funding should be vulnerable to reductions as the entire Air Force budget was vulnerable. Natalie disagreed; her arguments were that, if PAF were to be effective, she needed expertise on-hand—a stable or bench of expertise—that could respond quickly and thoroughly to Air Force needs for analysis. Furthermore, if funding was unstable and oscillated widely, those experts would find more-stable employment in other places. Reduced to its essence, Schwartz’s argument saw Air Force funding going to PAF that he believed exceeded the level of effort it produced. Natalie would counter that the expertise had to be retained and constant in order to maintain a strong organization. Furthermore, she was not shy about taking her arguments to higher levels—including to the secretary of the Air Force, to whom she had easy access. Schwartz says, “I understood that she was passionate and would use her access to get what she thought was correct. The secretary knew my views … but in the end I knew she would pursue her passion” (Schwartz, 2015).

In the military culture, “jumping” over levels of the chain of command is often a serious faux pas, so how did Schwartz view Natalie using her access to higher levels? “Natalie had access and she used that access, and I never saw that as being disloyal because I trusted her motives.” “There remains,” he says, “great affection, respect and appreciation for her knowledge of the technology of our business and her
fact-based analysis and the continuity that she provided to our airmen. Indispensable, frankly. I mean who else … has had quite the same impact?” (Schwartz, 2015).

Natalie argued for funding in other areas of the air staff and with other senior officers. Retired Lt Gen Steve Wood served as the deputy chief of staff for programming during which he “was accountable to the secretary of the Air Force and the chief of staff for all programming and budgeting decisions,” including internal programs, logistics, sustainment, procurement, installations, and funding to all FFRDCs, including RAND. Wood describes his view of PAF in a unique way; he calls PAF “our most valued critic and most valued wingman.” He also recalls that he and Natalie had professional disagreements not only about the amount of PAF’s budget but also the corporate process that established PAF funding. The corporate process, or “board structure” as many call it, is regimented and consumes the better part of a year from start to finish and spans the air staff from the lowest level of action officers up through the chain of command to a budget that is finally approved by the secretary of the Air Force. It is reviewed, vetted, modified, and approved at each step along the way, and Wood says, “vetted every dollar [the Air Force] spent.” It was a process of which, he says, “We were all proud.” Each level of the process has experts in every area, including funding to FFRDCs, that is backed by the experts’ analyses. So the professional disagreements between Wood and Natalie were not only about the amount of that funding, but also her influence on the corporate process, which as the head programmer, he felt compelled to defend the hard and meticulous work of his subordinates. She tracked PAF funding throughout the process; if she thought it was inadequate, she would confront Wood, and they would “hit heads.” Furthermore, if she did not get the answer she wanted from Wood, she would use her access to the chief of staff and even the secretary of the Air Force to argue her case. When that happened, Wood says, “I can’t think of

It’s the work that matters, not the applause.
—Natalie Crawford

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a single time when the secretary or the chief of staff didn’t call me to explain my position.” He continues, “Sometimes our corporate process for RAND [funding] was modified purely because of her ability to articulate her position” (Wood, 2015).

So what is Wood’s opinion of Natalie’s methods and work? “Like every other senior airman, I am a huge fan of Natalie Crawford … for what she has done for the Air Force and the nation over the years,” Wood says. Natalie was “one of our biggest critics when we needed to be scolded,” he says. But it was always based on research and analytics. “There was never a time when I thought she was not doing what she thought was best for the Air Force and the nation” (Wood, 2015). The trust that Natalie has garnered from these senior officers is the result of decades of professional and often very close personal associations in which she has always backed opinion with analysis and been scrupulously honest.
To some it may seem that there is a dichotomy between being so close personally with so many senior Air Force officers and being able to objectively analyze Air Force issues. Retired general and former RAND board of directors member John Handy pointed out in a discussion of Natalie’s familiarity with the Air Force, “my sense is [that] the critical issue for RAND is to be objective and critical as an honest broker.” He continues, “you lose value when you become an insider … if the Air Force finds you are becoming too much inside then [you are not seen as] an honest broker” (Handy, 2015). Natalie certainly walked a very thin line between insider and outsider for many years, and it is clear that there were times when she was seen as too inside or too connected—but, interestingly, she maintained her credibility even when there was significant friction. Schwartz, when asked if she had stepped too far into the Air Force as an insider, says, “She was never captured [thinking that she was an Air Force insider]. That’s true” (Schwartz, 2015). Many others reinforce his view. Natalie’s credibility as a clear observer of Air Force matters was continually reinforced by her often-blunt honesty. Former chairman of the Joint Chiefs and Air Force Gen Dick Myers says, “If Natalie tells you that your baby is ugly, you say, ‘Thank you’” (Myers, 2015). A RAND contemporary and frequent work partner, Al Robbert,
commenting on her direct approach, says that she once told him, “You have earned the right to bite the hand that feeds you” (Robbert, 2015).

Natalie believes that the heart of RAND work is described by two words: independent and objective. She says,

the Air Force can pay anybody to tell them what they want to hear, but … what they need to hear is what they need to hear … and the idea is to work close enough with the [sponsor] to make sure [we] have the facts, that we haven’t missed something, that we talk to [the sponsor] often enough, and if we’re finding something that is going to be a surprise … [the sponsor] finds out about it early. Very, very important. They pay us for that (Crawford, 2011).

Furthermore, she sees trust as an important goal, and she works hard at it in the same way she did with her childhood friend Gretchen. Natalie says,

[Trust and teaching] are very, very precious to me. That does not mean that I tell people in the Air Force what they want to hear. [It] is based on my best ability to analyze the question or the problem, that this is the answer that I can give you based on the assumptions. I will not [say] something to make you feel good. If it makes you feel good, well that’s nice, but it isn’t because that was my goal. My goal is to answer your question. I will never answer your question publicly. My job is to advise and try to give you the best I can, independently and objectively. That’s my job (Crawford, 2012).

Natalie believes she has credibility with Air Force leadership. “I work hard to have [credibility]. I don’t work hard to be their best friend, but I work hard to do the best I can for them. If I feel like I need to go tell somebody something, I will get on their calendar and go tell them. I will tell them respectfully” (Crawford, 2011).
Natalie applied her talent for building relationships to the formulation of effective project teams within RAND. Jim Thomson’s respect for Natalie came early in his years at RAND. He recalls that when he needed someone with expertise in weapons, aircraft, and munitions effects to do analysis of Warsaw Pact and NATO forces facing each other on the Central Front, Natalie was the obvious choice. He states that she “was very assiduous” (Thomson, 2015). He was just as impressed with her team building and leadership skills. In his words, she “built very powerful teams.” Thomson says that Natalie inspires work from her teams because she is loyal to her teams and they return it in kind. And he saw firsthand when Natalie took him to visit the weapons center at Nellis that her Air Force contacts were just as loyal to her. “Her access [to the leaders as well as the rank and file] was very obvious. Everyone knew her name” (Thomson, 2015).

During his leadership years at RAND, Thomson sometimes consulted an organizational psychologist, Clint McLemore, to advise him on personnel and management issues. Of Natalie, McLemore says, “She is the quintessence of a dedicated leader” because she can win the hearts of her people by “enrolling and franchising them.” People respect her, in part, because she respects them, and she cares “immensely” about them. These characteristics coupled with her “deep and thorough subject-matter expertise” are her greatest assets (McLemore, 2015).

Bart Bennett, who as a young analyst at RAND recalls some dark days when RAND was reducing its staff, and the uncertainty and anxiety within the staff wondering who would be asked to leave. He admired Natalie’s approach. She first got his team together and told
them what she knew. She was deeply concerned and visibly “upset.” He says he was “very touched” and wanted to stick with her because “she would fight for you” (Bennett, 2016). Others held the same opinion. Dick Hillestad says she was an advocate for her staff; whenever RAND needed to reduce staff, “she always fought for [them]” (Hillestad, 2016). Her staff members were not the only ones for whom Natalie showed great concern.

