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Dr. Jacqueline R. Henningsen, FS Interview (MORS)

Henningsen, Jacqueline R.

Military Operations Research Society (MORS)

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Military Operations Research Society (MORS) Oral History Project Interview of Dr. Jacqueline R. Henningsen, FS

Mr. Jim Bexfield, Fellow of the Society (FS),¹ Colonel Roxann Oyler,² Mr. Roy Reiss, FS,³ and Dr. Bob Sheldon, FS⁴

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INTRODUCTION

r. Jacqueline R. Henningsen joined the Military Operations Research Society (MORS) in 1985 and served on the MORS Board of Directors from 1993 to 1996. Dr. Henningsen served as the MORS Sponsor's Representative for the Office of the Secretary of Defense (OSD) from 1997 to 1998 and for the Air Force from 1999 to 2001. She was the Air Force MORS Sponsor from 2001 through 2014. Dr. Henningsen was elected a Fellow of the Society (FS) in 1998. She was a member of the Department of Defense (DoD) Senior Executive Service (SES) and was recognized with the DoD Distinguished Civilian Service Award (2001 and 2009), a Meritorious Executive Presidential Rank Award (2006), the Air F36orce Modeling and Simulation Moody Suter Lifetime Achievement Award, and a Distinguished Executive Presidential Rank Award (2012). Jackie retired in November 2014 after serving 16 years in the SES, including eight years at a Deputy Chief of Staff (three-star) equivalent level as AF/A9, Director of Studies & Analyses, Assessments and Lessons Learned. The Dr. Jacqueline R. Henningsen Air Force Analyst Lifetime Achievement Award is presented in her honor annually. She was recognized with the Air Force's Lt Gen Glenn A. Kent Leadership Award in 2015, and the MORS Vance R. Wanner Memorial Award at the 84th MORS Symposium (MORSS) in 2016, which also marked the 50th Anniversary of MORS.

Dr. Henningsen's official Air Force biography is available at https://www.af.mil/About-Us/Biographies/Display/Article/105035/dr-jacqueline-r-henningsen/. Another biographical sketch is available at *Northwest Missouri Alumni Magazine* (https://www.nwmissouri.edu/alumni/PDF/magazine/2007_winter.pdf). The December 2014 *Phalanx* (volume 47, number 4) has an article called "Tribute: Dr. Jacqueline R. Henningsen" on pages 2–3 that highlights Jackie's retirement and summarizes her career.

MORS ORAL HISTORY

Interviews with Dr. Jacqueline R. Henningsen, FS, took place on February 7, 2006, February 10, 2006, March 1, 2006, May 12, 2006, and September 10, 2016; Mr. Jim Bexfield, FS,

https://doi.org/10.5711/10825983271109 © Copyright 2022, Military Operations Research Society MORS Heritage Colonel Roxann Oyler, Mr. Roy Reiss, FS, and Dr. Bob Sheldon, FS, interviewers.

Editorial comment: Dr. Henningsen added some reflections after the last interview session. These reflections are noted in *[italics*].

Bob Sheldon: We're here in the offices of A9 for a MORS oral history interview with Dr. Jackie Henningsen. Let me start by asking you about your parents and how they influenced you in your education and career choices.

Jackie Henningsen: My father's name was Jack Vincent and my mother's name was Thelma Lienhart. They were both from O'Neill, Nebraska. Although I had no memory of it, I actually spent my first year at Langley Air Force Base (AFB), Virginia, where my father was in training to be an Army Air Corps flight surgeon. My parents divorced when I was two, and my mother later married John Burt, a World War II European theater Army veteran. I grew up in Omaha, Nebraska with my mother, stepfather, and three younger sisters: Judy, Cindy, and Bonnie.

My stepfather was born in Salt Lake City. After WWII, he worked, like his father, for the Union Pacific Railroad in Omaha as a clerk/accountant. He had no college education, but was very smart and was selected in the 1960s for special training in the emerging computer area. He found it fascinating, but health problems ended this pursuit. He demanded a lot of his daughters, both intellectually and in sports-related expertise. He wanted us to be able to defend the logic of statements we made, challenging us with "Why do you think that? Why do you say that?" In athletics, he taught me to always "follow through" in a golf or tennis swing, a baseball throw, swimming the Australian crawl, and even shadow boxing. Under his high jump coaching, I learned the western roll, the scissors jump, but luckily not the Fosbury Flop, as we only had dirt in our homemade pit.

I saw little of my biological father until I was about 13, when he opened a general practice in Canon City, Colorado, about 60 miles southwest of the Air Force Academy. I spent summers in my teens with him, and learned he retained a strong interest in the Air Force. He was a practicing physician until his mid-eighties. In his later years, he loved to visit the Air and Space Museum and was enthralled with pictures from the Hubble telescope. It was a thrill for both of us to have him attend my promotion ceremony to the SES in 1998 at the Pentagon.

I have been inspired by many amazing folks thru my life. Each did something to shape my views, my mindset, and my perspectives on leadership. However, two of them shaped who I am as a person: my mother and my husband, Carl. Each did it by living their lives with enthusiasm, giving unselfishly of their love, and demanding little, even while giving so much.

My mother, Thelma Lienhart, grew up a farm girl in the Sand Hills of Nebraska. She inspired my love of horses with stories of her pony, Dimples, and pictures of her dad's thoroughbred, King. She taught in a one-room schoolhouse shortly after graduating high school herself, just like her own mother. She was tireless; an eclectic reader and a quiet doer. There were six of us in a small (800 square foot) home in North Omaha, but it was set in an idyllic secret-garden-like half-acre where surprises of color, smell, taste, and texture were abundant. She worked as a beautician throughout our childhood, yet we never felt neglected – she was always present for us. She stayed up to the wee hours most nights reading or taking things apart and fixing them - the piano, the radio, the kitchen sink . . . broken when we went to bed; fixed when we woke up. I inherited none of these skills, but she truly gave me space to grow as a child, and she instilled a love of reading. My folks allowed me to travel around Omaha on buses and streetcars from age seven; roaming the city's museums, skating rinks, pools, and movies. I was truly a free-range child. My mother corrected us with pithy phrases and by quoting poetry. She allowed me to spend summer days reading. I was widely read-Dostoyevsky, Frost, Michener, Asimov, Bradbury, and many more – by my early teens. She was the one who provided a moral compass that gently shaped how I think people should be treated and how I view the world to this day. Sadly, she died of lung cancer in her early seventies as did my husband Carl's mother (of the same cause).

While growing up, I never remember anyone helping me with homework; it was just my responsibility, but there were books around all the time. The joy of summer for me was going to the library every other Saturday morning and checking out the maximum of 10 library books.

Bob Sheldon: Any of them math books?

Jackie Henningsen: Not necessarily. They were across a range of subjects. Even into my early adult years, I would browse through the Dewey Decimal System picking out one book from each category. So it wasn't that it was math or not math, but that it was different. I liked exploring a variety of ideas.

Bob Sheldon: One of your bios says you were in a science fair in Omaha's North High School. Did you also take an early interest in mathematics courses?

Jackie Henningsen: I was always a good student, with special interest in literature because of all the reading I had done, but I was very enthusiastic about science as well. I took all the math and science I could, but math didn't come alive for me until my sophomore geometry teacher, Ms. Heyser, opened up a new way of applying the logic I had been taught to practice at home. I still remember when we were studying the geometry of circles, she took our books away and said we were going to form small groups and use the experimental method and make our own "discoveries." It was very unusual for public education in the late 1950s. We just had protractors, compasses, straight edges and of course, slide rules for science. She would pose questions and then turn us loose to measure, hypothesize, and postulate – she introduced the appropriate vocabulary as well. Each team had to write a little book about the geometry of a circle. It was really intriguing to me. I still remember this approach as opening up a new way of learning. I wonder if it would even be possible in the age Internet searches.

Bob Sheldon: When I did a web search, North High School was listed as a magnet school. Was it a magnet school when you went there?

Jackie Henningsen: Oh, no. It was just a typical public high school. That was long before such concepts existed, at least in the Midwest. But we were fortunate to have some very good teachers, and I was able to take biology, physics, and two years of chemistry. However, there were no advanced placement (AP) courses. I truly loved chemistry and had intended to follow it as a career. I'll come back to that shortly.

About the science fair, my science teachers encouraged us to do experimental work. So starting in a summer biology class, one of my friends and I got the idea of experimenting with chickens and the effects of specific hormones. Using chicks and, based on the guidance of a local university researcher, we monitored and measured the changes in specific characteristics. When the project ended, I took the now fully grown chickens home to live outside in our dog's house. My mother, who was a farm girl, had prepared many chickens for Sunday dinner, but wisely decided that these chickens were not for eating. So they just retired in our yard.

Another year, we tested the effects of cholesterol using hamsters as our subjects. We had built this very complex device from glass tubing and used various chemicals to capture, measure and separate the components in the respiration of the hamsters. Unfortunately, the hamsters were good escape artists. They were constantly getting away and hiding in the walls of the lab only to emerge later to the detriment of our research.

Bob Sheldon: That must have been a sophisticated lab to have that kind of measuring equipment. *Jackie Henningsen:* We built it. We had a very fine teacher who connected us with a University of Nebraska Medical School researcher. We found blueprints and built the device from medical literature he provided.

After two years of chemistry, I really wanted to be a research chemist. That was my plan. I was a National Merit Scholar and had interest and scholarship offers from Nebraska, Northwestern, and several other schools. However, I had started dating Carl when I was 16. He had finished Army basic training and his specialist training at Fort Ord, California, when we met. He joined the Army Reserves and was working full-time as a catering manager for a restaurant. We got engaged when I graduated from high school, and he said if I would go someplace he could afford, then he wanted to go to college to become a teacher and coach. We decided to go to a nearby teacher's college – Northwest Missouri State University in Maryville, Missouri. Our annual tuition was only \$1,000. Carl was accepted on probation and saved to pay his own way without working the first year. Since he planned to be a coach, he wanted to go out for football. I had a scholarship, and my dad paid for my other freshman year expenses, but stopped when we got married our sophomore

year. To mirror a song, from that point on "we had love and a ['56] Chevy" but no money and little idea what the future held. I still hoped to be a research chemist, and never planned to be a teacher.

Bob Sheldon: Let me backtrack to your high school. You were on the Reserve Officer Training Corps (ROTC) drill team. Did you do anything else in ROTC?

Jackie Henningsen: We had a very creative physical education teacher. She and our school's ROTC instructor invited a group of us to spend one quarter doing ROTC drill team training instead of physical education. Since it was sponsored by the Army ROTC, they gave us some old jackets and hats and we found gold skirts to wear. We prepared a performance routine for the annual Military Ball, but that was the end of it. The next quarter we learned jazz and tap dancing.

Bob Sheldon: What other athletics interested you in high school?

Jackie Henningsen: Due to my stepfather's coaching, and perhaps some genes at work as my father was on the University of Nebraska's 1941 Rose Bowl football team, I was a good athlete and through eighth grade I played basketball, volleyball, ran some track, and swam on a competitive swim team. But Nebraska had no competitive high school athletics for girls at the time, despite the hugely successful basketball programs in neighboring Iowa.

[Quoting from history.nebraska.gov "In 1924 the Nebraska High School Athletic Association voted to abolish the girls' state basketball tournament and to bar girls' teams from entering any state, district, or county basketball tournaments in the future. Association members voiced protests against girls' competitive athletics in general. The move was part of a long **national backlash against women's sports**. The University of Nebraska had already disbanded its women's basketball team after the 1908 season. Physical recreation was OK, but highly competitive, "mannish" play was said to be inappropriate and even harmful to women."]

In 1975, following the enactment of Title IX, I had the pleasure of being a junior varsity coach in one of the newly established high school programs for women's volleyball in Nebraska. [My record over four years was 66 wins and six losses – good times and fun memories!]

Bob Sheldon: I notice one of the commonalities between your background and General Kent's is you both studied math education and you both taught and coached in high school, volleyball in your case and basketball in Gen Kent's case. Is there something to that background that makes for a good head of Studies and Analyses?

Jackie Henningsen: I expect so, but I don't know if it's sports, per se, or the experience of building teams and of course teaching. I truly believe that you never learn anything like you do when you teach it. The exciting part for me was that math, in particular, got more and more interesting over time. As a new teacher, I started out teaching a subject per the book and learning to handle the students, paperwork, and parents. By the second year, I had the subject and how to handle and engage the kids down pretty well. By the third year, I'd teach something, whether it be high school algebra, psychology, (later) engineering courses, or even volleyball, I would start exploring how to share the more intriguing, interesting parts of the subject. I eventually became incredibly absorbed with the way math linked across so many areas. The beauty of math emerged from underneath the layers of other things I had to do to try to inspire a whole range of students.

[Whether coaching or building organizations, it's the same. It's about bringing a team together and looking for skills and capabilities across the set of players and trying to structure things for success. You're trying to optimize the talents of a group of people to accomplish a goal. I think that's very similar to what you do in an analytic organization. You're trying to harness the unique synergy that comes from a cohesive team.]

Bob Sheldon: Let's backtrack to the "two most influential people in your life."

Jackie Henningsen: I talked about my mother, but I also want to say something about the significance my husband, Carl, has played for me. It's easy to postulate many different paths our lives could have taken when you remember that Carl has his own story which included a very strong mother and grandmother, but very poor role models for fathers. He loved sports, but his high school years were spent working nights and weekends. He was able to stay active in golf, church league basketball, and in ROTC. In 1959, at age 17, he joined the Army after barely graduating

high school. Due to his ROTC background, he thrived in a military environment. At the end of basic training at Fort Leonard Wood, he was selected as "Outstanding Trainee of the Cycle" out of 275 peers and encouraged to consider Officer Training School, but his mother was raising three young children alone, and he felt he needed to be there to help. He went to Truck Driving Specialist training at Fort Ord, California, and upon completion, signed up for an eight year commitment with the Army Reserves.

The women in his life taught him wonderful manners, and he was a bright, caring, courteous young man when we met. We started dating when I was 16 and got engaged when I graduated from high school. We chose a college where we could go together. He was a successful multisport coach, and a beloved physical education and business teacher for over 27 years. When I had an opportunity to advance, he willingly walked away from his career so I could continue to grow in mine. In DC, he replaced teaching with working for a student tour company, and eventually, in retirement, with background acting in movies (like *Head of State* and *The Wedding Crashers*), print ads, a stage production, and television shows (like *The Wire, The West Wing, Something the Lord Made,* and many others). He has some great stories from those times. What I can say, is that without his partnership, our lives would have been very different. We are blessed that our son, Jeff, and his wife Stacey have four amazing children (Reese, Blake, Abigail, and Lila) and soon to arrive great-grandchildren.

[As I noted in our college alumni magazine, "It's pretty rare to find a man like Carl. Each of us started in traditional teaching areas, but he was never intimidated by my desire to pursue a nontraditional career path. He's so incredibly supportive, which is just his character and something he does effortlessly." His reputation while teaching was "a man of much patience." He is truly the "wind beneath my wings."]

Bob Sheldon: Returning to your undergraduate math education curriculum, were there any parts of mathematics that interested you more than others?

Henningsen: When I started college, I was focused on chemistry, so I took math because it was part of the curriculum. In chemistry I got A's, but I was never encouraged to see myself as a "future chemist." Despite my declared major, all of the invited lab assistants were men. Truthfully, I didn't think about it at the time and took a job as a dorm resident assistant.

[One indelible memory I have of my sophomore college chemistry class was working on a lab assignment when someone came to the door and announced that President Kennedy had been assassinated in Dallas, Texas. The campus shut down for several days of memorials and mourning.]