Steve Hosmer, a RAND contemporary, has personal experience working on teams with Natalie. Following Operation Desert Storm in 1991, the Air Force tasked PAF to gather and analyze data from combat operations. Hosmer’s piece of the project was to assess the effects of airpower from the Iraqi perspective. In addition to combat battle damage assessments (BDA), Hosmer included analysis of lengthy interviews with Iraqi prisoners ranging from common soldiers to ranking Iraqi generals. Working alone to gain insight from the huge body of data available, Hosmer recalls that Natalie was “very supportive.” That support would become very important when Hosmer briefed his findings to the military; both the Air Force and the Army were annoyed, and some were “furious.” Hosmer concluded that the Air Force had not destroyed as many Iraqi armored vehicles as claimed; the numbers did not add up. Furthermore, he concluded that many of the vehicles the Army claimed as destroyed had already been abandoned. There was in his words, “an uproar” that included one general storming out of a briefing. Throughout this firestorm, though, Hosmer says that Natalie supported him, and he says she was very “interested in advancing the interests of the nation” (Hosmer, 2015).

According to Bart Bennett, Natalie knows how to build and lead teams. During one occasion when he was a team leader and Natalie was his program director, he recalls that he was struggling with a budget and staff allocations. She helped him put together the team, the budget, and instructions for the team. “She guided me … then let me

Her Rolodex was infinite!
—Carl Rhodes
run with the ball. [I] never had the feeling she was micromanaging. But, she was very direct about asking, ‘What do you mean by this? Are you sure that’s what you mean?’” (Bennett, 2016). Another longtime RAND colleague, Jeff Hagen, reinforces Bennett’s assessment, saying, “I’ve never seen her act as a [usual] project leader—step by step. [She is] much more of a strategic thinker … who knows the client very well and builds her teams accordingly.” Hagen observes that she is very focused on relationships, not only with the client but with her teams, and what she has really done at RAND is manage relationships (Hagen, 2016).

Followers look to team leaders for stability and direction during stressful times, and certainly there were many stressful times for Natalie over her five decades of service at RAND. The attacks of September 11, 2001, on America were one such dark time that challenged leaders at all levels. Carl Rhodes of RAND recalls one part of how Natalie, then the vice president for PAF and who was in the Pentagon during the attack, responded. She fired off an email to all PAF members two days after the attacks. In part, it said:

We are all so fortunate to live in a country that is as great and free as the United States. We have pulled together to fight and protect against foreign threats, threats we could identify and concentrate against and in their own territory, away from our shores. This has now changed. Not that it has been a secret or an unimagined event, but now we know for sure that we are not immune from attacks against our cities, attacks within our country’s boundaries. But as we have before, we will rise to the needs, rally around those who need our support, and do what we have to do to keep our country great and our people free.

Rhodes found her message to be “very motivating” (Rhodes, 2016). Hagen attributes many of his successful projects to Natalie’s ability to get data from the Air Force when he or his team met roadblocks.
of either concern or mistrust about sharing data. He wryly states about getting data: “We are dependent on the kindness of strangers” (Hagen, 2016). Natalie, though, had so many contacts, several of which were senior ranking officers who trusted her, that she was often successful in breaking up data logjams. Hagen cautions, though: “She’s a big hammer,” to be used only if absolutely needed (Hagen, 2016). Rhodes agreed; he says that Natalie could always send him to the right place for information, whether it was Global Strike Command, Air Force Research Laboratories, or any place. He says “her Rolodex was infinite!” (Rhodes, 2016).

Natalie applied the same talents for building relationships to her extensive contacts within the Air Force. In her 50 years at RAND, Natalie has built an impressive network of contacts there, as well as in many government agencies, industry, and academe, and she is skilled at bringing the right people together at the right time to solve current problems. In the words of retired Air Force Gen George Muellner, “she can put together folks to produce one-plus-one equals three.” Muellner cited the following example. During her long tenure as a member of the Scientific Advisory Board (SAB), Natalie learned of the concept for a bomb that could be guided using the global positioning system (GPS). Following her work on the RAND study of the 1991 Gulf War, Natalie also knew that the main precision-guided munition (PGM) of that war had been laser-guided bombs (LGB), but LGBs were purely a visual system, so LGBs were useless when meteorological conditions were poor. Muellner at that time was the director of the
research and development division at Tactical Air Command, seeking a path to develop a weapon that could be used in any weather. Muellner also believed strongly in Kent’s strategy-to-task methodology, a part of which was the formation of conceiver groups—a process that gathers diverse thinkers to solve a common problem. Together, Muellner and Natalie formed a small conceiver group with representation from Strategic Air Command, Tactical Air Command, Eglin’s armament laboratory, and Kent and Ted Harshberger from RAND. The group devised a plan to attach a GPS guidance kit—a strap-on—to a common general-purpose bomb that could be guided from space through the GPS. The group called it the all-weather PGM, because all the weapon needed was the target latitude, longitude, and elevation to

She can put together folks to produce one-plus-one equals three.
—Air Force Gen George Muellner

hit the target, no matter the weather. Test results of the concept proved very accurate. Ultimately, the concept they conceived became the joint direct attack munition (JDAM) widely, and successfully, in use today (Muellner, 2014).

Others ascribe Natalie’s “just being there” as an important part of her talent to facilitate problem-solving. A former Air Force chief of staff, retired Gen Mike Dugan, recalls the first time he met Natalie. He was a colonel at the Pentagon and the executive officer to the vice chief of staff when he watched Natalie in meetings. He recalls that she was not onstage, but she was sitting in the back row “listening all the time.” She was visible and wanted to make RAND’s skills available when needed. He recalls that she had a “graceful way of doing that informally.” Later, as the commanding general of United States Air Forces Europe (USAFE), Dugan again saw Natalie’s presence as often available, listening and learning, and offering RAND assistance or sometimes facilitating experts from other institutions. Dugan’s view was that she was “doing her duty. Seeing and being seen.” Natalie and
RAND had been very involved in the deployment of American cruise missiles into the theater, and Dugan expresses his appreciation for RAND and Natalie’s work. “RAND answered questions and the two or three others you should’ve asked!” he says (Dugan, 2015).

One of Natalie’s earliest supervisors at RAND was Steve Drezner, who says that most of her career was problem-solving by “getting the right people together,” and that she was “super at understanding the clients’ problems,” even though they were often complex, technical problems. He thinks that RAND was the perfect place for Natalie because she was by nature a problem-solver, and she learns fast and “learns deep” (Drezner, 2015).
Not all of Natalie’s contributions to national defense were made through projects directly contracted with PAF. During her later years at RAND, senior Air Force officials called on her sometimes for advice, sometimes for analysis, and sometimes to ask her to be their eyes and ears on important projects.

Air Force Gen Phil Breedlove has called on Natalie more than once. Breedlove recalls his first exposure to Natalie when he was a student at the Air Command and Staff College, Maxwell AFB, in Alabama. Her presentation introduced the students to PAF, described what it had done and what it could do. He came away impressed with the breadth and depth of what he heard. He made a point of reading “anything that had her name on it.” Her reputation was such, he believed, that if Natalie was on the task, all would benefit because she had “the ability to figure things out by putting herself into the problem.” She had “clarity” in identifying issues (Breedlove, 2015).

Breedlove would call on Natalie many times. One of the first was when he was the air staff’s chief of operations and plans. The new and in-development F-35 program was facing rising costs and under “a lot of pressure.” Breedlove approached Andy Hoehn, Natalie’s successor at PAF, and asked specifically that Natalie be available to help Breedlove monitor the development of the F-35. Hoehn recalls that Breedlove “wanted as close to [the] truth as could be” (Hoehn, 2015b).

Later in his career and after attaining a fourth star, Breedlove assumed duty as the Air Force vice chief of staff and thus the chair of the PAF annual research plan committee, Natalie came to his office, he says with a mixture of humor and respect, “to tell me what was
important in my job.” She discussed major issues of the day, such as active-reserve ratios and space technologies. All, he recalls, with no PowerPoint slides or even notes. She did not dwell on the mundane; rather she approached the “big view” of how the Air Force should look in the future and what its roles and missions could be or might be. At about the same time as his meeting with Natalie, Breedlove had his first meeting with the secretary of the Air Force, who told Breedlove what he thought Breedlove’s job was, and the top priority was to monitor the development of requirements for a possible new bomber, called at that time the long-range strike (LRS) aircraft. The secretary was concerned that, as was common in the Defense Department, many agencies would try to have their pet projects added to the requirements, so he posted his watchman—Breedlove. Breedlove went to RAND immediately and asked for Natalie and PAF. He told her, “I need you to live on this program” to minimize “mission creep.” She became his eyes and ears, and the effort paid off, according to him. In his view,

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**She’s a guided missile with a [100 percent] probability of kill.**

—Air Force Gen Phil Breedlove

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the LRS development stayed under control with space in the concept to grow as it developed. He also used her counsel in the Joint Strike Fighter (JSF) programs and its automatic logistics information system (ALIS). ALIS is a concept borrowed from commercial airlines, and it is a way for aircraft to automatically transmit operating parameters, such as engine run time data, to ground stations to provide information to logistics systems for replacement spares. The system has had a difficult time transitioning into maturity, and several senior officers have relied on Natalie to track the system’s progress and recommend improvements (Muellner, 2014). Of her abilities, Breedlove noted: “She has more impact than anyone in the [Air Force] will ever know. [She goes] to great depths and always finds the problems. Always. She is a guided missile with a [100 percent] probability of kill” (Breedlove, 2015).
Former Air Force Gen John Corley agrees that Natalie always got to the heart of the problem. He qualifies his remarks by noting that he did not always go to PAF for answers because sometimes other organizations had specific competencies more suitable, but, when he used PAF, he could count on Natalie and her people to be clearly focused on his questions and the Air Force’s needs (Corley, 2015).

Others remember association with Natalie and her people as Corley does. Retired Gen Ed Eberhart, former commander of Air Combat Command, recalls his time as a programmer on the air staff. At critical times in the budget-building process, decisions had to be made very quickly. For example, if a program’s budget changed, perhaps because it had a lesser or greater priority, something else in the budget also had to change to compensate because every dollar was earmarked. If one program increased, then another must decrease. Eberhart wanted to base such decisions on strict analysis, not seat-of-the-pants personal views. He turned to RAND and PAF and Natalie, even though they used other companies, which “weren’t as laser-focused as PAF.” He recalls several programs that Natalie and PAF analyzed, such as the conversion of officer billets to enlisted billets and the effectiveness of the F-22. He emphasizes that PAF’s analysis was very useful in identifying the points where risk could be unacceptable, so if a program’s budget was changed, it was quickly evident how much change it could absorb before the risk of failure became too great. Eberhart adds: “You might not get the answer you want, but you got the answer … with a recommendation for the right road” (Eberhart, 2014).

Fogleman, a former Air Force chief of staff, was impressed with how RAND could study complex issues, and especially how Natalie personally could “dissect the issues into understandable chunks.” She was a problem-solver who could leverage her access into the Air Force, where she had contacts in the operational units because of her large network. Furthermore, she was a bridge to analysts, and, in Fogleman’s view, it was a “two-way” bridge because she had such high analytical competency combined with a deep understanding of how the Air Force works. She also had credibility and therefore access to senior-ranking Air Force officers and civilians. She was an advocate for the Air Force but from outside the Air Force. She could talk to the right person at
the right level. Her style was credible and approachable. She was very persistent. He admired her honesty and recalls several instances when someone would call her “Dr. Crawford,” an error that she would correct immediately, since she was not the holder of a doctorate (Fogleman, 2015).

In fact, Natalie holds a bachelor’s degree in mathematics; although she did some postgraduate work, she did not attain an advanced degree. Retired Gen Paul Hester, former commander of Pacific Air Forces, does not recall her lack of an advanced degree as a negative. He stated that oftentimes there is too much credit given to advanced degrees for their own sake, and that Natalie had attained, through hard work, diligence, and experience, a level of “structured thinking” that inspired him to adopt her methodologies. Although PAF was usually engaged in many studies of the Pacific theater, Hester recalls that he often consulted with her not about the studies but how to determine “what is the real question?” and “how do I ask it?” Like many others, he credits her with a “lifelong thirst for knowledge and desire to structure answers and solve problems.” Her structured thinking allowed her to go directly to the heart of a problem, and he recalls her talent at leading PAF, his predecessors, and himself through a long effort to restructure Pacific Air Forces following the dissolution of the Soviet Union and especially after the end of the first Gulf War. He recalls always being interested in the formal studies but even more interested in her views of how to employ his forces. He opines that on the Pentagon’s air staff, there were many civil-service employees that provided corporate memory, but he views Natalie and PAF as significant contributors to that corporate memory (Hester, 2015).

Retired Air Force Gen Jim McCarthy supported Hester’s views. He says that he has observed a pattern to Natalie’s problem-solving skills. First, he says, she listens carefully to points made in a discussion, so her grasp of the issues is “very impressive.” She is not afraid to ask questions where others might hold back. She is not bashful and will “take on anyone, but in a very diplomatic way.” He observed senior officers who paid “careful attention” to what she said, and he states that “they count on her to summarize the problem then suggest a [way ahead]. Furthermore, her arguments, although they may be confronta-
tional, are always logical and delivered in a “considerate and respectful manner” (McCarthy, 2015).

David Ochmanek of RAND recalls an example of Natalie’s ability to identify a problem and connect the right people for a solution. In 2014, Ochmanek had just returned to RAND after serving as the deputy assistant secretary of defense for force development at the Pentagon. Russia had annexed Crimea and seemed focused on intervening in Eastern Ukraine. Natalie came to him and asked him what was being done to anticipate further Russian aggressive action. Ochmanek replied that nothing formal was being done because PAF had no task or funding to do so. She specifically wanted to know what PAF was doing to help Breedlove, the Supreme Allied Commander, Europe, with whom she had been in contact. Shortly thereafter, a project task and funding arrived to assess the implications of Russian hostility for the Air Force. Ochmanek decided to focus the bulk of the project’s efforts on gaming defensive actions in the event of a Russian attack against the Baltic States that are members of NATO. After several iterations of the game had yielded insights on the nature of the conflict and the sorts of things the United States and NATO should be considering to bolster their posture on the alliance’s eastern flank, Natalie arranged a secure telephone conversation between Ochmanek and Breedlove that resulted in PAF giving Breedlove a memo discussing such things as options and force enhancements that he used in conference with the defense secretary a few days later. Ochmanek sees this chain of events as an indicator of how Natalie saw problems that could arise and using her vast contacts to put the right people together to arrive at a solution (Ochmanek, 2017).

Andy Hoehn recalls that she had the “most extraordinary access” to the top military leaders. She could understand their problems, and she could translate those problems to RAND’s analytic and problem-solving
abilities. Furthermore, she was sometimes “prescient” in predicting their needs, and he provided an example. During her time as the leader of PAF, the Air Force was studying the requirements for a new long-range aircraft—actually a bomber. The Air Force vice chief of staff had tasked PAF to consider the attributes of such an aircraft, but within the Air Force and the Defense Department there was, according to Hoehn, “not much appetite” for PAF to do such work, and that any work PAF might do “wouldn’t matter much” because the Air Force’s internal study would be adequate to justify the new aircraft. Natalie pushed to complete the analysis even though the corporate Air Force essentially ignored it. However, in 2008, the Defense Department decided to cancel the program, but the secretary left open a door by stating that he would still be open to further analysis. Suddenly, the PAF analysis became valuable—and popular—within the Air Force and Defense Department; it was thorough, looked at a wide array of options and had a set of recommendations. It generated further study and ultimately the Defense Department reinstated the program (Hoehn, 2015a).

Certainly Natalie’s value to the nation extends beyond her analytical and leadership skills within RAND and PAF. She is a master at facilitating the success of a project or effort by bringing together people from diverse sources with the right combination of skills, backgrounds, and personalities. Perhaps that is not surprising for someone who has more than five decades of experience, but these are skills that Natalie developed very early in her career. Ron Iverson, former Air Force lieutenant-general and one of his generation’s most-respected fighter pilots, recalls his years as one of the original Aggressors when he was seeking information about Soviet training, tactics, equipment, and military culture to present as a key ingredient of the training the Aggressors offered to operational Air Force fighter pilots. He asked for help through his senior commanders and was referred to RAND and Natalie, who had not yet made her connection with the FWS, nor had she started her journey of flying in several Air Force fighters. Natalie referred him to contact points across the intelligence communities in the Central Intelligence Agency, National Security Agency, and the other military services. The academic presentations that resulted from Iverson’s and others’ efforts, aided by Natalie, were of a caliber never
seen before in the tactical fighter force and a highlight of Aggressor “road shows” worldwide.\textsuperscript{1} Shortly thereafter, Iverson was selected to fly actual Soviet aircraft in a then–top-secret program that exposed American pilots to the real threat. As this program, known as HAVE PAD, developed, Iverson recalls that he consulted Natalie and her intelligence sources regularly. “She was a wealth of information” (Iverson, 2014).