By our junior year, we were married, had a baby, and we were very, very poor. We lived in married student housing (Quonset huts from WWII) for \$32.50 a month, all utilities paid, concrete floors and an oil burning stove. Carl worked at the golf course as a bartender, at a lightning rod factory, and putting up hay. I tutored students in math. In the summer, we often ate bullheads (fish) that Carl caught at a local pond. We were certainly anxious to graduate and start making some money; particularly after the '56 Chevy's engine blew up leaving us without a car. My quickest path to a job was to leverage the math teacher shortage incentives, which helped pay off student loans if you taught in rural schools. I had plenty of math to be certified to teach, and I was not real excited about teaching high school chemistry, never having worked in the backroom of the lab. So I took a position teaching math, never realizing that I would learn to love it so much. I certainly have no regrets when I look back on the exciting path that choice opened for us. Carl took a business, health, and physical education position at Breckinridge, Missouri, a small school with only 80 students grades 9–12. His dream of becoming a coach came true with his first basket-ball team going to the State quarter finals with a 27–4 record.

[We attended their 50-year class reunion in 2017, and surprisingly, the school still exists even with only five graduating seniors.]

Bob Sheldon: How did you choose to go to grad school? Did you do that at night while you were teaching?

Jackie Henningsen: Not at first. We started in small high schools in Missouri, which allowed our student loans to be halved after five years. At Rock Port, Missouri, I taught algebra, geometry, and

pre-calculus. I was also the psychology teacher and coached the junior and senior plays. I loved coaching the plays and had a remarkably talented group of students, so I also formed a one-act play group. For two years in a row, our small school won top ratings at the state high school competition against Kansas City and St. Louis schools. Three of my students were offered full scholar-ships to the University of Missouri as the number one female and number two and three male actors in the state. Carl and I have maintained contact with these former students, and even saw one of their children acting in plays in the DC area. We will attend their 50-year class reunion in 2021.

In the summer, I took classes at nearby Tarkio College from Dr. R.W. George, a Duke University trained gestalt psychologist. His research on cancer and other disorders measured by perception tests of binocular rivalry was compelling. He also sponsored several international researchers as short-term fellows at the school. For instance, one was an African expert on the physiology of jerboa (desert rats) and their ability to survive in the desert without water for long periods of time. Perhaps remembering my high school research with hamsters, I convinced Tarkio College and my school administrations to schedule half-day workshops with these experts for our high school students who soaked up the interactions.

Bob Sheldon: You were doing some psychological experiments with the students? Or letting them participate?

Jackie Henningsen: Oh, they were well versed in the scientific method and were expected to use this knowledge for a capstone project. In the meantime, Carl had gone right into a summer master's degree program in athletic administration at Northwest Missouri State, and as soon as he finished, I was eager to continue as well. Fortunately the National Science Foundation (NSF) awarded Dr. Walter Mientka, at the University of Nebraska, funding for an NSF-sponsored master's program in mathematics education. It was held over three summers, and he was able to bring in faculty from across the country. We had about 30 in the program and took our classes together in an on-campus facility. Walter was an amazing man—a number theorist who would literally jump on the table and shout with joy as he reached the "punch line" on some especially remarkable proof. He was the executive director of the American Mathematics Competitions for 22 years. My goal was to be a teacher like him who inspired my students to love math. When I was accepted into the NSF program, we got a letter offering the male students a stipend for their wives and children to join them for the summer. Dr. Mientka was a bit shaken, but agreed, when I challenged him to offer the same for Carl and our son Jeff. Walter later kidded me "about being his first experience with a woman demanding equal support."

[Even into the 1970s, it was open policy in many districts that women in the same positions received lower salaries than men with the faulty explanation that men were responsible for supporting their families and women were just working until they got married and had children.]

Carl and I left Rock Port when our first four-year class graduated and accepted teaching positions in the Omaha Westside School System. He taught junior high physical education, business, health, and, of course, coached basketball, football, track, and later cross country. I was in the high school math department under department chair and mentor Al Gloor.

Bob Sheldon: Were most of your fellow students (in the NSF program) math teachers? Or math theorists?

Jackie Henningsen: They were all high school math teachers, but the courses were theoretical with the education components taken separately on our own time. The idea was to give us 27 hours of graduate-level mathematics, taught by noted professors brought in from across the country. I took educational psychology instead of education for my additional nine hours of electives.

Bob Sheldon: Did you teach AP math, or did they have courses like that?

Jackie Henningsen: There was no certified AP program, but we had math through calculus. I taught many levels over the next eight years, but I was by then really excited by the creative component of math. I was especially interested in the students that wanted to go to college but were struggling with math. Young women were over-represented in that group. I developed a course

incorporating concepts from algebra, geometry, and advanced algebra called "Topics in Math." I developed it in modules, and re-introduced Ms. Heyser's "Mathematics of the Circle" approach with little book learning, and more experiments. I particularly focused on logical thinking and nontraditional problem sets and approaches along with group work. The students progressed through areas like trigonometry, topology, and graph theory. My classes got the first set of simple calculators during that time. Of course, within a few years, we were working trig functions with scientific calculators. It is hard for someone who didn't start their scientific education with slide rules to grasp the power of this transition.

Bob Sheldon: Were you teaching mathematical intuition?

Jackie Henningsen: Yes, and a lot of problem solving of the kind that is not "two trains coming toward each other." In Topics in Math, we used colored pens to explore topological maps, art to examine transformations, figured out how Escher patterns are formed and created our own. My advanced level pre-calculus class students would often beg to have 10 minutes of whatever the Topics of Math kids were doing before they started their lessons. I began to infuse creative approaches into the advanced classwork as well. It was still before the plotting calculators were available, but insights from string art was fascinating. One of the advanced students' favorite games was "I'm thinking of a formula; how many number pairs will it take you to find it?" As these formulas got more complex, the other students had to use logic and develop new methods to break the code.

Bob Sheldon: Pretty exciting stuff for high school math.

Jackie Henningsen: It really was a joy! Part of it was me exploring new ideas and part experiencing the thrill of seeing students get excited about their ability to understand math. The turning point for me in terms of going in a different direction, was that so many of the young women were still dropping out of math. The brightest would stay through advanced algebra, and then my pre-calculus classes would have only four or five women students. It really bothered me, so in the mid-1970s, I started doing research in concert with a growing movement of educators looking at the impact and causes of "math anxiety." I wondered why I stayed in math. It seemed many girls were prone to believe "I'm not good at it" (if they didn't get A's) "therefore I shouldn't do it," as opposed to saying, "I need math for the things I want to do." They also had plenty of encouragement to "not worry your pretty little head about math" or "you'll never use it anyway" or "I was never good at math either." They often changed their goals in ways that narrowed their opportunities and potentially equated to lower lifetime earnings. At the time, the adjusted gender wage gap was about 30%.

I received a federal grant to have some young women in my classes help me develop presentations and a program with the theme "Do You Know Where You're Going To?" (using the Diana Ross song). We gathered statistics and developed outreach presentations. I also served on curriculum advisory groups for programs hosted by the state Board of Education. I was preaching – your horizons are broader when you stay in math. So, like my Dewey Decimal theory of selecting books, I started taking random classes with math prerequisites at the University of Nebraska at Omaha in areas new to me. Most were in engineering. In addition, I attended national conferences on addressing math anxiety and nontraditional careers for women and gave workshops for the local community. A linear programming class revealed the power of systems analysis and optimization. The creativity and teamwork required along with the opportunity for applications in so many fields of science, engineering, business, education, marketing, medicine, etc., fit perfectly with my eclectic approach to knowledge gathering. It was a serendipitous discovery for me. I dropped my random selection of courses and started in a second master's degree program in the Industrial and Management Systems Engineering Department at the University of Nebraska, Lincoln (UNL) with operations research (OR) as a focus. I commuted to Lincoln twice a week taking evening and weekend classes, and I met several folks from Strategic Air Command (SAC) doing the same.

Along with the focus on math anxiety research at the time, a parallel push to bring more women into nontraditional career areas led UNL's College of Engineering to seek to increase the number of women in their programs. In1980, I was offered an instructor position with the opportunity to work on my PhD. I traveled 100 miles a day for over five years, but was fortunate to join a carpool with other professors from mechanical, electrical, and industrial engineering, physics, and English who also lived in Omaha. They generously added their perspectives to my experiences.

[At UNL, I taught statistics and engineering economics. I was also appointed to the Chancellor's Commission on the Status of Women. In that role, I helped plan and lead a campus wide event called "The University: A Chilly Climate for Women" focused on elevating awareness of blatant and unconscious biases impacting women's educational success. Years later, a former Commander-in-Chief of SAC (CINCSAC) told me that the Chancellor confided when the Air Force hired me that I might have a bit of attitude, but was a really good hire!]

Bob Sheldon: Were there any of your professors at Nebraska who you felt were really outstanding?

Jackie Henningsen: There's so many I still greatly respect, including my department head, Professor Morris Schneider, and, of course, Professor Walter Mietka, as well as my outstanding advisor, Dr. Fred Choobineh. I also got help on university politics from my carpool friend and English department chair, Dr. Linda Pratt. [A serious scholar, she was always abashed to admit her paper "Elvis, a Symbol of the South" had been published by Rolling Stone magazine and continued to pay her royalties through the years.]

Nearly two decades later, the engineering department nominated me as a distinguished UNL alumni. Honorees were recognized during a football game halftime. I was excited to be the third family member to appear at Husker Stadium before a football crowd: my father at the 10-year anniversaries of the 1941 UNL Rose Bowl team; our son, Jeff, when he played quarterback for Missouri against the Cornhuskers in 1987; and me for career achievement in math and engineering in 2003. Nice family hand-off!

Bob Sheldon: What did you study for your dissertation?

Jackie Henningsen: My dissertation title was "A Conceptual Framework for Distributed Expert System Use in Time Sensitive Hierarchical Control." However, it took some redoes to complete it and receive my PhD in 1987.

One of the things I caution all the students that I counsel is the best dissertation is a completed dissertation so (1) be sure that you truly care about your subject; (2) narrow the scope so you best use the time available; (3) don't start with a particular outcome or tool already identified; and (4) be sure you've got an advisor who can stay the course with you.

Bob Sheldon: You mean that your advisor is not going on sabbatical during that time?

Jackie Henningsen: Exactly. As part of our program to qualify for the PhD level track, we had to do what was called an in-lieu-of-language research project. Rather than demonstrate second language proficiency, we were to show research skill. It was also supposed to be fact finding for your dissertation topic while early in your program. I did it on a network theory problem based on coloring algorithms for network nodes and arcs.

Bob Sheldon: Like the four colors mapping problem?

Jackie Henningsen: Yes, but focused on what networks can be traveled if you have failures and restrictions. You use color patterns as a way to show the constraints or blockages on networks. Although my independent research was completed successfully, it didn't match the ongoing research areas of any of the professors at the time. I began working with a new professor from Michigan on an emerging data-dependent time series approach applied to auto industry trends. After several months, it was clear I had fallen into dissertation traps 1 and 3; first by not really being interested in the subject, and second by selecting a hammer, causing every problem to look like a nail. So I started over, and this time, I let the questions generated by my work at SAC (more on the transition later) lead the analysis. The payback was not only in cohesion, but also in capturing and holding my interest. I still had to work carefully to control the scope of the problem, but Dr. Fred Choobineh from whom I had taken many OR graduate courses, fortunately agreed to be my advisor. He insured I stayed focused on the problem and a technical definition of the solution space.

The question of concern was, "How do you manage the effect of catastrophic failure in hierarchical systems?" At a time that preceded the Internet era, we were examining the basic elements in building robust command and control networks. I extended research by Tenney and Sandell reported in "Structures for Distributed Decision Making" in *IEEE Transactions on Systems, Man, and Cybernetics* (August 1981). They postulated a distributed expert system as a combo of a decision agent and its subsystem and called it a "domule." I added the interplay with a rule set designed into a machine-based expert system and identified it as a "trimule."

Bob Sheldon: You learned a little bit of reliability theory in the process, too.

Jackie Henningsen: True, this effort looked at building and testing robust networks so if you had a catastrophic failure you could rate the quality of information retained in the rest of the network. Maintaining robust and secure communications was the goal, and applicable, of course, across both the military and the commercial world. In a sense, a large part of my efforts through my years in DoD focused on this first interest.

[It's clear the issues of this 1980s work still challenge us in current national security risk venues including cybersecurity response planning.]

Bob Sheldon: You're talking about diagnostics to help people with problems.

Jackie Henningsen: Yes, I suppose so, but also to capture the knowledge of experts and be able to embed it in systems. The question I was exploring was, "If you embedded an expert system at a particular node in a hierarchical organization, how can you look at the decay of knowledge over time and how does that impact the confidence you have in information coming from that node, and then globally how does it impact total system performance?"

Scoping was really the hardest part because the question had so many really fascinating tracks. One couldn't hope to study all the ramifications and you also had to consider the psychological component. Some of the retention and the degrading of information will be affected because humans tend to default to certain biases and thinking patterns to evaluate knowledge. Some decision makers, for instance, have less tolerance for lots of information, and tend to go to "brightly colored" objects, gut-sense, personal experience, or insights from a "trusted agent." And there are some fairly predictable ways that people respond; until they don't.

Bob Sheldon: Almost like a neural network.

Jackie Henningsen: Exactly.

Bob Sheldon: In our career field of OR, there aren't too many of our analysts that have both the math background and the psychology background, so that ideally suits you for command and control studies.

Jackie Henningsen: Oh, yes, all of this fits together; and soon I was caught up in the richness of problems especially related to command and control.

Bob Sheldon: Let's get back to how you started working for the government.

Jackie Henningsen: I had been at the University of Nebraska teaching for five years. I knew that I was going to have to get a "real" job someday. I didn't consider my time at UNL a real job, because it was so much fun to go to classes, to teach, to go to the library during the day and have these great intellectual discussions with my colleagues (and carpool buddies). I thought it was a very wonderful life, despite commuting 100 miles a day.

Carl was a teacher and coach in Omaha, and we had lots of family and friends in the area. Jeff was in college and playing football at the University of Missouri, and we traveled to all his games. It was clear I needed to think about the Omaha area. So I started networking.

My first paid consulting OR work was for a woman in my PhD program named Paula Wells who was at the forefront of women-owned engineering firms at a time. She and her husband owned Wells Engineering, a civil engineering company in Omaha. It was a time of emphasis on total quality management (TQM) and application of W. Edward Deming's *Quality, Productivity, and Competitive Positioning* in business and industrial engineering circles. I was well versed in TQM and also the application of Myers-Briggs personality testing, so we combined these areas into training workshops for hospital groups, businesses, and chambers of commerce. The book

Cheaper by the Dozen is the story of Frank and Lillian Gilbreth, industrial engineers in the early 20th century who raised their 12 children using time management principals. Paula published a book about her own family in 2007 called *The Fabric of a Family: Lessons in Love Learned from One Husband and Eighteen Sons and Daughters.*

In 1985, the consulting work was interesting, but not a path to the full-time career I desired. Meanwhile, fellow graduate students worked in the OR Department at Northern Natural Gas of Omaha while others were at SAC at Offutt AFB. At SAC, I interviewed with Dr. Ted Hardebeck, who was one of two SES division chiefs in science and engineering. I expected to explore options with a summer job. I still remember our visit and me saying, "I don't know anything about the military or airplanes." And he replied, "You're not marrying the job so you can always walk away, but I think you are going to like this work!" I started on January 7, 1985, and I never once considered walking away.

Bob Sheldon: You were there when SAC was shifting away from the pure Single Integrated Operational Plan (SIOP). Can you talk about those challenges?

Jackie Henningsen: That was a very interesting era. I was in an organization of about 50 analysts, nearly all civilian, with a long history linked back to Gen LeMay and nuclear operations. We were in some ways like independent consultants and in other ways we had established roles in maintaining strategic planning factors. One of the first projects I worked on was with MORSian Gene Schroeder, later at Los Alamos. He led a structured look at the trade space between intermediate and long-range missiles. I didn't know the system characteristics or other specific information of that nature, but it laid out as a mathematical problem to me.