\textsuperscript{1} Ultimately the Air Force had three major Aggressor groups: one at Nellis for stateside training, one in Europe, and one in the Pacific. The Aggressors traveled to fighter bases periodically to train pilots for aerial combat versus Soviet tactics. For a complete discussion, see Anderegg, 2001.
Mentor, Partner, and Friend

Natalie can rattle off a list of others who have mentored her, and she is convinced that she has learned something from each of them. All of which fits into her mantra, “Every day is a school day.” Still, though, Natalie recalls her best mentor as her husband, Bob, who “taught me to think.”

Robert C. Crawford was an educator, author, inventor, tax accountant, athlete, and coach. He taught high school mathematics in his hometown of Salt Lake City, Utah, and later at Santa Monica High School and Santa Monica College in California. He co-authored a popular calculus text, and he was study director for a U.S. Department of Education program that “pioneered in teaching algebra to first graders” (“Death: Robert C. Crawford, Mathematician and Educator,” 1994). His inventions included a patent for protecting structures during earthquakes. He was an exceptional athlete and pitched for the Hollywood Stars in the Pacific Coast Baseball League. Later, he coached a woman’s softball team to national prominence, as well as men’s basketball teams, leading to his participation in selecting Olympians for the U.S. men’s basketball team. Later in life, he co-owned a minor league baseball team.

According to Natalie, Bob taught her critical-thinking skills, and how to break down a problem into its components, analyze the smaller
parts, and then begin constructing solutions to solve the larger steps. He was an advocate of George Polya’s heuristic approach to problem-solving, and, typical of Bob’s delight in always teaching, kept a ready supply of Polya’s book, *How to Solve It*, to give to visitors whom he thought would learn from it and find it interesting.

Bob was interested in everything, Natalie remembers. He always seemed to have a notepad available on the nightstand beside the bed or on his desk or on the arm of his chair where he wrote down ideas, questions, and observations. Usually his notes were thoughts about problem-solving, ranging from how to invent an opener for a pop-top soft drink can to the economic implications of the Federal Reserve system and its impact on American life. Although an engineer and mathematician by education, he had studied economics under Marriner Eccles at the University of Utah, and that experience fueled a lifelong interest in and curiosity for monetary systems. Bob Crawford was far from being solely an academic thinker, though. He believed that to be a good teacher, one had to have broad and meaningful life experiences. He told Natalie, “you can’t live between the covers of books … you have to live the events” (Crawford, 2016).

Natalie relates a story about Bob that underscores his love of problem-solving and his competitive nature. He loved chess and competing in chess tournaments. He was competing in a simultaneous tournament against a grand master wherein the master competes against several contenders at the same time, moving from board to board to take his turn. Late in the tournament, Bob and two other challengers survived, and Bob was still alive because he had eschewed traditional play to attack the master aggressively. The master’s manager told Bob that the master was willing to give him a draw, saying it would be an honor to play him to a draw and asked if he accepted. Bob responded: “But what an honor it would be to win!” He continued to play and won the game.

Natalie credits Bob with teaching her the value of relationships; not just relationships for the day or the project, but relationships that last a lifetime and that are nurtured as the parties’ lives evolve, advance, and mature. Furthermore, he was an important part of her relationships with Air Force officers, and he often traveled with her on her
business visits. Many interviewed for this book recalled Bob accompanying Natalie on visits, and his vast interest in many subjects and deep understanding of most of them. One said that he was highly intelligent, but “didn’t try to show off his intelligence” (Dugan, 2015). Another,
Natalie’s commercial driver Francene Hudson, recalls that Bob was a vibrant conversationalist who would discuss with Hudson “everything from sports to politics” as she drove. She stated: “He was very smart.” She also recalls that he always held Natalie’s hand as they traveled. “I could see the love between them,” she adds (Hudson, 2017).

Bob was particularly interested in the children of their hosts. One senior officer recalls his kindergartner daughter delighting Bob by knowing something of the Morse code. The next week a book arrived in the mail that was a young person’s tutorial on learning and using Morse code (Jumper, 2014). Another related that Natalie mentors his son, now a senior officer in the Air Force (Iverson, 2014). Another said of Natalie and Bob’s relationship, “living with Bob Crawford was like getting a Ph.D. in its own right” (Corley, 2015). Natalie and Bob were married 25 years; he passed away in 1994.

By the time Natalie reached the directorship of PAF in 1997, she had established relationships across the Air Force and the Defense Department. In many cases, her professional relationships were also personal ones, but she clearly understood that there was a line that she could straddle but never cross into the area where her personal relationships could cloud her objectivity. One person close to Natalie professionally and personally is retired Gen John Corley, whom Natalie met when he was a young major assigned to the studies and analysis division of the air staff. Although they had a close friendship over several decades, he recalls that when it came to work she was “fiercely objective.” He recalls that she mentored him as a young analyst by cautioning him that there would be times when he would be asked to “back in” data to support previously decided conclusions. She told him, “It’s the work that matters; not the applause.” Corley says that one of her greatest strengths is that she builds relationships “based on trust and respect.” She builds professional relationships, often mentoring, then “enhances” them by building personal ones as well. Corley points to her continuing interest in a person’s career and interests through regular contact. He says, “She doesn’t just show up when it’s business.

1 Corley later became the director of Air Force acquisitions as a three-star, the Air Force vice chief of staff, and then the commander of Air Combat Command as a four-star.
She has a genuine interest in your work and your personal life.” Early in their relationship, they discussed a mutual desire to make the Air Force better; according to Corley, they understood that one way to do that was to mentor people to achieve their highest potential. Another technique that Corley learned from Natalie he calls “follow through.” When a report is finished, she makes sure that the right people read and understand it. He recalls a time when he was a four-star major command commander, asking to see an abbreviated version of a PAF study. Natalie called him and encouraged him to see the whole thing so that he could fully understand it. She knew that he was busy, but she convinced him that he needed to take “the time to get the right picture.” Corley also credits Natalie with encouraging him to be a broad thinker. He expresses his and her frustration that too often projects submitted for PAF study had “not a lot of thought from broad, visionary thinkers.” He says he and Natalie were in agreement that first should come a broad vision and then strategies mapped to the vision all the way down to the tasks needed. Kent mentored Natalie; Natalie mentored Corley (Corley, 2015).

Others found her mentoring a necessity. As a newly minted one-star general, Ed Eberhart came to the Pentagon fresh from a tour as wing commander having been assigned to a slot in Air Force programming, the office responsible for determining the apportionment of funds to programs. Eberhart recalls needing help, and he had seen Natalie in action. “No doubt that she mentored me. I was looking for help and she was someone I could count on,” he says (Eberhart, 2014). Others had similar observations, but one observer’s perspective is interesting; she says that some Air Force leaders had such a close working relationship with Natalie that they could be completely open and say, “[I’ve got a problem, but] I’m not sure what I want or what to do” (Austin, 2017).

On one of her many trips to Nellis AFB, Natalie met Bruce Don, a Vietnam combat veteran and highly experienced instructor at the F-4 weapons school. Natalie invited Don to RAND, and while there he learned about the graduate school, which fit his plan to attain higher education even if it meant leaving the active-duty Air Force. With Natalie’s encouragement, he made the leap and took his doctorate at
RAND, where he stayed for decades. As a program director at RAND Arroyo Center (RAND’s Army Research Division), Don worked closely with Natalie and PAF on an “impressive series” of models of expected Warsaw Pact capabilities, capacities, and tactics facing NATO. The models underpinned the RAND analyses that ultimately informed the Alliance’s decisions to modernize and expand in the late 1980s and 1990s (Don, 2017).

Cynthia Cook, who has had a noteworthy career at RAND spanning two decades, recalls three areas where Natalie had a “profound influence: researcher, mentor, and role model.” Cook says that, as a researcher, Natalie demonstrated a remarkable ability to get at the heart of an issue. No matter the quality of the briefing, Natalie could extract what (if anything) had value to the sponsor and describe and present it in a more-coherent way. She showed Cook how to derive fundamental findings and link them to how the work could impact the Air Force. Mentoring Cook, Natalie showed her how to connect with the Air Force and how to understand its culture, always being respectful of the RAND charter for objectivity and not crossing the “insider/outsider” line. Natalie taught Cook that “words matter” and to be specific and focused in her communications (Cook, 2017).

Wanda Austin, former president and chief executive of The Aerospace Corporation, interacted frequently with Natalie and relates a similar observation that Natalie gave her “career encouragement support and validation. There are not many women in this business. Sometimes it feels like you are on an island, and it’s really important for support and validation” (Austin, 2017).

Finally, Cook notes that Natalie served as a terrific role model, both for the quality and skill of her leadership, which was the source of many useful lessons, and also as a woman serving as a RAND vice president and leading an important unit. “Natalie’s support helped me grow as a colleague, as an analyst, and as a leader, and has been fundamental to whatever subsequent success I have had at RAND,” she concludes (Cook, 2017). Such narratives were common among those interviewed for this book, as many noted Natalie’s talent for connecting on a personal level yet always staying focused on the mission. Cook notes, however, that she sees that ability not merely as a natural gift of
Natalie’s but something she has worked very carefully and thoughtfully to cultivate (Cook, 2017).

Many others in RAND reaped benefits from Natalie’s mentoring. She fondly recalls the accomplishments of Don Stevens, whom Natalie hired from a major aerospace company, recalling that his work was “fabulous” as an engineer but that he was “restless” and wanted bigger challenges. In the early days of the advanced tactical fighter (ATF) development, Natalie, as a program director within PAF, worked closely with the Air Force office charged with studies and analyses, and she linked Stevens with then–Maj John Corley so that RAND and the Air Force could share data and work closely as the ATF requirements and forecast capabilities evolved. All along the way she taught Stevens what she knew through what she describes as “active mentoring.” Their offices were nearby and their relationship was such that either could drop in on the other to discuss topics ranging from the personal to the professional and from successes to frustrations. Natalie recalls that “every conversation involved teaching and sharing.” Stevens went on to be a program director himself and applied his and his teams’ analytical talents to newer programs, such as the precursor to today’s joint strike fighter—the F-35. Natalie recalls that he had a “terrific ability to mentor without smothering” (Crawford, 2016).

Ron Iverson, the former Aggressor, recalls Natalie mentoring him, not so much in the aspects of his duties but rather in his professional career. “She advised me all along the way,” he says, “always enthusiastically willing. She always asked what I planned [for my future career], and when I told her she would agree or suggest another path she saw as available to me.” Iverson and many others agree that Natalie’s personal association with the Air Force was a reflection of her view of the Air Force as her family. In Iverson’s view, this became especially true following the death of her husband, Bob, when she “completely immersed herself in the Air Force.” Although she and her husband had no children, Iverson states without apology that she is “absolutely the mother of generals” (Iverson, 2014). And this claim is not without agreement as several others, many of whom attained the highest ranks, believe the “mother of generals” appellation to be accurate. Gen “Norty” Schwartz, former Air Force chief of staff, in reference to her frequent mentoring
of young officers, commented: “She had lots of babies along the way,” adding, “[She was] a person who gave her entire life essentially to our Air Force. She was so dedicated and adopted so many of us along the way and invested her intellect in us. She is the quintessential mentor from outside the Air Force” (Schwartz, 2015).

Schwartz is one of many who credit Natalie with broadening their Air Force horizons into areas in which they had little previous experience. In his case, she was particularly helpful when he was in a senior billet in programming. The bulk of his early career had been in special operations, so he admits having “blind spots” when it came to mission areas, such as space and conventional attack. Natalie introduced him to experts at RAND that could “enlighten” him. Later, when he became chief of staff, he assesses himself as not a “technical guy.” But he knew he could get an authentic answer from PAF that was “not influenced by a contractor or any of the tribes in our Air Force.” He believes this experience to be true of his predecessors who worked with Natalie (Schwartz, 2015).

Bart Bennett started his career at RAND in 1984, saw Natalie in action, and “patterned my work habits after hers.” One such habit was thinking in analytical terms and Bennett relates his recollections of Natalie’s mentoring in a specific, orderly list:

1. Do not be intimidated by higher-ranking people. “Everyone puts on their pants the same way.”
2. Do not hesitate to pick up the phone and ask the client a question. Talk to them.
3. See people. Remember their names. Walk in their shoes. Get out of the library or office and go to them. Know their limitations and concerns.
4. Do not be a slave to your briefing slides. Be able to answer questions without shuffling through the [slide] deck.

He recalls that Natalie “had the uncanny ability to make everyone in the room believe that she was their best friend” (Bennett, 2016).

Others noted her talent for putting new acquaintances at ease and then nurturing the relationship over time to one of mentorship. Heidi Shyu, who had a long career in the defense industry as an engineer and
executive and rose to become an assistant secretary of the Army, recalls her first meeting with Natalie as “very personable.” Shyu, a key developer of a radar system for the JSF, briefed Natalie on the system and remembers that Natalie not only asked “very deep” questions about the system, she also expressed genuine interest in Shyu’s background and interests, which Shyu notes “was very unusual in the industry.” From then on, Shyu feels that Natalie was a mentor to her, often discussing their common business but always including discussions about family and career paths that Shyu could pursue. She also noted the example Natalie set for her gender: hard work and a genuine concern for the people and deep love of the Air Force.

Natalie expresses her view of gender in the workplace in typically pragmatic and blunt commentary. Natalie has never felt that her opportunities in life were in any way affected by her gender. She says: “I have never felt different, ever.” She recalls being the “only girl” in her math and physics classes, and that seemed normal to her. How she got along was driven by how she performed, a lesson learned from her demanding high school math teacher. So it was always about achievement to her both within RAND and the Air Force. She believed that if she presented a case with solid analysis that is all that mattered. She says,

I never felt like I had to claw my way into any situation. Maybe there are people who think that because I’m female and I’ve done what I’ve done in my career that I’m a special example, but I don’t feel like one. I’m happy to mentor anybody, no matter girl or boy, but the main thing to me is that you earn respect one day at a time. You lose it in a heartbeat. So you always have to do the best you can. I’ve had incredible opportunities offered to me because of my work at RAND and for the [Air Force] … I’m grateful for that, [but] I didn’t get anything because of any other reason than I earned it (Crawford, 2011).
So, it is not difficult to see why Shyu views Natalie as a role model, someone that she deeply admires. Shyu notes Natalie’s trait of acting now to solve issues; not merely with words but with deeds. If there is a problem, she will deal with it directly and promptly. “Right now, not next week” (Shyu, 2016).

It would be easy for a skeptic to dismiss Natalie’s deep associations with so many Air Force senior leaders as contrived and to assume that she cultivated relationships along the way that would benefit her own career. The record, however, reflects the opposite, as many interviewees expressed their views of Natalie’s intentions as always trustworthy, and her objectives never personal but always striving to advance the interests of the nation, RAND, and the Air Force. Several people provided examples of Natalie’s interest in young officers throughout her career. Shyu noted that Natalie “always had time for young officers” (Shyu, 2016).

Perhaps the best example comes from Michael Kennedy, who relates a day when Natalie, at the time RAND’s vice president for PAF, and he were walking through the Pentagon on a very busy schedule. Natalie took a detour to the small office of a young major to congratulate her on being promoted to lieutenant colonel. She spent an hour chatting with the young woman, and Kennedy says the officer was “walking on air” afterward. Kennedy says the important thing to know about Natalie is that the young officer was in a career field in which further promotion was highly unlikely. There was no personal advantage to Natalie taking the time, but she is “genuinely generous with her time and … cares about people” (Kennedy, 2016).

And one last example of her teaching and mentorship: Retired Air Force Gen “Mike” Hostage recalls his first impressions of Natalie when he was a young officer and aide to the chief of staff. She attended many meetings where she “seemed to know more about air power than others in the room … and she had strong opinions about air power.” Their

I never felt that being a woman at RAND made a difference one way or the other.