The first projects I tackled myself as OR lead linked to my grad work co-publishing a guide to "Problem Solving in Small Diverse Groups" and related work developing scientific surveys. A pilot retention problem was looming. It was attributed to increased airline hiring, coupled with the retirement of the Vietnam-era pilots due to up-or-out promotion policies. Overall, there was great concern about being able to maintain the force. I was asked to put together a survey that would also help address what appeared to be general dissatisfaction in the younger crew force.

I was paired with operational experts, who thankfully forgave my lack of specific knowledge, and appreciated my ability to introduce statistical reliability. The "Air Crew Duty Day Survey" was developed to gather information that was considered important to making some changes in how the crew force was being handled. There were scheduling problems with circadian rhythm and back-to-back flights issues with effects in terms of the training and flying cycles. There was an evaluation system in place, called the 1-2-3 evaluation system that required a specific distribution of ratings within groups. It was a morale buster.

The interesting part, which I think links to the Lessons Learned organization I led in later years, was that as an analyst you're not identifying something unknown, because many people knew that there was a lot of angst in the crew force. However, by applying systems analysis thinking, we were able to step outside the box and package the concerns and the issues in ways that transcended individual complaints. We helped provide a step-by-step framework, put findings into a broader context and allowed insights to coalesce while informing decision makers on potential options.

Bob Sheldon: A technical question about the survey: what percentage of the respondents actually filled out the survey?

Jackie Henningsen: This one was relatively high for a survey. If I remember right on that one, it was over 65%, which can be indicative of either pressure to respond or respondents feeling like they really had a lot to share.

Bob Sheldon: Did you worry about biases of people that were more disgruntled and would be more likely to fill out this survey?

Jackie Henningsen: Yes, we did; so I always did an initial write-up of findings and layout of statistics. This was followed by what we later called the "fall foliage" tour. Our small team flew to five northern tier bases in seven days, from Maine through Michigan to both Dakotas. At each, we brought the young crew members in separately from their senior leaders and informally showed them what we had gathered and asked them to explain it to us.

Bob Sheldon: Was this survey Air Force-wide or just SAC-wide?

Jackie Henningsen: This was SAC, but it had more than 150,000 people, including the missile, tanker, and bomber forces. This work focused on the bomber force. I later did similar studies on missile and security forces.

[For the Missile Duty Day Survey, I was able to include the first base with female crew members. Originally they were in women-only teams, but later mixed gender teams. Not surprisingly, one of the issues noted was not harassment per se, but the isolation they experienced as they tried to fit in with sometimes less than welcoming bosses, crew mates, and spouses.]

Bob Sheldon: Let me backtrack. When you were hired by the Air Force, were you hired into the 1515 track as an analyst?

Jackie Henningsen: In 1985, I was hired as a GS 1515-11 OR analyst consistent with the rules for hiring. However, I was in a track that allowed yearly promotions up to GS-13. There were very few professional women (military or civilian) at the time, and by 1992 as SAC was dismantled, I was told I was the most senior woman in the command as a GS-15. This is not an anomaly, but an indication of the times and the beginning of an era of opening opportunities for women in DoD. Kerry Kelly joined SAC/NR a few months after me. She retired in 2019 as the U.S. STRATCOM/J6 after a very successful career, including years as an SES.

Bob Sheldon: Who did you brief on the results of this pilot satisfaction survey?

Jackie Henningsen: The Director of Operations, and sometimes SAC's Commander-in-Chief. Gen Larry Welch was highly interested in analysis and had tasked the previous study as well as the next effort as he soon became 12th Chief of Staff of the Air Force (CSAF). There had been three B-52 accidents over a few years period followed by full accident board investigations, but Gen Welch wanted to explore possible nonidentified systemic issues in the bomber force. This wasn't about the accidents per se, but about the impact of post-Vietnam-era training. I was again paired with operational experts as OR lead with my knowledge of survey development again coming into play. We designed a very confidential system of gathering feedback and got more than 3,500 surveys back from the rated crew members. We laid out the results and asked representative groups of crew members for insights during another multibase tour.

After so many years, the order of studies blurs, but the excitement of being an analyst interacting with big issues still remains with me. The art of survey work is being able to distinguish between general griping and real trends. The group work helped sort through the reams of data and the pages of comments. How much of this is just stories; how much is just bravado? Why is that a problem? And beyond the change of culture, something else emerged. The B-52 is a crew airplane with navigators in a compartment separated from the pilots, so it's very highly dependent on good communication. The two teams were using charts specific to the duties of their positions. However, we were in a time period when there was increasing interest in using bombers for lower level missions. Communication wasn't just about where the bombs would land, but also about the aircraft routing including possible en route bomber target changes.

Bob Sheldon: When you had these interviews with the crews, was it one-on-one, you the analyst and one pilot?

Jackie Henningsen: No, we gathered several full crews together and put information on the table (often box-and-whisker charts or other graphic tools) and said, "Look here's what we're seeing – can you explain it to us?" Next, we consolidated what the crews had told us, and briefed SAC leadership who directed us to convene a command-wide workshop to come up with recommendations regarding any changes to rules and regulations. We spent days working through each finding with unit representatives proposing actions. The accidents hadn't occurred when flying the emerging low-level profiles, but the insights revealed a lot from what the crews told us that highlighted the differences in experiences from the Vietnam-era crews and 1980s alert crews. Approved recommendations included a mandatory change to common flight charts in the

navigation and pilot positions, guidance on responsibilities sharing between the pilots, and new training guidelines. The ops team lead and I presented results in a special session at the annual Bomb Competition Symposium at Eighth Air Force.

Bob Sheldon: Who were some of the other MORS people you remember from SAC?

Jackie Henningsen: The head of SAC/NR during that time was Frank O'Meara. Dr. Ted Hardebeck was my boss through the SAC years. Ted was recognized when he retired with the Air Force Analysis Lifetime Achievement Award. Colleagues from the 1985–1991 timeframe that remained active in MORS through the years, included MORS Fellows and Past Presidents Tom Denesia and Pat McKenna, Gene Schroeder, Kerry Kelly, Lynne Baldrighi, Dr. Mark Gallagher, Richard Jourdan, Balf Callaway, Mike McMillie, Ray Valek, Linda Bors, and Lt Dave VanVeldhuizen.

[Expanding on this answer: I met a series of MORSians and analytic leaders in this time period that were role models for me. In particular, I remember the wise guidance of Marion Williams, FS, at AFOTEC who influenced so many young analysts through the years. I was honored and humbled to meet MORS Fellow #1, Clay Thomas, during that time as well. I also was fortunate to first meet the legendary Lt Gen (ret) Glenn Kent during the 1987 timeframe when he attended a study planning meeting at SAC where several FFRDCs (federally funded research and development centers) were contending to lead a study. It was a daylong meeting, and in the morning SAC principals laid out the problem. In the afternoon, the visitors were to describe what they would do to address the problem. They each proposed months-long studies. Gen Kent waited patiently and then said, "If I can have an hour today, I will tell you how to solve this problem with no study time." I soon learned, this was classic Gen Kent. In 2003, I led an Air Force Analytic Community ceremony at the Air Force Institute of Technology (AFIT) honoring Lt Gen Kent, and announcing the Air Force's Lt Gen Glenn Kent Leadership Award in recognition of leaders whose vision and leadership established the Gold Standard for the Air Force Analytic Community. Natalie Crawford of RAND, whose stellar guardianship and wise counsel guided me thru the years, was the first recipient in 2004. The second honoree was Gen Larry Welch, 12th CSAF in 2005. I was humbled to receive the award in 2016.]

Bob Sheldon: The projects you picked up at SAC, did you just raise your arm because it sounded like something you could do? Or did they throw things at you?

Jackie Henningsen: I had responsibilities for annual bomber and tanker mission planning factors, and later as liaison to the Joint Staff-led Modern Aids to Planning Program (MAPP), and because I was inquisitive, there were always pop-up challenges needing an OR touch. For instance, I led a decompression accident study and a cancer incidence rate study for the SAC Surgeon General; polygraph screening test implications for Intel; and collaborated on missile launch facility ergonomics with the Rapid Execution And Combat Targeting (REACT) group at Wright-Patterson AFB. I also participated with SAC teams on missile basing strategy reviews, sensor data requirement assessments, and relocatable target tracking efforts.

Then Dr. Hardebeck volunteered us for SAC ADVON (Advanced Echelon) training and exercise roles. We were sent as analysts to both live-play and Command Post Exercises like WINTEX across NATO and Ulchi Focus Lens in South Korea. We would collect data, observe processes, and generate reports working with military operational and intel experts on optimal procedures and to identify bottlenecks in the planning processes. We gathered data during exercises on the communication lags between echelons and how that communication and traffic delay could impact the passing of operational guidance. We examined coding and entering data on targets, and projected demands in real-world operations. We introduced and tested new planning tools and captured insights for training purposes.

Bob Sheldon: In other words, did you 'train like you fight'?

Jackie Henningsen: Yes, exactly.

[Some of the best words of advice I got as a woman pursuing a career in this field came while working in a bunker during a NATO exercise. The Archduke of Liechtenstein was coming to visit, and I asked a team member what the protocol was for meeting an Archduke. The crusty Master Sergeant advised me as follows, "Ma'am, never curtsy in a combat zone!"]

Bob Sheldon: You talked about your dissertation earlier, and this is about the time you're finishing up your dissertation? Were you able to apply some stuff you learned from your dissertation topic to any of the projects at SAC?

Jackie Henningsen: Yes, I finished in 1987. Thinking through command and control requirements in terms of nodes, the connections, and networking was a very important part of my work as I gathered exercise data. The CINCSAC, General Chain by this time, also asked NR to build an inhouse conventional wargaming capability for SAC. Dr. Hardebeck assigned me as co-lead of the effort. Nuclear wargaming had been in use for decades. We wanted better involvement in the conventional games the Joint Staff and Navy ran. I joined SAC's team of military experts attending the annual Joint Staff Total Force Capability Assessment (TFCA). At this time, I met MORSians Bill Lese, U.S. Central Command (CENTCOM/J8) and Vince Roske, Joint Staff/J8 Analysis lead.

Bob Sheldon: Let's talk about your first involvement in MORS.

Jackie Henningsen: In June 1986, the MORS Symposium (MORSS) was held at National Defense University. It was the first for Kerry Kelly and me.

Bob Sheldon: The first MORSS you went to, did you present a paper?

Jackie Henningsen: We presented as SAC/NR policy required you to present to attend. I think my topic was related to my dissertation. I only missed one MORSS in the next 36 years. I remember 1989 was my first trip to Monterey and for a special session on Applications of ORSA to Wargaming and Exercises, Christine Fox (later head of OSD Program Analysis & Evaluation and then Acting Deputy Secretary of Defense, DepSecDef) and I were the presenters. The next year, following the fall of the Berlin Wall with high Congressional interest in a peace dividend, Ted Hardebeck and I proposed a MORS mini-symposium be held at Offutt AFB focused on "Measures of Deterrence in a Changing World." I chaired the meeting, and we were fortunate to get Cold War strategist and negotiator Paul H. Nitze as our keynote speaker. It was held in the winter, which is always risky in Nebraska, and we had a huge ice storm the day before, but somehow people arrived, and the last piece of the puzzle came when Major General George Harrison, head of AFSAA, flew a DC contingent in via military air. I couldn't dream that I would become the head of AFSAA a decade later? It was a conference that really captured the changing times.

[We held a follow-on MORS special meeting at Johns Hopkins University Applied Physics Lab (JHU/ APL) 15 years later, and I gave a presentation on the evolution of deterrence strategy since the end of the Cold War.]

Bob Sheldon: What studies were you working on at SAC at that time?

Jackie Henningsen: We were particularly focused on using the B-52 in conventional operations as a more adaptable, flexible, responsive platform, by exploring low-level missions with bomber target change options. This also had ramifications for the nuclear mission, since the aircraft could be alerted en route with a new target or threat location, and have to re-plan the route, possibly while flying low level. It was a strenuous mission profile, so we tested feasibility in flight simulators before going to live target ranges.

Bob Sheldon: This was prior to Desert Shield/Desert Storm?

Jackie Henningsen: Yes. By 1988, SAC and Eighth Air Force were focused on both B-52 in a lowlevel flight profile and setting up bare bases in order to practice flying continuous operations. This was tested in a month-long exercise called Bull Rider at a closed base named Clinton-Sherman AFB in Oklahoma. Eighth Air Force hauled in all the War Readiness Spares Kits (WRSK), crews, support teams, and supplies for eight aircraft. The concept was if something broke that wasn't available onsite, then support teams either had to improvise or send back "home" for the part(s) with the appropriate delays for overseas transport.

Headquarters (HQ) SAC operations, logistics, Eighth Air Force principals and our analysts spent nine months setting up the exercise and test design concepts for this very extensive accounting that had not been examined since the Vietnam War era. I led an operations analysis team, and Dick Jourdan, a superb SAC/NR senior analyst, was head of logistics and maintenance analysis. (Dick had a fascinating bio. He left college to serve as a noncommissioned officer in the Korean War and was

wounded within the first week on the frontlines, but stayed as an aide and recorder.) There were eight B-52s onsite with 500 people living in austere conditions for over a month. The concept was to fly a 0.8 sortie rate per day for 30 days. Toward the end of the month, the crews invited me to go on a mission.

Bob Sheldon: What seat did you sit in?

Jackie Henningsen: I sat in the instructor pilot seat behind the pilots. I was not afraid of the flying, but I was petrified that I would get sick, and they would abort the mission and spoil our sortie rate record. (They later assured me that they wouldn't have stopped the mission for me being sick.) Anyway, I took a Dramamine before we took off to calm my nerves; and just before we went into low level in the Utah test range, I took another just to be sure I could handle low level. I made it through three hours of night low-level flight and experienced the excitement of aircraft dropping bombs, chaff, and flares. As soon as we came out of low level I zonked out, and when I opened my eyes there was an airplane in my windshield view. I started screaming; but of course, they were just refueling. However, once back to base, I nearly sabotaged the future mission success rates. Upon arrival in the early morning, I was given the ceremonious hosing down (a complete surprise). I had brought a cheese blintz to share over coffee during the debrief, but the crews had headed out before I got done drying off. I had a pastry and coffee and went to get some sleep. Shortly, I woke up with what turned out to be a very bad case of food poisoning. Luckily it was only me in sickbay for the next few days.

Bob Sheldon: So nine hours in the B-52.

Jackie Henningsen: It was enlightening. But for an analyst, the best part was the many months spent working on the data identifying how to build a better WRSK and processes to support future operations. One of the big questions we examined from the ops view was the capability to "flush" the aircraft between flights in the event of an unexpected base attack.

In addition, SAC/NR was in charge of the ops planning factors that were updated every year. For the weapons effectiveness planning factors, we gathered the bomb scores from all of the units throughout the year to create the circular error probable (CEP) standards. We gathered the bombing effectiveness rates, the time on target rates, and all of this rolled into a set of planning factors that were used to support investment strategies, estimate fuel requirements, evaluate missile and launch vehicle reliability in both the conventional and the nuclear weapon systems of the command.

Another study area that our team was actively investigating, in coordination with the operational planners, was threat avoidance routing and extension of low-level flying based on the emerging threats in both conventional and nuclear missions. A goal shared by all engaged was to extend the traditional bomber mission survivability by developing new automated tools that projected terrain mapping of potential threat locations. This was the Cold War era, and work on the SIOP continued to drive major investments in analytic and intelligence resources. The conventional side of that equation emphasized a big clash with the Soviets coming across the Fulda Gap in Germany with missions that encompassed the defense of Europe and the NATO nations. However, there was a whole counterpart effort focused on the Pacific and the exploration of distributive mission planning to support the South Koreans was equally investigated. Both the Pacific Air Forces (PACAF) in Hawaii and the U.S. Air Forces in Europe (USAFE) had robust analytic organizations during the 1985–1990 time period. It was an exciting time to be an analyst with lots of new aircraft initiatives as well as travel to exercises and wargames across the globe.

Bob Sheldon: Gen Larry Welch, former CSAF, said that when he was CINCSAC, one of the mindsets he had to embrace was being schizophrenic. If you're doing nuclear planning, it's strictly by the rules. If it's not nuclear, you need to be very creative and think outside the box. Did that kind of thought process translate to the analysts?

Jackie Henningsen: It translated in the sense that those of us who worked on the conventional side recognized that we were more expendable in an existential or budget battle, but felt fortunate to be encouraged to plan out of the box more freely. There was crossover, though, as the concern

for relocatable threats and moving targets increased in the late 1980s. So even nuclear plan execution required real-time replanning capabilities.

Bob Sheldon: How was your transition from being an analyst to being a supervisor, when you became chief of a group of analysts? How did that happen?

Jackie Henningsen: It was a title evolution, but the teams were small so even with an added layer of responsibility everyone had to perform at multiple levels.

Bob Sheldon: How did you develop the capabilities or the models for doing the studies?

Jackie Henningsen: I have always believed it is fundamental to recognize that the analysts, not the models, are the critical factor. The models can always be better than they are. They were adequate to the job, and we continuously worked with others to try to improve them. Tactical warfare (TACWAR) (the campaign model of the day) was never exceptionally good for air, but one of the rules that we operated on was, if one of the key organizations that we needed to influence used a model, then we would learn how to use it. The second rule was our analysis was to be done in-house.

During this period at SAC, my group was able to initiate a conventional campaign modeling capability to support CINCSAC's direction to build a SAC wargaming capability with support from the MAPP. MAPP was started in the mid-1980s to provide Joint Command staffs in-house analytic tools to help them with their planning processes. A J-8 run contract vehicle provided configuration control and model support for members. SAC/NR was SAC's liaison to MAPP, and I became heavily involved. With MAPP support, we set up DoD's TACWAR model, and an alternative campaign model called Combat IV, as well as a mission-level model called the Extended Air Defense Simulation (EADSIM). We were also able to install SAC's first video teleconferencing (VTC) capabilities to support engagement in Joint distributed wargames. MAPP was the subject of many MORS events.

[The MORS oral history for Bill Lese provides excellent background on the history and personalities behind MAPP.]

Roy Reiss: It was continued under OSD PA&E Collaborative Analysis for a time in the first decade of this century.

Jackie Henningsen: Right, but with the end of the Cold War, the focus on supporting in-house command groups changed. In 1991, the OSD established, with Congressional approval, the Defense Modeling & Simulation Office under the Director of Defense Research and Engineering (DDR&E). It had about \$60 million in funding for an Executive Council for Modeling and Simulation (M&S) (EXCIMS) to incentivize advances in info sciences, communication networks, and high-performance computing. I started on its advisory groups while in PA&E, and eventually was the Air Force EXCIMS rep.

Bob Sheldon: Did you learn some things from the exercises you participated in that you brought back into the modeling and analysis?

Jackie Henningsen: Absolutely. I have a chart that highlights the flow, interactions, and feedback loops among exercises, wargames, M&S, and analytic studies. We should always remember that they are all aimed at illuminating the challenges and informing the decisions facing our leadership.

In 1988–1989, we not only had a strong focus on the conventional role of the B-52, with particular emphasis on low-level flying, but also on the emerging threat of relocatable threats in the SIOP (nuclear) mission. Both led to attention on the use of en route bomber target changes. One of my very interesting projects was setting up a bomber target change experiment at Minot AFB, North Dakota, in their B-52 simulator. Crews would do their original mission planning and fly routes in the simulator. Then we would repeat the mission but communicate encrypted bomber target or route changes. They had to decode the changes while experiencing the effects of the motion simulator and plot a modified route. "Crashes" were frequent, given the departure from the preplanned point-to-point routes. [*The questions were: what kinds of missions were amenable to this training; was there a learning curve for more effectively flying these routes; and could communication system advances help increase success?*]

Bob Sheldon: Did you find a learning curve?

Jackie Henningsen: I only set up the initial design. The learning curve was investigated over time by the on-base training teams. There were a wide range of issues that could cause problems, including miscoded translation on the digits, miscommunicated codes, simulator failures, disconnects between crew positions, or truly infeasible routing challenges. Adding one last-minute threat into a routing solution could simply close all paths when already in low-level mountainous terrain. Parallel studies of other technological advances in communications and night vision goggles were also ongoing. [There is a fascinating story about the role noted RAND analyst, Natalie Crawford and three young captains at the Fighter Weapons School played at the time in the heads-up display concept development.]

Bob Sheldon: A lot of human factors?

Jackie Henningsen: Yes, there were a fair share of human factors issues in every study. The part that I found particularly intriguing about the role of SAC/NR was we were able to contribute study insights across multiple mission challenges. Analysts were valued, not as evaluators, but as partners in capturing insights and testing concepts. Of course, the capacity we had to send message traffic was a major issue, so we had to try to find ways to condense file information. Many frustrating aspects of our computer systems over the years were due to work-arounds built in to address data storage capacity limitations. We were also integrated into teams hauling very large parallel planning systems hardware overseas. We hoped someday they would get smaller, lighter, and more reliable, and of course, planning did go from truckload sized systems to laptops over the years.

In addition to the previously described ADVON roles, I participated in wargames at the Warrior Preparation Center, SHAPE Technical Center, Falcon Air Base (later Schriever AFB), Joint Staff and OSD Net Assessment games, and Service exercises like Air Force's Blue Flag.

Bob Sheldon: From 1988 to 1989, you were the chief of the Combat Analysis Group and then you became chief of the Capability Assessment Division. Was that an evolutionary process again at SAC?

Jackie Henningsen: Yes. Based on changes related to the continued implementation of the 1986 Goldwater-Nichols Act, SAC/NR was dissolved under the emerging Joint focused, J5 umbrella. I became the Chief of the Capabilities Assessment Division (J534).

Following our work in Bull Rider, our team continued work with the Eighth Air Force commander on more rigorous conventional operations activities. In June 1990, we had a particularly in-depth planning exercise at Barksdale AFB, Louisiana, involving all the bomber units in SAC. Our headquarters oversight team was composed of a Vietnam-era bomber pilot representing SAC/DO, SAC's leading targeteering expert, myself as SAC/NR research analyst, and a couple junior analysts. We were joined onsite by Eighth Air Force HQ reviewers. Each SAC bomber unit brought in a full planning team (bomber, tanker, intel, com) and set up in the Eighth Air Force auditorium areas in camouflage tents with equipment for 24-hour ops planning. Over a week's time, the white team would generate mission orders for certain "realistic targets" to be executed on a schedule "flying" from forward bases in Europe. The clock was real-time, but there was no actual flying, just planning, virtual plan execution, debriefs and feedback by Eighth Air Force evaluators.

It was an intense competition to see who could optimize use of resources to attack a particular set of targets that was laid out. Over a week, each subsequent mission got more complex including updated day-of-mission intel and equipment problems. The last mission was nearly impossible due to distance, location, projected threats, as well as last-minute weather issues and en route realignment of tankers. It was a solid exercise; good training. The Eighth Air Force commander complimented the teams after the end-of-exercise review, and we submitted our initial report expecting units to derive lessons for future training. However, less than 30 days later Kuwait was invaded, and the detailed report became a preparedness benchmark. It turned out to have been an amazingly prescient, just-in-time preparation conceived by the Eighth Air Force commander. A key recommendation written by the pilot on our team was a caution about the training lapses in

high-level flight given the extensive time that had been spent on low-level training. The warning was spot-on when the bombers were forced to return to high altitude profiles for all of Desert Storm.

Since our analytic team had developed a strong reputation related to the Eighth Air Force work, we were asked to set up a cell within the SAC headquarters command post, and I attended the daily ops briefs. One of the issues the ops, intel community, and we attacked immediately after Desert Storm kicked off was the CEP appeared to have climbed significantly compared to our planning factors. A discernible directional bias seemed to be contributing to the error. Our team's expert intel/targeteering assessment advisor, Maj John Parsons, had already been called to the Pentagon to support Checkmate, but another civilian analyst/reserve pilot had the CEP planning factor portfolio. His team did a rapid assessment tracing thru the modifications and training records for specific aircraft. The peacetime focus on building planning factor databases meant we had data available. A quick-fix offset was calculated and sent forward.

Bob Sheldon: In the Gulf War case, it didn't require buying new hardware? The fix was in the operation of it?

Jackie Henningsen: Well, the fix at the time had to be in the operation because there was no time to buy anything new. We just had to give them an aim factor adjustment. They were able to correct it almost immediately.

Bob Sheldon: What was the response time from discovery of the problem to developing a solution?

Jackie Henningsen: This was identified and addressed within two days of dropping the first bombs in Desert Storm.

Bob Sheldon: It's a quicker response time than the OR groups did during WWII changing tactics.

Jackie Henningsen: Communications capabilities made sharing data and information in near realtime possible. (Remember the nightly news coverage from Iraq.) We were one of the reach-back teams for analysis of SAC missions.

[Of course not every problem can be quickly solved. I note that more than 25 years later when I was the AF/A9, our analysts, led by Dr. Mark Gallagher and Col Scott Long (PhD in OR), were asked to help develop initial assessments of the issue with F-22 pilots intermittently experiencing hypoxia-like symptoms. A massive sensor-based data collection effort captured enormous quantities of data, but the incidents were rare and causality was difficult to assess. However, in this case, based on advances in computer technology coupled with some new algorithm developments by junior analysts working closely with the Air Force Human Factors lab and AFIT, they were able to pinpoint areas for attention in the On Board Oxygen Generating System.]

Bob Sheldon: Were there any other kinds of problems during Desert Storm that your team found and helped out on?

Jackie Henningsen: Many day-to-day questions flowed through the system, but once the war fight began, it was in the hands of the operational forces to execute what they had trained to do. However, as Desert Storm drew to an end and as visiting teams of assessors from a range of agencies, Congressionally appointed task forces, and functional groups began to seek information, it fell to our team to put in place processes to quickly capture the SAC specific observations and lessons from the war before our people packed up and went home. This was done in parallel with the historians who were busy gathering what they needed for reports. We set up a SAC Gulf War lessons learned data collection process that could fold information into the calls from the aforementioned groups. I remember at that time SAC had the operations and logistics for the tankers, bombers, intel, and command and control assets. The use of the Internet was not in place and there were too many units to cover by our small team. We identified a command-lead within each deployed unit along with the in-place historian, where available, and sent out tape recorders, and a set of instructions. We covered hubs with a traveling team that went from location to location training the onsite leads to do structured interviews with commanders, crews, support team members, etc., and gather all the available data possible before it evaporated. The lesson I learned was it is nearly impossible with hundreds of hours of tape to get it transcribed for use. We had an internal SAC conference for representatives from all our different units come in and sieve through their materials, identify top insights, and organize them into themes. Data storage limitations were the norm, and it was common to write over one set of mission data with the next.

[OSD/Policy and Joint Staff had the lead to capture Gulf War lessons for the DoD. The major commands (MAJCOMs) and Services were asked to consolidate information and share it as part of several conferences. OSD PA&E and RAND were responsible for development of a report for Congress. The next year, we had a MORS mini-symposium on "Analysis of Lessons Learned from Desert Storm/Desert Shield" in support of USCENTCOM and the Joint Staff. Each command analytic organization under the MAPP structure gave a presentation. SAC/NR analyst Ray Valek and I presented the work for SAC. He and his team lead, Dick Jordan, had focused on logistics flow and had a huge amount of feedback from Desert Shield when we moved forces and set up resupply. I think that the MORS workshop was one of the best ones we ever had because it was so relevant to follow-on needs. The model work of AFSAA using EADSIM was presented in detail relative to its support for Checkmate and the in-theater planning groups. There are various MORS, FFRDC, and Service-specific reports from that timeframe that capture the story of the planning, the buildup phase, and the assumptions that influenced the modeling.]

Bob Sheldon: One of the semantic debates about "lessons learned" is, we shouldn't call them lessons learned unless behavior is changed as a result of the lesson.

Jackie Henningsen: I agree, so I would prefer to describe an "observe/identify/capture/learn/ disseminate" process, but the phrase L2 is well entrenched in the defense lexicon. I believe a successful L2 program has to be embedded in the day-to-day culture, like "safety" and "security." This was a best practices focus when I later led the Air Force Lessons Learned (L2) Program.

Bob Sheldon: Did you do a lot of analysis after the fact to see how we could have fought Desert Storm better with your SAC warriors?

Jackie Henningsen: All DoD replayed Desert Storm and variations for the next decade. There were lots of different cases explored such as nuclear and chem/bio usage. For the Air Force, this continued through the whole Operation Southern/Northern Watch period when we maintained no-fly zones throughout the 1990s. Continuous forward engagement has gone on from that point to the present. The deliberations of QDR-97 concerning worldwide postures and future wars were influenced by issues of sustainability.

[I also vividly remember over a decade later when a senior acquisition civilian assailed me at the start of Operation Iraqi Freedom (OIF) about the "failure of modeling and analysis in Desert Storm." She was vitriolic and it took me a bit to figure out that she was decrying the projections that a much larger number of ground forces, aircraft (and crews) could be lost in the first week. Like many of us have learned, explaining that model projections are best interpreted by understanding underlying assumptions and confidence intervals, did little to change her mind. In Desert Storm, warfighting planners built a brilliant strategy that started by heavily attriting enemy C4ISR and combat forces with air before initiating the ground battle (which included a bold and decisive move as well). Prudence said to assume the enemy would use rather than turn off or flee with their systems to avoid engagement. The role of all Services were crucial, and in my view, the modeling did what good risk analysis should; show what the worst outcome might be and then support the warfighting planning experts' efforts to systematically diminish or replace that outcome.]

Bob Sheldon: Can you translate any of those "what if" questions that you asked into any management decisions that were made at SAC?

Jackie Henningsen: One change was that the attention on low-level B-52 flying ended. But most significantly, as we entered the era when the Berlin Wall came down and the Cold War ended as we had known it for over 40 years, the other roles of SAC and all of DoD took on new perspectives.

[MORS was again an important player in framing analysis to examine the post-Cold War future. In 1991, I chaired the previously described mini-symposium at SAC called "The Role of Deterrence in a Changing World." The first two days focused on nuclear issues, but the third day was dedicated to

deterrence in the conventional arena by analyzing Gulf War lead-up in the context of the evolution of nuclear policies over time. Aspects of this theme played out in many wargames over the next decade.]

In spring 1992, as a GS-15, I was selected for the Senior Officials in National Security course at the JFK School at Harvard. It was mind-expanding in terms of gaining a wider perspective on the role of DoD thru interactions with peers from other agencies, Services, and communities.

Bob Sheldon: How long was that curriculum, and what were the major issues discussed?

Jackie Henningsen: It was about two months long, and although after the fall of the Berlin Wall and Iron Curtain, it was still focused heavily on the Soviet/United States relationship. The program covered broad-based national security related policy, economic, negotiation, and security issues. Classes were taught and lectures given by JFK School experts (like later 25th Secretary of Defense, SecDef Ashton Carter). We attended historic talks; for instance, the former Gen Secretary of the Communist Party of the Soviet Union (1985–1991) and President of the Soviet Union (1990–1991) Mikhail Gorbachev spoke on the challenges of introducing *glasnost* (openness) and of *Perestroika* (the program to restructure Soviet Socialist Republics [USSR]). The influence of the 1986 Chernobyl nuclear disaster on world affairs was also a key topic.