—Natalie Crawford

2016).
relationship strengthened over the years so that, by the time Hostage was a four-star general and commander of Air Combat Command, it was not unusual for him to discuss his challenges with Natalie. An example he cited was the serious problem F-22 pilots were experiencing with the air supply system in the new jet. In fact, there was a period of time during which all of the F-22s were grounded pending a solution. During this crisis, Hostage recalls that Natalie was “very much a mentor” to him (Hostage, 2015).

Many interviewees related stories of their often decades-long friendship with Natalie, but one serves as a solid example of the comments made by many. Francene Hudson, a commercial driver, chauffeured Natalie for 30 years in the Washington, D.C., area to business meetings and evening functions. “I admired Natalie because she was so down to earth; she was an everyday person to me,” Hudson says. She recalls many times when Natalie met with distinguished people, she would introduce Hudson not as my driver, but as “my friend.” She credits Natalie with giving her “hard core” advice at times even though Hudson did not necessarily agree. Hudson says that she and Natalie were “on opposite ends of the political spectrum,” yet she is sure that they have learned a lot from each other and that they respect each other deeply (Hudson, 2017).

Hudson cites one instance as typical of Natalie. Natalie was attending a large Air Force dinner as Hudson waited in her automobile. An Air Force captain approached Hudson and told her that Natalie had arranged for her dinner. The captain escorted her to an area behind the scenes where the support staff were dining and seated her at the table. “I’ve never had a client look out for me like she did,” Hudson says (Hudson, 2017). That loyalty cut both ways as Hudson remembers Natalie being in the Pentagon when it was attacked on September 11, 2001. Despite the chaos surrounding the Pentagon building, Hudson maneuvered her car to the entrance and was waiting there when Natalie emerged with thousands of others evacuating the building. Hudson states firmly, “I wasn’t leaving without her” (Hudson, 2017).
Senior Fellow, Distinguished Chair in Air and Space Policy, and Professor at the Pardee RAND Graduate School

After leaving the PAF directorship, Natalie became a RAND Senior Fellow, a distinguished chair in air and space policy, and professor at the Pardee RAND Graduate School (PRGS)—positions she has held for slightly more than a decade. Her duties are diverse as she continues to advise, mentor, teach, and work special projects in which the corporation needs her expertise. Her fingerprints are on many issues, but one stands out as illustrative of how Natalie has dedicated her life to seeking

Natalie with 2016 PRGS graduates. Photo courtesy of the RAND Corporation.
excellence and putting it to work for the betterment of those she touches. Beyond her teaching duties, she is personally involved with the students at PRGS, which is the nation’s only graduate school to focus solely on the attainment of a doctorate in public policy analysis. Students come from many sources, domestic and foreign, but Natalie has given special attention to one source in particular—those from the Air Force. Natalie participates in the selection of Air Force candidates, and then follows each closely through the three-year journey to a doctorate. Some candidates come from the active-duty force, but a few, about one or two a year, come directly after graduating and commissioning from the U.S. Air Force Academy (USAFA). No matter the source, once the Air Force candidates graduate, she stays in touch with them as they develop and mature in their officership skills. Dana Born, a retired Air Force general and former dean of faculty at the USAFA says, “Natalie, from the time of acceptance and throughout their lives, keeps up with the USAFA RAND graduates as if they are her family—and she invests in their development personally and professionally—a lifetime guarantee!” (Born, 2017).
Many sources interviewed for this book expressed deep admiration for Natalie’s commitment to volunteerism beyond her professional career by taking active, often leadership roles, in many organizations ranging from ones that have influence across the nation to smaller ones in her hometown of Boonville. The following discussion focuses on three of importance to national defense: the Falcon Foundation; SAB; and her efforts in promoting science, technology, engineering, and mathematics (STEM) education.

**Falcon Foundation**

Shortly after the USAFA admitted its first class, a group of retired senior officers formed the Falcon Foundation, a nonprofit organization whose mission is to provide highly motivated USAFA applicants with the opportunity to improve their academic skills by attending a preparatory school before admission to the academy. Working in conjunction with the USAFA admissions office, the foundation selects applicants who fall just short of academic requirements for admission but are otherwise highly qualified (Falcon Foundation, undated). It is no small undertaking as the foundation provides preparatory school scholarships to approximately 60 applicants per year.

Jim McCarthy has seen Natalie at work in the Falcon Foundation for more than 20 years. He particularly admires her work as chair of the diversity committee, and states that the foundation has provided scholarships to a “significant number of women and minorities
as a result of her efforts.” Another retired general, Gregory Martin, describes her efforts on the foundation to add weighting to nontraditional areas, such as inner-city schooling and fluency in non-English languages. He estimates that the diversity of scholarship students has increased as much as 30 percent thanks to Natalie’s leadership (Martin, 2014). Her emphasis is on characteristics of the applicant rather than race. McCarthy also pointed to her effort to include more women on the board of trustees of the foundation. He remarks that initially there were no women trustees, and that Natalie has taken time to recruit women of the right experiences to join the foundation. He says Natalie played “a major role” in that effort (McCarthy, 2015).

As a chair of a committee, Natalie also was a governing trustee of the foundation, and one of her important themes was to gain a wider involvement of the general membership in the decision process. McCarthy makes an interesting observation of her skill in gaining consensus for a more democratic approach, saying: “She seems to navigate the minefield of divergent opinions” with great success. Furthermore, he credits Natalie with leading the foundation’s efforts to match the right educational opportunities to remedy the lack of some applicants’ skills, in particular those applicants from disadvantaged educational systems. “She has been very effective in understanding those relationships,” he says (McCarthy, 2015).

**STEM**

Many American educational programs and policies use the STEM acronym to describe advancements in education of science, technology, engineering, and mathematics. Natalie, a mathematician by education, has championed STEM or STEM-like programs her entire adult life. She co-chaired with Muellner a panel on STEM education in the Air Force, which delivered its results in a well-received report titled “Examination of the U.S. Air Force’s Science, Technology, Engineering, and Mathematics (STEM) Workforce Needs in the Future and Its Strategy to Meet Those Needs.” The report’s preface describes the need for such a study:
For a variety of reasons, concerns have arisen over the future of both the military and civilian contingents of the Air Force’s STEM workforce. Emerging mission areas, particularly in the space and cyber domains, as well as increasing use of technologically sophisticated systems, such as unmanned air systems, are expanding the need for new technical skills and expertise. Simultaneously, force reductions, ongoing military operations, and budget pressures are creating new challenges for attracting and managing the needed technical skills. Assessments of recent development and acquisition-process failures have identified loss of organic technical competence as an underlying problem. A growing percentage of science and engineering graduates in the United States are foreign citizens and thus ineligible for the security clearances that many jobs in the Air Force and in the aerospace industry require. The existing STEM workforce is aging, with many individuals nearing retirement. Women and minorities are underrepresented in most S&E [science and engineering] educational pursuits at a time when they constitute the majority of college students and therefore the majority of the future workforce. The market for STEM-educated U.S. citizens is becoming much more competitive (National Research Council, 2010).

The Air Force immediately adopted 17 of their 18 recommendations, including those of how STEM-degreed personnel are assigned and provided continuing education. Furthermore, those recommendations established a formal advisory system and position under the supervision of the deputy chief of staff for acquisitions with a retired general officer as director. Muellner credits Natalie for maintaining a high-level of interest in STEM process and policy within the Air Force. He likened her tenacity to a “junkyard dog” (Muellner, 2014).

**SAB**

“The Air Force Scientific Advisory Board is a Federal Advisory Committee that provides independent advice on matters of science and technology relating to the Air Force mission” (Air Force Scientific Advisory Board, undated). The SAB, formed in 1944, reports directly to the secre-
tary of the Air Force and the Air Force chief of staff. The SAB usually has about 50 members appointed by the defense secretary from the nation’s leading experts in industry, FFRDCs, national laboratories, and academia. Generally, the membership is divided equally to achieve a balance of skills (Martin, 2014). Members’ travel costs are reimbursed, but they are unpaid volunteers. Members serve two-year terms with an option for a second term. Each year, the Air Force secretary and chief of staff task the SAB to conduct studies on critical issues and to recommend application of technologies that can improve Air Force capabilities (Crawford, 2014). The SAB also does in-depth reviews of programs within the Air Force Research Laboratory (AFRL) on a four-year cycle. The SAB is led by a chair who is appointed by the Air Force secretary. A vice chair assists the chair. An executive committee, led by the chair, provides oversight of SAB activities (Air Force Scientific Advisory Board, undated).