However, I had something heavy on my mind while attending. Earlier that year, it had been announced that SAC and Tactical Air Command were standing down and a new Joint organization called United States Strategic Command (USSTRATCOM) was being stood up. It was a real shock to most in DoD, certainly to the SAC system and its Air Force members. The new command leadership roles at STRATCOM were to be Air Force, Navy, or Marine military generals. The establishment of the organization significantly changed the hierarchical structures with all Services to be represented. It also required significant reduction-in-force (RIF) actions. Nearly all SES and GS-15 positions were eliminated, and my position equivalent was moved to Air Combat Command (ACC) at Langley AFB, Virginia. I could move, or stay at Offutt with a two year savegrade/save pay option, then "retreat" to a GS-14 level. This was my first experience with RIF drills, but certainly not the last over the next 25 years. With the decision to eliminate all GS-15s, I knew it was time to move, and luckily Carl, after teaching and coaching for over 27 years, was supportive of a new adventure.

[In 2012, during another large Air Force reduction, related to sequestration, I told my A9 folks the story of my RIF experience and how it led us to move to DC and the Pentagon. I gently confided that "though painful at the time, it hadn't turned out too badly for me."]

Bob Sheldon: Where did you and the other SAC analysts go?

Jackie Henningsen: By summer 1992, our SAC analytic folks were scattering to the winds. I'll focus on the MORS members that I stayed in touch with through the ensuing years. Gene Schroeder had previously departed for Los Alamos, Dick Jourdan retired, Balf Callaway left for ACC, Tom Denesia went to U.S. Transportation Command (TRANSCOM) and later to USNORTHCOM. Dr. Ted Hardebeck, Kerry Kelly, Ray Valek, Pat McKenna, Linda Bors, and a few others remained at USSTRATCOM. I briefly considered taking the parallel transfer to ACC. However, I first sought advice from some of the MORSians I had met in earlier wargaming efforts. Bill Lese and Vince Roske both encouraged me to apply to OSD PA&E. Congress had set up a Cost Analysis Improvement Group (CAIG) due to issues with a costly aircraft program failure. The Resource Analyses Directorate was hiring CAIG members under PA&E's open advertisement for GS-1515-15s (even though it was for a cost analyst). I accepted a job in the Force and Infrastructure Cost Analysis Division and started in September 1992.

Bob Sheldon: So it was mainly via your MORS contacts that you found out about the good jobs and got some good advice on where to go?

Jackie Henningsen: True, both MAPP and MORS were essential roots for mentoring and developing DoD analysts. When I joined the Cost Analysis organization at PA&E, I was assigned the strategic and space launch cost portfolio for the CAIG based on my SAC background. The CAIG was established by Congress as an independent reporting organization to the Defense Acquisition Board (DAB). Not too much later, Dan Barker came to PA&E from AFSAA, and had tremendous impact on the restructure of the Planning, Programming, and Budgeting System (PPBS).

Bob Sheldon: Was the Navy A-12 the failed program that led to formation of the CAIG?

Jackie Henningsen: Yes it was. Active in my portfolio as Strategic and Space Launch Systems lead was the Minuteman and the Trident D-5 upgrade programs, the B-1 Computer Upgrade, and the Titan IV. The Titan IV was a space launch vehicle that had been put into heavy play to give us access to space after the Challenger disaster. For several years there had been a very aggressive schedule of development under black world programs as it was a "must do, must succeed" effort. My CAIG challenge was to prepare Titan IV for a normalized, transparent program evaluation under DAB guidance.

Bob Sheldon: How did you teach yourself cost analysis? Did you read books? Attend classes?

Jackie Henningsen: When I got to PA&E, they were going to send me to a cost analysis training course, but we were so busy that I was never able to go, but I had exceptional leaders to rely on. Dr. David Chu, Assistant Secretary of Defense and Director PA&E (1981–1993) approved my hiring. His distinguished history in DoD, spanning over 50 years, meant he continued to be an influential presence throughout my DoD career. An economist by training, he was a staunch supporter of competitive analysis in the mold of Lt Gen Kent. My mentor and boss, Dr. John Morgan, was a respected expert in cost analysis field and taught me through on-the-job-training (OJT). My second level supervisor was Dave McNichol, who later led Resource Analysis at the Institute for Defense Analyses (IDA) for years. Commander Don Tison, later Army's PA&E, was my Navy program guide and partner on the D-5 upgrade. Finally, Dr. Frank McDonald was the maintenance and logistics expert for all of our CAIG programs and was always ready to lend help. Frank had a genius for teaching and mentoring young people. When I later led AFSAA, I was fortunate to promote Dan Barker and subsequently Frank McDonald as senior leaders serving as scientific advisors and mentors in the role previously held by Clay Thomas (FS-1). Clay respected Dan and would have bonded with Frank over their shared dedication to development of young analysts!

Bob Sheldon: So it was OJT.

Jackie Henningsen: A lot of OJT and good advice from experts like Dr. Morgan. The first couple years in the CAIG were the most stressful and intense time of my professional life. It was full immersion in the deep end of the pool. However, it was invaluable preparation for everything that followed. Nothing else taught me more about how to be an analyst in DoD than the time I spent on the CAIG. I had to learn to work on programs at the work-breakdown structure level and then condense the findings to identify the most significant cost drivers. I spent time with manufacturers and think tank experts. We examined every detail of the Service and industry cost estimates; trying to understand the financial aspects, industrial challenges, operational drivers, engineering concerns, facilities infrastructure demands, and the whole span of manpower requirements.

At that time, the Services were doing a full cost estimating process for each program. Titan IV was an ACAT 1 (Acquisition Category) program, obviously a huge program, so we went through the Service's cost estimate in excruciating detail. We were using many techniques; cost estimating relationships, comparing to prior history on components or on different aspects of the rules of thumb on propulsion on down to individual component cost estimating. We had to focus on the high risk areas and the rule was that you had to use a different technique than whatever the Service had used. That always was interesting because they got to go first.

Bob Sheldon: Two different techniques? What do you mean by that?

Jackie Henningsen: Well, if they used a cost estimating relationship based on historical data, then we might use an engineering projection based on something to do with the weight or size of components. There were different models that we used. Some were standard tools, but others were new relationships using Monte Carlo simulation with large interlocking spreadsheets. This was coupled with a lot of engineering-level comparison between the specs versus what we found at the manufacturing plant or in exchanges with the engineers. The reliability of the solid-fuel rocket

boosters was a big cost driver. Even today, watching a commercial space launch, I get a thrill remembering climbing up on the launch pads at the Cape and Vandenberg.

Bob Sheldon: This was before the buzzword COEA (Cost and Operational Effectiveness Analysis) started?

Jackie Henningsen: COEA started at about this time period, and you will find some interesting background in Bill Lese's oral history. We had a big MORS conference early in that time period to support PA&E's kickoff of COEA.

Bob Sheldon: In the MORS community, we tend to separate the cost analysis from the effectiveness analysis. You have both backgrounds?

Jackie Henningsen: I believe it is essential to understand both to support the PPBS. It's understandably critical to understand acquisition from the cost side, but if you don't understand the effectiveness component, then you are not as respectful of the need to build in capabilities that also add cost into the systems. So I found it's very much a balance. I encourage folks to make sure they have experience with both. With great partners on my team, we got our estimates completed and ready for the DAB review under the timeline. Our estimate for Titan IV was around \$37 billion; the Service came in about \$32 billion. The DAB certified the program based on my team's estimate. Of course, that just sets a benchmark. The next stage is working with budgeting to try to close the gaps. A lot of work between the program office and OSD transpires as learning curve information develops through the various stages of a program's lifecycle, but it seldom gets cheaper.

After two years, I took a position with Bill Lese in his Regional Assessment and Modeling division which was closer to my roots at SAC. At about that time, there was a briefing to DepSecDef (soon to be SecDef) William Perry on the status of command and control, intelligence, surveillance, and reconnaissance (C2ISR) capabilities. And the comment was made during the presentation by the Joint Staff that they couldn't really answer the question that the DepSecDef asked about C2ISR. The tool that they were using at the time, TACWAR, was cited as inadequate. The SecDef said, "Come back to me in two weeks and tell me how you're going to fix it." The people in the room at the time included leaders from PA&E, Joint Staff J8 and OSD Policy. Attending were Edward (Ted) Warner III, Assistant Secretary of Defense (Strategy, Requirements, and Assessments), William Lynn III, Director (Program Analyses and Evaluation), and Admiral William Owen as Vice Chairman of the Joint Chiefs of Staff. Also present were SES deputies Fred Frostic, Bill Lese, and Vince Roske who were tasked to come up with an approach to address the issue. For this initial phase, I was appointed their lead action officer to stand up a planning team. Basically, I was their meeting organizer and PowerPoint Ranger. We joked they had the power to point out to me what to fix.

[Regarding C2ISR, computers and communications were added to the discussion and it soon became C4ISR. At a still later point, MORS Fellow Stu Starr of MITRE gave presentations on C6ISR and beyond.]

To meet Secretary Perry's guidance to come back in two weeks with a way-ahead plan, the question became, "Would we start fresh with a new requirements-based model, adopt one of the models Services were working on to replace TACWAR, or adopt an architectural approach like the DoD training folks were using on another big model project called Joint Simulation System (JSIMS)?"

Bob Sheldon: What were the C2ISR questions that were being asked that we couldn't address with the current models?

Jackie Henningsen: Secretary Perry and Admiral Owens were concerned about dominance and if we invested in more C2ISR assets, would it diminish our need for forces of another nature like ground forces, air forces or naval forces. Basically, would it shift the balance of what we needed, and could a model help us go through trade space questions. So we called a meeting of all the players: the Services, Joint Staff, the PA&E staff, Policy staff, and did a roll call of what models each had in development. The Air Force was moving ahead with the Synthetic Theater Operations Research Model (STORM), a follow-on to Thunder. The Navy had the Naval Simulation System (NSS) in initial program development. The Army was working on the Advanced Regional Exploratory System. Bill Lese insisted that we start by evaluating the model requirements and not start with existing or planned models. The other principals agreed and rejected a best of breed approach or trying to kluge something together from other efforts. This was the start of a new Joint warfighting campaign-level model. It was timely as TACWAR and similar models were based on old software that was becoming less able to capture the emerging capabilities of new systems. I believe it was a very solid strategy to first do a rapid requirements review, and then go forward with a plan based on new (at the time) software development thru rapid prototyping. The Secretary approved that approach and directed working with the Services to refine the plan for this new model. The Services assigned their leading experts to the effort, including Doug Kupersmith from AFSAA and John Shepherd from the Center for Army Analysis (CAA).

We spent the next year developing a foundation for the program officially named the Joint Warfighting System (JWARS). The Service experts were key players, and the scale, unlike JSIMS, was based on a single model development. The goal was to avoid the long timelines of a fully executed Operational Requirements Document (ORD) process, and the red tape of applying a full acquisition program approach to software development. The idea was to do rapid prototyping, move out quickly, get something on the table, play with it, draw the best insights on viability from the Services; e.g., move it forward as quickly as we could. This approach was endorsed by Admiral Owens when we took it to the Joint Requirements Oversight Council (JROC). It also got strong endorsement to press forward from Dr. Anita Jones, the DDR&E. However, during the following year there was a turnover of the JROC leadership and the whole process was upended.

Bob Sheldon: What year, and what happened?

Jackie Henningsen: In 1996, JWARS was making good progress. The Services, although initially uncomfortable, had appointed advisors to the development team led by Jim Metzger of PA&E. We were scheduled for the final JROC approval of the Rapid Software Development approach. Unfortunately, three things happened. First, the most knowledgeable leader concerning the purpose and history of the program, Admiral Owens, Vice Chairman of the Joint Chiefs of Staff (VJCS) and head of the JROC, retired. Second, the government shut down the week of the meeting due to lack of a continuing resolution. Finally, Bill Lese had a medical issue and couldn't attend. In fact, only the military nonanalytic team members were there to prep the new VJCS, and there was no one knowledgeable to defend the proposal. I wasn't supposed to work as I wasn't emergency essential, but with Bill gone, I was tapped, but it ended up not mattering as the first question out of the new Chair's mouth was, "Where's the Operational Requirements Document?" Followed by "Come back when you have one ... Next!"

The team had to put JWARS under the lengthy ORD process. In the years that followed, there were multiple efforts in DoD to streamline the acquisition process, but all were difficult to put in place. With JWARS, it took at least 18 months, maybe two years, to develop an ORD because of all the new players and multiple layers of coordination. The Services, sensing rough roads ahead when the model didn't meet deadlines for the next two Quadrennial Defense Reviews (QDRs) kept TACWAR warm while maintaining work on STORM and NSS. Jim Johnson took over from Bill Lese, and I soon left the program and began work on new projects. In my opinion, despite valiant efforts by very talented leaders like Jim Metzger and later Al Sweetser and others working on the program, JWARS never recovered from the bureaucracy introduced by that one decision.

In the meantime, in DoD's training community, a major development called Joint Simulation System (JSIMS) was also underway. In the early to mid-1990s, Dr. Anita Jones, head of OSD/DDR&E, had directed the Defense Modeling and Simulation Office (DMSO) to "assure interoperability and reusability of defense models and simulations." She introduced the concept of a highlevel architecture (HLA) to federate all Service component training simulations. The vision was to build Service models independently, but link them through a common architecture. Service training components were responsible for meeting their own requirements while coordinating with the whole, for instance, the Air Force for building the National Air and Space Model and the Army for their Warfighter Simulation (WARSIM). Efforts with JWARS, JSIMS, and a third effort called Joint Modeling and Simulation System (JMASS) dominated M&S over most of that decade. However, in DoD and MORS, we also explored using new techniques in M&S for Operations Other Than War (OOTW).

Bob Sheldon: What else was going on in this era of huge expectations for large-scale M&S?

Jackie Henningsen: At the same time, I was also responsible for program review of the Joint Staff's portfolio. I started with a big project tasked by the DepSecDef, John White, to look at reduction of warfare centers across the DoD. This portfolio soon expanded as DoD and Congress approved the stand up of Joint Forces Command (JFCOM) and the Asia Pacific Center. The differences were dramatic. For the former, I worked with IDA and Congressional staffers on major infrastructure requirements and watched personnel hiring grow by the hundreds. At the same time, I had to be able to answer queries about the Asia Pacific Center's request to hire a couple additional instructors for an international studies course.

I also served as a theater assessments liaison to Joint Staff studies and wargames. Wargames were a big part of QDR-97 preparation including a major wargame called Dynamic Commitment. Underway in parallel was a pivotal study called DAWMS (Deep Attack Weapons Mix Study).

[MORS Fellow Jim Bexfield of IDA was one of the two study leaders. He reminded me that it was a comparison of two versions of TACWAR (the IDA and J8 versions) and that the main goal of DAWMS was to find the best mix of weapons from an OSD (corporate vice Service) perspective. Jim's MORS oral history has more details.]

Bob Sheldon: Which organizations were involved in Dynamic Commitment?

Jackie Henningsen: Dynamic Commitment (DC) was part of a significant year-long wargaming study effort with major ramifications for roles and responsibilities in the ensuing years. It was set up and run by Lisa Disbrow of J8 in coordination with OSD Policy and PA&E. It was a global engagement capability evaluation with all the combatant commanders in their roles and the Services "supplying forces."

Bob Sheldon: What did OSD use Dynamic Commitment for? Any decisions at OSD?

Jackie Henningsen: SecDef Perry had focused the National Security Strategy review on U.S. capabilities to execute two near-simultaneous major wars while maintaining engagement in multiple smaller conflicts, peacekeeping, and humanitarian relief actions. DC was designed as a capacity test.