Studies typically start in January and are assigned to panels that study the issue for six months. Panels then present their findings to the larger board, which then votes on recommendations to the Air Force. These recommendations, representing the board’s views, are then presented to the Air Force senior leadership, which is generally represented by the secretary, the chief of staff, and major command commanders.

The SAB also conducts annual in-depth reviews of the science and technology programs in the AFRL. Each of these weeklong reviews addresses programs in one of the AFRL Technical Directorates, with essentially all AFRL research programs being reviewed every four-year cycle (Martin, 2014). These reviews are briefed to Air Force leadership and influence science and technology pursuits and are often adopted by the Air Force. The SAB is advisory only and does not have the authority to direct Air Force decisions.¹

¹ A list of current and past SAB studies is available at the Air Force SAB website (undated).
Natalie started her extensive contribution to the SAB in the 1980s on a panel that did a study in her earliest area of expertise—aircraft munitions, especially those envisioned to penetrate hard targets. One recommendation of the panel was the pursuit of a hard-target penetrator with most of the mass devoted to the bomb casing with a relatively small proportion of explosive. The Air Force did not buy such a weapon until years later when such a device was needed in the 1991 Gulf War to penetrate Iraq’s deep reinforced bunkers. The weapon was developed quickly for the F-111 and proved highly successful, and Natalie stated that it was “exactly as the panel had recommended” (Crawford, 2014).

Another challenging study that Natalie recalls was one to investigate the cost of stealth materials and manufacturing costs. She recalls the study was “complicated,” and the results surprising to some, including the commander of Tactical Air Command, whom Natalie recalls as remarking, “I never thought it would be that expensive to achieve stealth” (Crawford, 2014). She also contributed her time on studies for theater air defense against cruise and ballistic missiles. Another studied the use of sensors to support combat operations. One SAB member states that Natalie has been “one of [the SAB’s] best advocates for pushing technology,” and always advocating for Air Force funding for research and development (Wong, 2015).

One of the most important reports of the SAB is “New World Vistas: Air and Space Power for the 21st Century.” The report, which marked the SAB’s 50th anniversary, made a bookend with the SAB’s first report, “Toward New Horizons,” which was written in 1944. Natalie speaks with great pride about her position as chair of the attack panel on “New World Vistas,” a cursory scan of which reveals the incredible breadth and depth of the study beyond Natalie’s panel. One example from the summary, written two decades ago, reveals the prescience of the report:

In the fiftieth year of the Air Force Scientific Advisory Board, both the Air Force and the Nation are at the brink of a new era. Our Cold War adversary no longer exists, and we now face threats which are not precisely defined. The situation is further complicated by changing alliances as much as by the absence of
well known adversaries. Armed conflict around the world shows us that the world is still a hostile place, but responses which may have been appropriate during the Cold War are no longer appropriate. There appears, however, to be even more widespread pressure for the United States to remain a stabilizing force throughout the globe. Our military forces are involved in dangerous humanitarian and peacekeeping operations at an increasing rate, and anti-terrorist operations can be expected to increase as well (Air Force Scientific Advisory Board, 1995).

Natalie’s commitment to the SAB has spanned some three decades, and she has served as a panel chair, SAB vice chair, and co-chair. Muellner, who has worked often with her at the SAB, humorously remarks that during the times that Natalie had to be off the SAB because of term limits, she is “in withdrawal” (Muellner, 2014). On a more serious note, Gregory Martin says, “I don’t know anyone not in the Air Force that has been such a contributor to the Air Force as Natalie Crawford” (Martin, 2014). Another retired Air Force general, Frank Gorenc, was the commander of USAFE and recalls Natalie’s “uncanny ability” to help others clearly articulate Air Force requirements. He remembers being asked by the SAB to be in a teleconference to discuss his view of Russia’s recent emergence as a military force with the capability to threaten NATO. The SAB especially wanted to hear his views on USAFE’s potential to operate in contested environments because the Air Force’s recent combat experience in Iraq and Afghanistan had been in uncontested environments. Natalie was also in the conference, and he remembers that she had a complete understanding of the issues, and, more importantly, she was able to guide the discussion to focus on what he considered to be the important points: new requirements, how to define them, and how to program for them. He says this was not the first time Natalie had assisted him in articulating requirements throughout the defense establishment, thanks to her “decades of experience and her insights” (Gorenc, 2017).
Natalie grew up in a strong extended family that valued hard work, education, self-reliance, and commitment. In her young world, there was no such thing as half-in; one did one’s best every day. She took those values with her to California and then the RAND Corporation, where she committed herself to every day being a school day. As her career progressed, she evolved from student to teacher to mentor.

Although she researched and analyzed weapons and aircraft data, she came to understand that the real might of America’s military is in its people, and she devoted her life to helping them succeed. Her personality and her personal values enabled her to establish an enviable, perhaps unique, position of being highly respected, as well as being truly loved. Perhaps her greatest gift is her ability to fearlessly speak truth to power. Time and again, interviewees cited her fierce objectivity and unassailable integrity, both of which she communicated without personal agenda or self-aggrandizement. Her mark on RAND and the Air Force is indelible.
Of her many awards and honors, Natalie selected the following as representative of her career.

**Office of the Secretary of Defense Medal for Exceptional Public Service**
This award was established to recognize noncareer federal employees, private citizens, and foreign nationals for their contributions, assistance, or support to activities receiving operational support from the Joint Chiefs of Staff (Inspector General Instruction 1432.1, 2006).

**National Defense Industrial Association’s Lifetime Achievement Award**
The National Defense Industrial Association (NDIA), comprised of its affiliates, chapters, divisions, and 1,600 corporate and 85,000 individual members, was founded to educate its constituencies on all aspects of national security. For nearly 100 years, NDIA has provided a platform through which leaders in government, industry, and academia can collaborate and provide solutions to advance the national security and defense needs of the nation (NDIA, undated).

**RAND Medal for Excellence**
Former RAND president Jim Thomson initiated the RAND Medal for Excellence in 1998. Natalie was presented the award for strengthening RAND’s relationship with the Air Force and for negotiating a new 10-year contract.
Vance R. Wanner Memorial Award from the Military Operations Research Society

The Military Operations Research Society (MORS) exists to enhance the profession of military operations research. Each year, MORS grants the Wanner Award to a military operations research professional who is deemed to have played a major role in strengthening the profession. MORS takes pride in honoring these pre-eminent leaders in this relatively young, but increasingly important profession (Military Operations Research Society, undated).

Thomas D. White National Defense Award

Established in 1962, the award is given annually to a U.S. citizen who has significantly contributed to national security through their support for science, technology, international affairs, and other fields. Earlier recipients of the award include the Air Force’s first chief of staff, Gen Carl Spaatz; former National Security Adviser Condoleezza Rice; and actor Bob Hope. Natalie was selected for the award by former Air Force Academy Superintendent Lt Gen Mike Gould, stating, “Ms. Crawford
Lt Gen Michelle Johnson adds Natalie’s name to the White Award plaque at the Air Force Academy in 2012. Photo courtesy of the U.S. Air Force Academy.
has selflessly worked behind the scenes for nearly 50 years to improve Air Force aircraft, weapons and space systems capabilities and has supported Air Force Scientific programs” (The RAND Blog, 2013).

**Election to the National Academy of Engineering**

Election to the National Academy of Engineering (NAE) is one of the highest professional honors accorded an engineer. Members have distinguished themselves in business and academic management, in technical positions, as university faculty, and as leaders in government and private engineering organizations. Members are elected by peers who are current NAE members (NAE, undated).

**American Institute of Aeronautics and Astronautics Honorary Fellowship**

With more than 30,000 individual members from 88 countries, and 95 corporate members, the American Institute of Aeronautics and Astronautics (AIAA) is the world’s largest technical society dedicated to the global aerospace profession (AIAA, undated). The title of Honorary Fellow is AIAA’s highest tribute. In 1933, Orville Wright was its first Honorary Fellow. Fewer than 1 percent of AIAA’s members achieve this honor. Natalie was so honored for her professional devotion to the U.S. Air Force through unwavering commitment to optimally integrate technology, the warfighter, and operations through critical thinking, candor, objectivity, independence, and thoroughness (Crawford, 2017a).