Roy Reiss: In part that was the year when the Services, particularly, started to worry about ops tempo and the impact on the units and the people. Dynamic Commitment was an effort to understand the limits of worldwide commitments of our military forces.

Bob Sheldon: What was your role in the wargames?

Jackie Henningsen: In most of them, I was the PA&E Assessments liaison to the OSD Policy and JS/J-8 gaming teams.

Bob Sheldon: What was your impression of the wargames and how the people interacted and the outcomes?

Jackie Henningsen: Dynamic Commitment set an expectation for a whole-of-DoD collaborative process. Whatever you think about what emerged, it established a broader marketplace of ideas. It was the strategic planning effort that helped us think through the Department's challenges. We'd come through the post-Cold War era expecting a "peace dividend" but then dove directly into Desert Storm. The capacity for organizing the Defense Strategy by two Major Combat Operations or competing Major Theaters of War (MTW) as well as OOTW needed careful evaluation along with our relative investments in emerging areas like space and C4ISR.

QDR-97 was the start of an era of cross-Departmental assessments supported by both studies and analysis and structured committee processes. One QDR org chart had over 60 different "committees" that were set up to contribute various inputs including those for DC. Some folks in the end opined that nobody paid any attention to the Dynamic Commitment and other "committee" recommendations. I tend not to be of that cynical opinion. I think that ideas were socialized across broad groups and light shined in some unexpected places. Leaders still had to arrive at decisions, but in many ways the dynamics of decision making was changed through this more transparent interchange of information, data, and ideas.

[To be of value, you had to have something to contribute and a willingness to bring evidence to be scrutinized. British analysts were sometimes called "scrutinizers" and QDR-97 certainly demanded that expertise.]

Dynamic Commitment was a game laid against a worldwide engagement background. Months went into building the vignettes. After the first game PA&E Land Forces Division threw the red flag on the Services for "gold plating" the requirements. They stated, "There is no way in the next decade that we will have a demand for this many division-sized events." [*Think about that in retro-spect!*]. However, commanders pushed back with their demands, so between the first and the second game the J-8 led game team commissioned a tracking tool; really a mega spreadsheet, that allowed automatic monitoring of force availability. So if a unit was used in one location or fight, it couldn't be reused without allowing for feasible reconstitution, resupply, and movement time. It limited commanders saying, "I've got to have 10 here and 12 there simultaneously," and aided evaluators asking, "if you have assets deployed to this location, can you realistically get them to another conflict in an acceptable amount of time." From the Policy view, it meant addressing the question of "how many wars of what type we would be willing to use to plan to fight" as a guide for PPBS. The outcomes influenced numerous future Strategic Planning Strategies starting with planned time separation between MTWs.

Bob Sheldon: About how many people played in that wargame?

Jackie Henningsen: As I remember, there were about 20 Joint commanders and other OSD leaders at the main table backed by senior subordinates. Also engaged were backroom and reach-back experts for each major and supporting command, Service, and pertinent agencies. In total there were probably a hundred with direct or more peripheral ties. There were also dedicated white teams, red teams, and game advisors. Folks on the white team were tasked with keeping things moving and ensuring players worked to gain insights rather than 'fighting the game'. The red team introduced threat and competitor/enemy actions. The assessment/advisory team from OSD and Joint Staff ensured data was captured for evaluation.

Bob Sheldon: Was this your first experience with that kind of a wargame?

Jackie Henningsen: I had actually been engaged in wargames since my time at SAC including Schriever Games in Colorado Springs, the Warrior Prep Center in Germany, SHAPE Technical Center in The Hague, Netherlands, Air Force Wargaming Center at Maxwell AFB, Andy Marshall's Net Assessments Summer Games at the Naval Postgraduate School, JFCOM planning games, as well as previous J8 games like TFCA and many others. By the 1997 time frame, I frequently served as a designated senior role player/advisor or invited game mentor. My Capability Assessments Division also ran a series of games for STRATCOM when it first stood up in 1992. These games were set up to help examine leaders roles under a new command structure. We worked with the J5 staff to set up games with mission challenges aimed at allowing J-Staff members to work through their responsibilities. For example, what should they do with a hurricane striking a submarine home base, or perhaps a coup in a nuclear-armed country leading to a potential loose nuke situation. Questions such as who should be involved and what options were available were designed to examine the links between roles and missions?

There were a series of other games and activities in the mid-1990s to examine our post-Cold War and post-Desert Storm understanding. One significant effort was called Nimble Vision. It was part of a series that sought to get some insights on the value of information. The question roughly being posed was, "If you have 80% knowledge versus 90% knowledge, what difference does it make?" In words, how much should you be willing to invest to get additional 'knowledge'? These were tabletop wargames, with a lot of work going into identifying constraints.

I met one of my most inspiring mentors, then-Brig Gen Bob Linhard, in 1991 when he helped lead the transition from SAC to USSTRATCOM. Bob was a brilliant thinker who had served as a senior Defense programs director for the National Security Council and as a special advisor to President Reagan for nuclear issues and arms control. He guided many of us in exploring the National Defense Strategy, including my colleague, Gen Paul Selva, later Vice Chairman of the Joint Staff. Gen Linhard was generous with his time and maintained an open door policy for dropins to brainstorm projects laid out on a board in his office. When we both were in the Pentagon, I could drop by after-hours and he would say, "Jackie, sit down and let me run some ideas by you." He would do this with a range of folks to sharpen his ideas, but it also educated those of us lucky enough to participate. He vociferously wrote notes on what went on in meetings with principals and then transcribed them into an organized form at the end of each day so he could retain and ponder leadership lessons. Sadly, Maj Gen Robert E. Linhard unexpectedly died in 1996 days before becoming Director, Air Force Plans and Programs (AF/XPX).

[One of the significant insights that I discussed at length with Maj Gen Bob Linhard during the Nimble Vision game series was the relation between increased knowledge and the likelihood of preemptive actions. This discussion shaped my A9 inputs on strategic nuclear deterrence during planning sessions led by Lt Gen (ret) Bob Elder 15 years later.]

Bob Sheldon: What was your impression of this latest wargame? How well was it run? How was it arranged? How the players interacted?

Jackie Henningsen: As I said before, I think Dynamic Commitment set a new standard for how we would expect wargames to help inform decisions. It had ripples that carried on for a long time because so many parts and members of the DoD community were involved. It looked at warfighting, logistics, sustainability, and force structure questions. Another major effort at the time that generated significant insights related to force structure investments was the Mobility Requirements Study, Bottom Up Review Update Study (MRS BURU). These were pivotal studies that used cross community wargaming as well as M&S analysis techniques to support interplay between operational and functional experts.

As part of the QDR-97 "hotwash" General Ralph Eberhart, the Air Force Vice Chief, sent a memo to the Vice Chairman of the Joint Staff endorsed by all his Service counterparts, suggesting development of a more collaborative process in preparation for future QDRs. This memo proposed that the Service analytic communities working under guidance from OSD Policy, OSD/PA&E and JS/J8 aggressively work toward development of common databases, scenarios, and strategic planning level analytic processes. Everything that was laid out in that memo became a basis for the Joint Analytic Model Improvement Program, as well as the Joint Analytic Data Management Programs that followed. These cross-cutting organizational efforts captured the attention of the entire DoD in a collective attempt to "elevate the analytic playing field." The proposal reflected the recommendations of many of us who were considered analytic thought leaders at the time and who were incentivized by our experiences to work together to assess force structure requirements.

[This common analytic baseline effort carried DoD through a significant era of analytically informed planning and programming over the next decade. MORS was a major player in workshops, special meetings, and other events both scrutinizing and encouraging the quality of this effort.]

Bob Sheldon: What other efforts were you involved in while in PA&E?

Jackie Henningsen: In the 1996–1998 timeframe, I got an opportunity to play a role in an exciting project under the Partnership for Peace (PfP) program co-led by State Department and OSD/ Policy. Under PfP, OSD/PA&E was tasked to provide a Defense Resource Management Study (DRMS) program to help former Soviet-bloc countries transition to civilian control of their military spending. PA&E led teams accompanied by IDA resource analysts were assigned to each country bidding to join NATO to train the host country teams on how to establish a modified planning, programming, and budgeting process. PA&E principal, Bill Lese, appointed Col Gary Morgan to lead DRMS. Bill, along with his Policy and State Department counterparts, Gary and a country team lead would open the discussions with the political leaders and generals. Our country teams worked in-country on a series of two week on-and-off rotations for about a year. The focus was on building databases and planning tools to prepare a budget for inclusion in NATO applications.

The countries would agree to establish a permanent DRMS team with civilian government and military members.

Bob Sheldon: What countries are you talking about?

Jackie Henningsen: I was a country lead for Bulgaria and the Czech Republic. I was also an alternate for Hungary, and backup in the Baltic states.

Bob Sheldon: Who were your counterparts from Bulgaria? What kind of people?

Jackie Henningsen: At the senior level there was often a military general and a political leader. At the working level, teams tended to be led by an O-6 from the Ministry of Defense and cost folks who were civilians from the country's political component. We brought in computers with models and training by the IDA experts to help establish a modified cost-effectiveness analysis process. The goal was to develop a five year budget for their military that aligned with NATO identified objectives.

Bob Sheldon: What kind of tools did you use?

Jackie Henningsen: They were tailored small-scale effectiveness models and a lot of logistics planning tools. We focused on issues like, "What are you trying to accomplish in this particular country?" That was a challenge in itself, because to join NATO the investments had to change from systems that would be focused on fighting against NATO. On the other hand, we didn't expect them to plan for fighting against the former Soviet Union bloc countries or their neighbors either. The focus needed to turn to how do they make coalition-based contributions in cooperation with NATO missions in areas like OOTW. This meant restructuring investments in recruiting, training, promoting, and moving troops, restructuring force composition and payrolls, upgrading very old equipment tooled to the Soviet system, and investing in new systems and equipment aligned with the new realities. (Buying a new F-15 aircraft needed to go off the wish list.)

Bob Sheldon: Did you suggest any wargaming activities for them?

Jackie Henningsen: Yes, wargaming on a modified scale was an ongoing aspect.

Bob Sheldon: You got to spend some time in Prague?

Jackie Henningsen: Yes. Prague at that time was a wonderful experience, but each of the countries had unique cultural aspects and dedicated team members who enthusiastically worked to make their program a success. We usually brought the teams to the Pentagon for an orientation and training visit. Many of these countries were still reeling from leaving the USSR where their military leaders had received their education and training. There was one story Bill Lese and I felt was an indication of how much we shook their fundamental beliefs: The Bulgarian team principal was a two-star general with a very long last name who told us to call him Gen "P." When he visited our country, the State Department allowed his team a day to tour the DC area upfront. He immediately asked to change the schedule and see New York City. So the liaison officer drove to NYC and they visited the sites. He later admitted he expected a Potemkin village type tour and was stunned that we had the freedom to change the agenda on the fly at his request.

A highlight for me was the opportunity I had in winter 1998 to lead a very large conference cohosted by the Marshall Center and funded by DoD and the State Department. We brought together all the PfP team leads, the NATO country counterparts, and observers from the "Stans" for a week-long conference. The conference site was a chalet style hotel in the foothills outside of Garmisch, Germany in early January. The day before everyone arrived, we had what I termed a "Heidi Snow" which buried everything in a magnificent white blanket. It was a time when you'd thank your stars for being an ORSA at a particularly magical time and place. I was sure no one would be able to get in, but by the next day the trains were running, and folks poured in excited to be involved in a meeting that had no precedent.

Bob Sheldon: Were there any cultural clashes between these different countries' representatives? *Jackie Henningsen:* Oh yes—but very civilized when the PfP teams gave updates on their DRMS projects. The Marshall Center had headsets with simultaneous translation, which was a challenge with about 40 countries in attendance. Most spoke English, French, or Russian; but some required special translation. We had a stellar program and every group was very proud to present and

answer questions. The fact that these particular countries were able to give an open meeting presentation in a question and answer format would have been unheard of a few years earlier which was a real measure of success in itself. The 'Stans' were not in the DRMS program, but as invited observers were allowed time the last afternoon to talk about their observations and goals. One of the Stan's reps got up to present and instead of talking about the program, began haranguing the bordering country reps with a long diatribe about terrorists attacks from across the border. The next Stan rep started countering, so by the time I ended the conference that day there were three countries that were belligerently hurling accusations at each other. The mood had obviously greatly sobered.

We had the closing banquet that night and it happened that those particular countries had sent very senior people; military generals and senior civilian politicos, whereas most others sent their DRMS team leads. These Stans' senior folks were at the head table along with Bill Lese, a senior OSD Policy representative and me. I was nervous that it was going to be very unpleasant. Well, we got to dinner and the Stans' reps all greeted us and each other effusively. Soon they were singing folk songs and telling stories about their families. It was bizarre. The whole room picked up the relaxed vibe and we had a really "feel good" and collegial closing – which was very enlightening as well in so many ways.

Bob Sheldon: What MORS activities were you involved in at that time?

Jackie Henningsen: I participated in many MORS groups with a pretty heavy focus on Joint Campaign Analysis and OOTW.

Bob Sheldon: You chaired or co-chaired that one?

Jackie Henningsen: Not for OOTW, but in 1994, when I was Vice President for Meeting Operations, we held the largest MORS non-symposium event to date. Fred Hartman was chair with co-chairs Vince Roske and LTC James Cooke for a pivotal workshop titled the "Joint Requirements Oversight Council (JROC) Process." Chris Fossett (later MORS President and Fellow) chaired the Synthesis Group.

Bob Sheldon: Just up the hill from the Pentagon at the Sheraton Hotel?

Jackie Henningsen: Yes—well over two hundred attended, including many people who hadn't participated in MORS before. This workshop was the bookend to one in 1993 that rolled out COEA, which later became the analysis of alternatives process.

In 1996, I chaired another large meeting with Robert Statz and Dr. Roy Rice, FS (famous for the phrase *"IS THIS A GREAT DAY TO BE IN MORS OR WHAT?*) as co-chairs. It was called *"Quick Response Analysis Methodologies: Prep for QDR."* QRAM had a broad range of working meetings and was the first in which MORS provided the venue for DoD to gather analysts and planning leaders to prepare for the first mandated QDR.

Two years later, in 1998, "QDR Analysis: Lessons Learned and Future Direction" looked back at the QDR-97 Defense Review process. Chairs were Mike Leonard and Jim Bexfield, and I chaired the Synthesis Group. Our group report focused on the analytic community's need to Respond, Prepare, Shape by focusing on investing in analysis, intellectual preparation, and data transparency.

Bob Sheldon: Which year did you come on the MORS Board of Directors?

Jackie Henningsen: I came on the MORS Board in 1993 when I was in PA&E.

Bob Sheldon: And while you were in OSD, you were a MORS Vice President (VP)?

Jackie Henningsen: I was VP Meeting Operations 1994–1995 and VP Professional Affairs 1994– 1995, then a MORS Sponsor's rep. Later I was the Air Force Sponsor's rep and finally the Air Force Sponsor through 2014. I was also privileged to participate in many international exchanges like the biannual Korean Institute of Defense Analysis (KIDA) Seminar co-hosted by the KIDA President and the legendary Walt Hollis, Army Deputy Undersecretary for Operations Research. During our early exchange, the South Koreans gave carefully scripted presentations of academic studies, but as we continued to bring in studies of depth, they also built capabilities, adopted many tools, and sent analysts for training in the United States. After Walt retired, several of us took turns hosting the U.S. delegation to ensure this event continued. Other international exchanges occurred with the United Kingdom, Canadian, Australian, and other NATO MS&A committees. Over the years many of these analysts have built a presence in MORS. Attending ISMOR in the United Kingdom with Gene Visco was always a delight.

(See info on the MORS website about the Gene Visco ISMOR prize.)

Bob Sheldon: I'd like to talk about your transition from OSD to the Air Force. What was your motivation? Who recruited you?

Jackie Henningsen: I had applied for some OSD SES positions, but it is a long process to find the right fit. In 1995, the Air Force had held a Four-Star Summit on M&S. The summit set 10 goals they wanted to accomplish in the years ahead. One of the goals was to stand up an Air Force Agency for Modeling and Simulation (AFAMS). Allen Mursashige, the AF/XOC Tech Director, sought my help to prepare a proposal and secure OSD approval. In June 1996, AFAMS was stood up as a Field Operating Agency (FOA) in Orlando, Florida, in the Central Florida Research Park where other Services and agencies had their centers for training simulation. A few years later, the Air Force created a new SES position called the Associate Director for Modeling, Simulation and Analysis. The position's technical qualifications emphasized experience with the QDR, PPBS, Joint models, databases, the major M&S development triad, the technical and operational underpinnings of tool development. Network frameworks like HLA, and experience working with the Defense M&S community. In essence, I had been "living in and training for" this position since I joined DoD.

[I believe, however, my work during QDR-97 was the final determiner, which probably contains this lesson for analysts seeking senior level positions: build both depth and breadth in experience but always maintain relevance thru expertise in the leadership's top concerns of the day.]

I started as an SES in July 1998, in the Office of AF/XOC, Modeling, Simulation and Analysis within the Directorate for Command and Control as Associate Director for Air Force M&S. In this role, I had oversight of about \$90 million in infrastructure and investment funding plus the organizational structure for Air Force M&S. M&S programming and budget recommendations from AF/XOC were presented to a three-star caucus led by the Assistant Vice Chief of Staff during biannual meetings.

Bob Sheldon: Was AFAMS part of the "New Vector"?

Jackie Henningsen: Yes, and as Associate Director for M&S, I had oversight of its mission and represented the Air Force M&S at major DoD conferences like Interservice/Industry Training, Simulation and Education Conference (I/ITSEC) in Orlando. The Air Force had a very robust training simulation program with extensive infrastructure including a center at the Pentagon linked to live, virtual, and constructive activities at Mesa, Arizona; Albuquerque, New Mexico; The Fighter Weapons School at Nellis AFB, Nevada; Hanscom AFB, Massachusetts; Maxwell Wargaming Center, Alabama; the Joint Strike Fighter Sim Center at Air Force Material Command, Wright-Patterson AFB, Ohio; and several other locations.

Bob Sheldon: Was the stress of the Air Force job equal to or less than the stress in OSD?

Jackie Henningsen: I don't think it was more or less; it was just different. I moved from my PA&E role to a Service lead role on the various DoD M&S steering committees. The big model focus of the Department as I became an SES continued to be JSIMS, JWARS, and JMASS. As previously discussed, JSIMS investments had reached over a billion plus dollars when it was ended in 2004. JWARS was substantially less, but it was also ended when it did not deliver the anticipated capability or return on investment and repeatedly missed QDR deadlines.

[RAND's Paul Davis, FS, who has brilliantly contributed to the best of DoD analysis for decades, commented on this time period that "It's been said that JWARS was poorly conceived but well managed and that JSIMS was brilliantly conceived and disastrously managed. The bill for these failures apparently exceeded \$1 billion. What are the lessons?" In reply, I noted "From my experience, the two efforts approached the problem of software development and state-of-the-art computing from two very different directions and while neither succeeded, like space launches, the residual products provided some significant, albeit costly lessons. In JSIMS, the Defense Training, Acquisition and Research communities put great faith in technology advances and took the path of building a massive federated simulation projecting that cuttingedge software design, expertise and structure could solve massive integration challenges. (A decade plus later, other large DoD personnel and financial software system initiatives struggled for similar reasons.) A cutting-edge architectural network, HLA was laid over the top of independent developments by the Services and it was assumed setting common standards would ensure it was robust enough to address the existing differences in approach, endless appetite for growing content, the multi-level security issues, and the differences in Service training audience goals. The "weight" of the effort and requirements creep drug it under. The bulk of the \$1 billion went to JSIMS with the Army most deeply invested, but all paid a hefty price. JWARS, coming somewhat later from the PA&E community, was developed in recognition of the issues with JSIMS and designed as a single model with one configuration manager and developer. It also planned to take advantage of state-of-the-art software developments, but less aggressively. Due to these restrictions and since it specifically addressed campaign-level warfare, OSD invested a fraction of the JSIMS's cost. I still believe the 1996 ORD decision that drove a bureaucratic vs rapid acquisition approach doomed it. The effort, in the face of growing requirements, never delivered. In fact, the eventual adaption of the Air Force's STORM by the Navy and subsequently by other Service and International organizations was essentially the result of its similarly, carefully controlled development and maintenance by a small core team. Remember, STORM was one of the contenders when JWARS was started. Under AFSAA oversight by Doug Kupersmith and others, it was always under tight technical control. Garth Morgan of Group W was the STORM guru with leadership liaison provided by Jim Brady. The focus on requirements-based iterative development helped avoid "wishful thinking" leaps regarding unproven technologies and kept delivery promises on-track. In recent years, complementary work led by Dr. Mark Gallagher (initiated when A9 Tech Director), Johns Hopkins Applied Physics Lab (JHU/APL) and The Perduco Group are pushing the envelope on software and analytic advances while drawing data from existing higher resolution models. Bayesian Enterprise Analysis Model (BEAM) evaluates strategies and force structures in various scenarios using probabilities of engagements and probabilities of effects/outcomes while avoiding the runtime associated with Monte Carlo analysis.]

Bob Sheldon: After the J-Models, what was your next challenge in the Air Force? What other kinds of projects did you work on?

Jackie Henningsen: Projects were always running in parallel. When I took over the Air Force M&S program, there was a lot of emphasis on Distributed Mission Operations support under a concept called the Joint Synthetic Battlespace (JSB). In my first year, with JSIMS under duress, we laid out a strategy to have four ignition events in a six-month period to jumpstart the JSB effort and prove that it could be successful with existing simulations. There was a fairly sophisticated Air Force Sim Center in the Pentagon with a flight simulator linked to other hubs. Since this effort was under the Director for Command and Control, focus was on testing C4ISR advancements.

In 1999, I was also heavily engaged in an evaluation effort called the Joint Expeditionary Forces Experiment (JEFX). The goal of this project was to test new conceptual approaches of applying C4ISR to warfighting. JEFX provided a testbed for contractors to bid to play out their initiatives in a major live-virtual-sim linked effort that was developed over nearly a year's timeframe. My particular interest was in the viability of the legacy mission training simulations that were still carrying the M&S load.

Bob Sheldon: You'd been working in your past history with analytic simulations in OSD and at SAC. How did you come to conceptually understand virtual simulations and linked simulations?

Jackie Henningsen: I'd never treated analytic modeling as a separate component. When I was at SAC, we started with the idea of interfacing a broad range of tools starting with wargaming and exercises linked through modeling, simulation, and analysis; so to me, it had always been a part of the live-virtual-constructive world. It was easy to get stove-piped if you dug deep into one area, but I was always attracted to a system of systems approach. This led me down an executive rather than a more technical path.

The era of Integrated Joint Model Development also included investment in developing a model suite at the engineering level based on a standardized architecture vision. JMASS, initiated in the mid-1990s, was developed under both DMSO and Service funding as an advanced open architecture and backplane approach to support DoD M&S development and standardization at the engineering level. In 1999, DMSO EXCIMS members joined MORSian Dr. Pat Sanders, acting for the OSD/DDR&E, in a rigorous review of funded efforts that identified successes, but JMASS ultimately suffered the fate of the other "J-models" as requirements exceeded the capability to deliver.

[One 1995 directive that came out of the Air Force acquisition community oversight of engineering models was called the Muellner Directive. It restricted use of data to model the sensitive capabilities of specific highly classified Air Force systems using M&S. The restriction was aimed at JMASS type tools, but proved a challenge for years at many other levels.]

Bob Sheldon: How did you find working with the AF/XO general officers, the alpha male types that tend to dominate the AF/XO world?

Jackie Henningsen: [Laughter] It was something that I'd been doing for 13 or 14 years by that time, so it wasn't like the world had suddenly changed. The AF/XOC was a two-star general. His one-star deputy and I started at the same time. I led modeling, simulation, and analysis-related aspects, and he was principal deputy and led command and control efforts. We had a very effective and mutually supportive relationship.

As you know, AFSAA had a legacy of leadership under two- or three-star generals with Lt Gen Kent being the most renowned. However, at the end of the Cold War, the CSAF, Gen McPeak at the time, decided that the analysis provided by AFSAA was no longer needed. Meanwhile, parallel budget cuts led to analytic organizations across the board being greatly reduced or eliminated in USAFE, PACAF, and other MAJCOM organizations as a part of wide-sweeping concept of capturing a "Peace Dividend." It is reputed that then-SECAF, Don Rice, saved headquarters analysis by hinting it could always be moved to the Air Force Secretariat. Strong interest also existed on the military side in bringing analysis directly under operations or planning. A compromise was reached and half the AFSAA personnel were added to a new DCS for Programs and Evaluation that morphed to Strategy and Plans (XP). By the end of the decade, XP had moved most of its analysts into contractor positions (former AFSAA leader Brig Gen (ret) Leon Goodson was a principal contract lead). The other part of the compromise designated a FOA called AFSAA be established under AF/XO. It reported first to the Directorate for Modeling and Simulation (AF/XOM) and later for Command and Control (AF/XOC).

Col Tom Allen, FS and MORS Past President, was the Commander of AFSAA at the Pentagon through the mid-1990s, and his oral history provides great insights on this timeframe. He is a wonderful MORSian, analytic leader and friend who can be thanked for preserving the excellent reputation of AFSAA during this challenging period for analysis. He was followed in 1998 by Col Kurt Cichowski. Kurt was not a career analyst, but a brilliant strategic and operational leader who subsequently rose to the rank of Lt General as Associate Director Military Affairs, Central Intelligence Agency. These two leaders (and others in the FOA) were critical in keeping the valuable core of AFSAA capabilities through this difficult era for analysis. AFSAA had incredible analysts including the legendary Clay Thomas (*see MORS Fellow #1 oral history*) who provided analytic mentorship and career field oversight. Air Force analysis would not have survived this era without these amazing analytic champions who understood the value of investing in people. I was blessed to follow in their footsteps and those of legendary Studies and Analysis (SA) leaders such as Lt Gen Glenn Kent, Maj Gen Jasper Welch, Maj Gen Rosie Rosenberg, Brig Gen Leon Goodson, and Maj Gen George Harrison.

During the 1990s, following Desert Storm and into the 2000s, a continued high battle rhythm was maintained for the military overall, and for the Air Force through Operations Northern Watch, Southern Watch, support of numerous OOTWs as well as the Air War Over Serbia (AWOS). Following AWOS, CSAF appointed Brig Gen John Corley as the head of Lessons

Learned (L2) and Analysis at USAFE, Ramstein Air Base, Germany. The goal was to capture "bone marrow lessons" to prepare for future conflicts. Gen Corley asked AFSAA to provide technical deputies like MORSians Roy Reiss, FS, and Dan Barker, and other team members to augment the USAFE team by spending three- to six-month rotations in Germany on his staff. The USAFE/AWOS team was dismantled after completing its after-action report. One of their recommendations was to maintain a core Lessons Learned (L2) evaluation structure that was ready to rapidly reconstitute. CSAF approved the plan for AFSAA to maintain trained L2 operators and analysts ready to move under a general officer during wartime.

[I consider Gen Corley a significant mentor of mine in the art of building organizations and caring for people. In 2006, the Air Force recognized his "leadership and vision" with the Lt Gen Glenn Kent Award.] Bob Sheldon: Let's talk about your transition to AFSAA.

Jackie Henningsen: In summer 2000, Acting Secretary F. Whitten Peters, CSAF Gen Michael Ryan, and VCSAF Gen John Handy had a meeting discussing a litany of major resource investment decisions. I never knew the driver, but there was a moment of frustration in which Gen Ryan was reported to have said, "What happened to that elegant analytic organization that served my predecessors so well?" Reminiscing about the 1960s–1980s Studies & Analysis resulted in the statement, "Gen Handy, you are now 'czar-analysis' and I want you to put it back together." Interestingly, there was also a major Congressional influenced, SECAF directed study underway on the composition of headquarters in the next century (called HQ Air Force 2005). The top two recommendations that emerged from that intensive year-long study was the need for a stronger independent HQ analytic organization and for better end-to-end analysis of systems requirements.

Gen Handy asked my boss, the AF/XOC, to identify a project lead to support him in reconstituting Air Force analysis. I was named to work for him in rebuilding a SA organization at some "to be determined, but higher" reporting level. I turned to our two most talented civilian leaders in the FOA, Roy Reiss and Dan Barker, who had superb analytic credentials plus great insights on historical times when SA had last directly supported senior leadership. The FOA was located at the time in Rosslyn, Virginia, as part of the near decade long Pentagon remodeling. Using historical records and reports from the extensive onsite library, and reaching out to many alumni, we looked at optimal/feasible sizing, and the structure and manpower required for different levels of mission responsibility. They put together a solid, realistic plan with time phased additions of capabilities. Then Gen Handy, who was a superb programmer, personally hand scrubbed every aspect. We spent months putting this together systematically and built a paper trail for every approved decision and tradeoff. I can't tell you how many times over the ensuing years' budget drills that I referred back to that solid documentation to defend dollars, manpower, and mission decisions. It guided and protected us through numerous DoD reductions up until 2012 when sequestration devastated every organization.

In February 2001, with Gen Handy's endorsement, we presented the proposal to the Chief of Staff and the Secretary of the Air Force. It recommended establishment of a Direct Reporting Unit (DRU) under the Vice Chief. This plan also called on MAJCOMs to restructure their own analytic organizations to not only provide analytic capability directly to their leadership, but also to align with the HQ DRU as analytic community Centers of Excellence with regard to career field member development, model and tool standardization, and data and study quality metrics. The reporting chain still went thru their MAJCOM chain of command, but it was envisioned as a Community of Practice with career field guidance vested in the DRU. The later concept proved challenging as the 61S and 1515 career field oversight remained under the acquisition community. The proposal and documentation were approved, and we stood up AFSAA as a DRU on 1 May 2001 in an official ceremony led by Gen Handy.

Bob Sheldon: Backtracking to Gen Ryan, do we know why he had a warm feeling for AFSAA dating back historically?

Jackie Henningsen: I can't tell you for certain, but as I mentioned before, he famously gave us a clue when he asked, "what happened to the elegant analytic organization that served my

predecessors so well?" Historically, he would have served under previous CSAF's who were SA alumni, such as Gen Alvin Gabriel and Gen Larry Welch, but perhaps more significantly, his father was CSAF during Glenn Kent's era as head of SA.

[Jim Bexfield also reminded me that 12th CSAF Gen Larry Welch was Fighter Division head under Lt Gen Kent (then a 2-star) and built the F-15 model.]

Roy Reiss: I know we supported Gen Ryan doing lessons learned for the Allied Force while he was commander of USAFE, before he came to headquarters.

Jackie Henningsen: There is another event that may have been connected with the frustration that there was no independent analytic function directly serving top leadership. It came after an incident that I thought characterized what happens when you get an analytic function buried too deeply in the organizational structure. AFSAA (the FOA under AF/XOC) had developed a quick look model of a unique new fighter capability for the proposed F-22 and had shown it to the platform's action officer. The action officer said, "Thanks, but this doesn't show what I want to present." Shortly after, Acting Secretary Peters was getting ready for Congressional testimony on the same fighter, and he was upset that he didn't have compelling analysis explaining its unique capabilities. Luckily, his exec commented, "I think AFSAA may have modeled something like that." Within an hour, a young major from AFSAA was sitting at the SECAF's desk running the model with Acting Secretary Peter's posing questions to be analyzed on the spot. The insights were able to successfully support his Air Force testimony.