**Air Force Association Lifetime Achievement Award, 2011**

Natalie’s citation reads: “It was her responsibility to ensure that the research agenda of PAF addressed problems of greatest enduring importance to the Air Force and that the research was of the highest possible quality and responsiveness. Mrs. Crawford is also a consummate and tireless mentor. She never misses an opportunity to infuse her analytic expertise and substantive knowledge of Air Force systems and organizations into the next generation of military operations research analysts” (Air Force Association [AFA], 2011).
Honorary Doctorate in Engineering from Michigan State University

The citation that accompanies the award of the degree cites Natalie’s leadership during a more than 50-year career in service to the nation at the RAND Corporation that has significantly bolstered the national security of the United States. In part it says, “You have led a number of high-impact technical studies that have enhanced our understanding of the security concerns regarding potential threat areas around the world.”

The Clarence L. “Kelly” Johnson Memorial Lockheed Skunk Works Award, 1999

This is perhaps the most unusual of Natalie’s many awards. Kelly Johnson’s Skunk Works at Lockheed gained an unmatched reputation for the superb design and manufacture of leading edge aircraft, among
them the U-2 Dragon Lady, the SR-71 Blackbird, and the world’s first production stealth fighter, the F-117 Nighthawk.

A Complete List of Professional, Scientific, and Honorary Affiliations

AIAA Honorary Fellow (2017); Project AIR FORCE Distinguished Chair in Air & Space Policy (2014); United States Air Force Academy Thomas D. White National Defense Award (2012); Air Force Association Lifetime Achievement Award (2011); OSD Medal for Exceptional Public Service (2006); NDIA Combat Survivability Lifetime Achievement Award (2006); RAND Medal for Excellence (2006); Lifetime Achievement Award, Air Force Analytic Community (2003); Lt Gen Glenn Kent Leadership Award (2003); Decoration for Exceptional Civilian Service, U.S. Air Force (2003, 1995); Vance R. Wanner Memorial Award, Military Operations Research Society (2003); Kelly Johnson Award, San Fernando Valley Engineers Coun-
Awards and Honorary Affiliations

• cil (1998); Woman of the Year, Santa Monica Chamber of Commerce
  Women’s Business Council (1997); Santa Monica High School Hall of
  Fame (1995); YMCA Woman of the Year, (1983); Who’s Who in the
  West; Member, JPL Advisory Council (2002–2009); Member, Sandia
  Nuclear Weapons External Advisory Board; Member, National Acad-
  emy of Engineering (2001); Fellow, AIAA (2011).

RAND Alumni Association

Natalie was elected president of the RAND Alumni Association (RAA)
in January 2009. Under her leadership, the membership has grown by
more than 1,200.

In 2014, the RAA launched an annual $100,000 fundraising
campaign, known as the Alumni Impact Fund, to support the efforts
of RAND staff to further the reach of recent research projects. Each
year, RAND President and CEO Michael Rich nominates several proj-
ects for inclusion; all who contribute to the campaign are invited to
choose from among those selections, and funds are distributed to the
top two projects as voted on by alumni. The Alumni Impact Fund has
resulted in follow-on research, creation of tools, events, and targeted
outreach to policymakers on such critical topics as veterans’ employ-
ment, health care reform, violent extremism, the use of armed drones,
opioid abuse, and the global problem of antimicrobial resistance. The
campaigns of 2014, 2015, and 2016 all exceeded their $100,000 goals,
in large part because of Natalie’s tireless efforts.

During Natalie’s tenure, the RAA has also continued its tradi-
tion of sponsoring alumni get-togethers in Santa Monica, and expanded
efforts to engage with East Coast alumni at events in Washington, D.C.
“IT’s really important to me that people stay connected, even after they
leave RAND,” Natalie says, “and that we preserve this mission-driven
culture that we’ve created over many, many decades.”
Natalie W. Crawford Biography

- RAND, 1964–present
- RAND Senior Fellow, 2006–present
- Project AIR FORCE Distinguished Chair in Air and Space Policy, 2014–present
- Vice President and Director, Project AIR FORCE, 1997–2006
- Associate Director, Project AIR FORCE, 1995–1997
- Director, Force Modernization & Employment Program, Project AIR FORCE, 1993–1995
- Director, Theater Force Employment Program, Project AIR FORCE, 1988–1993
- Associate Director, Theater Forces Program, Project AIR FORCE, 1986–1988
  - Senior Staff Member and Project Leader, Engineering & Applied Sciences Department, 1974–1986
  - Member Technical Staff, Engineering Sciences & Aeronautics/Astronautics Departments, 1964–1974
- Air Force Scientific Advisory Board
  - Co-Chairman, 1996–1999
  - Vice Chairman, 1990–1991
I am indebted to Dick Anderegg for his patience in writing this biography. Admittedly, in the beginning, I eschewed the thought of telling the story of my life’s journey, being one who shunned the spotlight.

But Dick had a vision for what shape he felt this journey would take, which I learned to trust.

I am indebted to the many people who spoke to Dick as he wrote this book. For each of you there are scores more people who shaped my life, too numerous to list. Were I to try to mention them, surely I would leave out someone important to me. For those whose names do not appear, be assured that I have not forgotten how you influenced me and helped to shape my career and enabled me to make a difference. I say the same for those who are no longer with us.

In the end all that has ever mattered was to contribute to the defense of our nation, and the safety and well-being of the men and women who fight for our freedom each day. It has always been the work that mattered, not the applause. Every event, encounter, question, and challenge made me work harder to learn more. Every day of my life has truly been a school day.

To each of you who has touched my life and my soul, I am forever in your debt. You know who you are.

Natalie W. Crawford
Santa Monica, California
August 1, 2017
C. R. Anderegg is a retired Air Force colonel and a retired member of the Senior Executive Service. He served in the Air Force on active duty for 30 years and, as a civil servant, served for ten years as the Director of Air Force History. Currently, he is an adjunct faculty member of the RAND Corporation.

He holds a bachelor’s degree in English from Hobart College and a master’s degree in International Affairs from Troy University. During his active-duty years, he accumulated more than 4,000 hours in the F-4C/D/E/G and the F-15A/C/E. He is a graduate of the U.S. Air Force Fighter Weapons School and served two tours as an instructor pilot there. He has commanded an F-15 squadron, two fighter groups, and was twice a fighter wing vice-commander. He is a veteran of the Vietnam War, where he flew 170 combat missions in the F-4D.

Following his retirement from the active force in 1997, he authored three books and served as a consultant in Project Checkmate at the Pentagon during the planning and execution of Operation Enduring Freedom and Operation Iraqi Freedom. Subsequently, he re-entered the Air Force as a civil servant and became the director of Air Force history with duty as the historical adviser to the Air Force secretary and Air Force chief of staff, and he was the functional manager of the worldwide history and museums program.

He and his wife, Jean, make their home in Springfield, Virginia. They have two children and three grandsons.
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A special thanks to Maria Vega, Robert Guffey, Kimbria McCarty, and Diane Baldwin, all of RAND, who assisted me in countless ways. And, as always, when I finish a book, I am eternally grateful to my patient wife, Jean, who holds my hand throughout.
AFA—See Air Force Association.

AIAA—See American Institute of Aeronautics and Astronautics.


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Natalie W. Crawford grew up in a strong extended family that valued hard work, education, self-reliance, and commitment. In her young world, there was no such thing as half-in; one did one’s best every day. She took those values with her to California and then the RAND Corporation, where she committed herself to every day being a school day. As her career progressed, she evolved from student to teacher to mentor. Although she researched and analyzed weapons and aircraft data, she came to understand that the real might of America’s military is in its people, and she devoted her life to helping them succeed. Her personality and her personal values enabled her to establish an enviable, perhaps unique, position of being highly respected as well as being truly loved. Perhaps her greatest gift is her ability to fearlessly speak truth to power. Time and again, interviewees cited her fierce objectivity and unassailable integrity, both of which she communicated without personal agenda or self-aggrandizement. Her mark on RAND and the Air Force is indelible.