This particular incident led me to set some guidance as I stood up the DRU. Despite those who loved the TQM emphasis on broadly defining *customers*, I told our folks that we've got one set of true customers; the leadership of the Air Force. All others in the chain of command are our partners in serving these top decision makers. Later when I became AF/A9, the statement was modified, respectfully, to the top two. Now this can be quibbled with in terms of chain-of-authority, but it provided a useful framework to help us remember the criticality of leadership having independent analysis informing their decisions.

It took a long time for it to sink in that I wasn't just mouthing words, that it meant we didn't need coordinated permission to take key insights and analysis to the leadership. If I goofed it up and wasn't careful and reliable about what we took forward, then I/we would pay the penalty over time. This could mean our advice would be devalued, I would be dismissed, and this re-elevated analytic organization would not survive. I think it proved to be one of the critical elements that allowed us to work across the seams of the Air Staff and DoD while ensuring our top leadership had full confidence that I would directly warn them, if necessary, using the words of Glenn Kent, "I can't analytically fireproof you with that decision, but here is what I can tell you is analytically defendable."

Bob Sheldon: You mentioned the "top four" Air Force leaders earlier. Were there some of them who came to you with heavier taskings than others?

Jackie Henningsen: We had re-established AFSAA as a DRU in May 2001, but when Gen Jumper became CSAF in September 2001, he had already determined that elevating the role of analysis was one of his priorities. He appointed a Grey Beard Panel to scrub AFSAA and give him recommendations. So, although we had just gone through months of hard scrub to convince the previous leadership in May 2001 to stand up the DRU, starting in November 2001, his panel of grey beards came in with a fresh mandate.

You will appreciate what I'm saying if you are familiar with Lt Gen Glenn Kent's style of interrogation. Gen Kent led the panel which also included prior AFSAA commanders: Major Generals George Harrison, Jasper Welch, and Rosie Rosenberg. They really wire brushed us. It was incredibly interesting in retrospect, but at the time it was extremely painful as we balanced our full-time engagement in 9/11 support while defending the new roles laid out for the DRU. I thought we had a good structure based on the effort that went into getting the reorganization approved. Each division had a clear mission and organizational scope. The Grey Beard Panel wanted a series of three-hour briefings to go through our mission statements line by line, and then word by word. Those of you who knew Lt Gen Kent know that choice of words meant everything to him. We seldom got off the second slide of the day as he "coached" us on how to lay out strategies and tasks precisely. This went on for two months, and then they gave their report to Gen Jumper. I was not there and never saw it.

In the meantime, we were working on wartime analytic and lessons learned following 9/11. Gen Handy directed that my DRU Deputy Director position would be filled by a Brig Gen select to give us a respected, operational leader to ensure linkage to emerging issues from the field, and establish a continuum of specially selected Air Force future leaders with solid understanding of the value of honest broker analysis. It was another example of Gen Handy's organizational genius. Brig Gen (sel) Rudy Wright was my first deputy, and he provided an amazing foundation in the core Air Force values for all deputies who followed. He was unfailingly loyal and focused on how to clarify and achieve our mission. He arrived in early December 2001 and observed carefully as we briefed the Grey Beard Panel. Others may have waited to see how the winds would blow with the CSAF, but Rudy never wavered from full support from day one. Then we waited and waited for a decision from the CSAF on whether we would change or even endure. Finally, one day I just said, "Well, we must be doing okay because we haven't heard anything, so we are going to press on." We proceeded with the vision, mission, goals, and plans established (with some wording modifications based on the panel's advice).

[Other future general officers that filled the military deputy role were selected to establish firm foundations in significant Congressional interest areas such as Brig Gen Phil Ruhlman during the fighter/bomber force balance review; Maj Gen Randy Fullhart on mobility and tanker acquisition; SOCOM leaders Maj Gen Norm Broznick, Maj Gen Mike Kingsley; plus Lt Gen Dave Fadok (later head of Air University). Additionally, O6's like former astronaut Paul Lockhart and reservist Bruce Johnson were brought in for their expertise in emerging Congressional interest areas.]

The vision was "AFSAA (later AF/A9) sets the gold standard for DoD analysis"! This remained the vision throughout my years in leadership. It was underpinned by specific mission related goals in three areas.

SHARPENING THE WARFIGHTERS EDGE: through operational analysis of Air Force capability to support current and future combatant commanders.

ILLUMINATING EMERGING ISSUES: by shedding light on Air Force new and future force structure demands.

FIREPROOFING INVESTMENT STRATEGIES: by analytically scrutinizing and defending the Air Force's resource and budget decisions.

Back to your question about leaders with high demands for analysis. Gen Jumper felt it was really critical to underpin decisions with analysis. I used the phrase "analytically fireproof" positions, and we did a lot of analytic work to develop the underpinnings for core force structure decisions. Some critical resource decisions were impacted as we rapidly delivered highly defendable insights. This started in mid-2002 when SECAF James Roche and CSAF Gen John Jumper halted the annual programmers and planners fighter/bomber force balance review with an intense twoperson, hour-long exchange on what each thought was lacking. They demanded a more transparent, analytically-based process to evaluate the options. They turned to me and directed AFSAA to return in two weeks with a new force structure analysis that would allow them to compare the value of multiple investment strategies. Led by Dan Barker, with our Force Structure Analysis deputy Randy Hall presenting, we developed an extraordinary model-based layout that allowed for the desired comparisons. It was designated the Beacon Force and provided capability assessment ratings of eight force mix options. The SECAF and CSAF quickly requested other "personally named" options to be analyzed and results were returned in days. This responsiveness confirmed AFSAA's role as the Air Force analytic honest broker and was significant in going from a DRU to AF/A9. Working with our operational and plans partners, the Beacon Force Study was presented at CORONA (a periodic Air Force four-star summit), to OSD, and to Congressional committees as a key Air Force PPBS defense.

On February 1, 2006, AF/A9 was stood up as a Deputy Chief of Staff equivalent organization, and I reported directly to the CSAF. (*By DoD regulations, civilians cannot be DCS's, but the A9 was a protocol equivalent.*) We received taskings in a lot of ways. We had mission directives defining areas for which we were responsible annually. We also were identified as the analytic lead for many Congressionally directed or OSD-directed studies. We partnered with other DCS's to support major challenges. In addition, we focused on various high-level issue areas to give better insights on a particular system's effectiveness, or a structural or organizational requirement, and we maintained innovative research and involvement in emerging issue areas and hot topics so we could rapidly engage. Our focus was on building and maintaining a "warm analytic baseline" both internally and cooperatively with other Service and OSD members to support responsive analyses as part of the Defense Review cycle.

Returning to 2001, and the early days of AFSAA as a DRU, Gen Jumper held his first staff meeting as CSAF on September 11, 2001. In the middle of the meeting, intel suddenly brought up the TV screens in the room and we saw the first plane hit the World Trade Tower. Along with the rest of the world, we watched in horror. Shortly after, I was waiting outside the CSAF's office along with Gen Corley and others for guidance when the plane hit the Pentagon. We were safely evacuated out the east side of the building. I remember Gen Corley grimly saying "jet fuel" as we exited. Calls went out for folks with medical training to come around to the other side of the building. Soon we were ordered to move further away from the entrance as another plane had been detected en route to DC. Now we know it held the brave folks on Flight 93 that brought down the terrorist hijacked plane in Pennsylvania. We had no phone communication with the exception of one senior acquisition civilian who had one of the first Milspec Blackberry cell phones. I walked to Crystal City hoping to make a call to the office and home. There were long lines to use the lobby payphone, but none had local connections, so when I got a phone, I used long distance (1-800-call AT&T) to connect back locally to AFSAA and to Carl, who had gotten one call much earlier from our office in Rosslyn telling him I was in the Pentagon, but they didn't know where. My military deputy, Col Richard Smith, and the other leaders onsite, ensured our folks in Rosslyn were accounted for and got them on their way home.

I will never forget the scene as I walked up the hill where the Air Force Memorial now sits and looked down at the clear path of the aircraft's destruction. The newly renovated wedge of the Pentagon which was beginning to refill (particularly with Army and Navy staff) took the straight on hit. There were so many heartbreaking stories. Although our folks in Rosslyn were safe, some experienced personal trauma as they attempted to reach family or colleagues. In particular, those with youngsters at the Pentagon childcare facility learned when they frantically tried to get to their kids that the staff had taken them across the highway into a "field" for safety. One hundred 25 lives were lost in the Pentagon, and another 64 on the plane flown into the building, including Bryan Jack, a PA&E colleague and former MORS Director (1983–1987) who was on the plane headed on a work trip to California. The Pentagon 9/11 Memorial is a somber site for contemplation, as is the 9/11 Memorial in New York City. That day is a pivotal memory for our country!

[I have no tolerance for those with the audacity to claim it didn't happen.]

Following existing plans, the Lessons Learned folks immediately started rotations in the Air Force command center that evening. They already had the data collection systems in place. Meetings were held in the Pentagon the next day even as the fires continued to flare up. CSAF immediately stood up Task Force Enduring Look (TFEL) to capture lessons learned and appointed a Brig Gen to lead the 24/7 effort. The Global War on Terrorism, specifically Operation Enduring Freedom (OEF) was declared on October 7, 2001, followed with air strikes in Afghanistan.

[I first met a key player in the future of A9, Col Jim (Mel) Brooks during this time as he served as XO's Chief of the Ops Training Division and a Director of the AF Command Center. His background as a pilot, military expert, and organizational leader with natural analytic thinking processes were incredibly valuable in guiding war room activities at this stressful time. He joined A9 from 2006–2008 serving in Senior Leader and military commander roles. He later was selected to SES positions in the VCSAF's Air Force QDR office,

the National Guard Bureau, and as the Assistant DCS for Strategic Deterrence and Nuclear Integration *AF/A10 a Tier 3 SES position*. He and his wife, Kitty, are Carl and my close friends. He has been a key mentor, advisor, and defender of A9 through the years.]

TFEL was a major player during the war in Afghanistan named Operation Enduring Freedom (OEF); but by March 2003, as OIF commenced, TFEL was beginning to draw down per the plans. Gen Michael Moseley became VCSAF and then succeeded Gen Jumper as CSAF. He had been commander, Ninth Air Force and US Central Command Air Forces and made extensive use of deployed combat analysts and Lessons Learned team members in theater. MORSian Col Roxann Oyler, his chief analyst, led the Lessons Learned team in theater and became the Air Force Chief Analyst in AFSAA as her follow-on assignment. When Gen Moseley returned to the Pentagon, he wanted a permanent Lessons Learned organization for the Air Force rather than the temporary wartime org in place, so he established AF/XOL, the Office of Lessons Learned. Subsequently, when AFSAA became AF/A9, the Office of Lessons Learned merged into A9 as a full division led by a series of operational O-6s and a GS-15, Paul McVinney, as deputy director. A superb program developed over the next eight plus years focused on ensuring lessons were identified, tracked, and disseminated. The CSAF identified about 10 annual report topics and the L2 team added high profile, event specific ad hoc reports in partnership with MAJCOMs and other Air Staff DCS organizations as well as the OSD-wide Lessons Learned program. Budget cuts related to sequestration kept pulling resources from this group until in 2015 it was moved to the LeMay Center, Air University at Maxwell AFB. [I recognize the budgetary and Congressional pressures to reduce HQ staff, however, I believe this removal of Lessons Learned from HQ greatly diminished the effectiveness of its mission to embed an L2 culture in every organization, much like safety and security, and to systematically address the cost of constantly relearning lessons previously identified.]

Bob Sheldon: Which studies would you point out, in particular, that have really made an impact on decisions in the Air Force?

Jackie Henningsen: In the "Sharpening of the Warfighters' Edge," I would particularly look at the work we did for OEF/OIF and the following conflicts with several hundred runs of different options for the employment of air power. This also included post-9/11 mission analysis of Operation Noble Eagle's protection of the homeland or combat, intel, and air drop missions for Afghanistan. Our special program work provided significant insights to theater commanders on current and projected actions.

Back to the discussion of studies with impact, there were many, but in the "Illuminating Emerging Issues" area, we built and developed a baseline to support decision making for major Budget and Defense Reviews. It started with an analysis that allowed the exploration of our force structure in terms of plans for modernization. A significant research project showed that system age was not the critical factor most expected when considering recapitalization. This helped underpin decisions by the Air Force that dealt with a nearly 500 aircraft reduction as we tried to identify the way ahead for new and more effective aircraft including the F-22 and the Joint Strike Fighter (F-35). This expanded to a systematic evaluation of our bomber, tanker, airlift fleets, and C4ISR capabilities. We later provided study work for SECAF Michael Wynne's Cyberspace Task Force. The looming dangers were clear, but proposed actions were challenged by budget issues, inter-Service competition and eventually the firing of both the CSAF and SECAF following differences with the SecDef on investment priorities. I met my close friend, Dr. Lani Kass, during this period as she served as a Special Senior Advisor to Gen Moseley and oversaw the SECAF's prescient guidance to prepare for the cyberspace security challenges ahead. [Dr. Kass later became Senior Civilian Advisor to the Chairman of the Joint Chiefs of Staff. We served together on the Air University Board of Visitors AFIT Subcommittee from 2015–2021.]

Analyzing force structure requirements paralleled the evolution of the previously described DoD level Analytic Agenda led by Joint Staff, OSD Policy and PA&E, renamed CAPE (Cost Analysis and Program Evaluation) to build common databases and planning scenarios. The focus on this collaborative effort endured for over a decade but succumbed in the face of budget related sequestration pressures and changing views about short term versus long term roles of the primary DoD decision makers. In particular, in 2010 the CAPE Director expressed concerns that campaign models were unreliable and lead to the wrong focus. Further, J-8's movement away from its prior wargaming leadership roles led to the demise of its support for the Joint Collaborative Analysis program (and for MORS). Many of us had a differing view; that campaign analysis was never intended to give single point answers, but instead provided a framework to systematically examine the wide range of factors that had to be considered in planning for future force structures and potential large-scale wars. The change in focus may have been inevitable given the continued high rate of overseas deployments, as well as emerging political and budgetary demands.

[Ironically, a Congressionally directed review in 2018 of DoD planning by some of the same think tank players pointed to failures to maintain what sounded very much like collaborative (campaign-level) analysis processes to support Defense Strategy related investment planning.]

At the high point of acceptance for collaborative analytic processes, the Department had developed Analytic Baselines that DoD leaders from the SecDef down the Defense Department, Hill staffers, and our allies cited. Most were cognizant of the value of understanding and using what went into the baselines and related scenarios.

Even when the focus on DoD-led collaboration waned in about 2010, key partnerships maintained the momentum. Critical was support by Dave Ochmanek of OSD/Policy (Dave later returned to RAND). The most enduring relationship was between Air Force A9 and the Navy N-81 Assessment Division under Trip Barber, and later Chuck Werchado. My deputy, Kevin Williams worked closely with the remarkable N-81 deputy, Robbin Beall to advance scenario work. The Navy embraced the Air Force developed STORM as their campaign model of choice and aggressively worked to vet, expand, and strengthen its capabilities in the maritime domain. Shortly, the Marines, plus others, joined this collaboration. STORM is the only successful survivor of the efforts of the 1990s because of solid oversight and the partnership with N81. The STORM development team has provided outstanding training and support for approved users across DoD and internationally. In fact, it became a challenge to control the appetite of functional groups (with investment funds) wanting to use STORM to explore disparate efforts like energy saving innovations, weather impacts, and smaller unit actions. Maintaining careful configuration control remains critical.

At this time, one of the most significant studies done in my nearly 30 years in DoD, was the collaborative Air Force/Navy effort to look at "Future War in the South China Sea" using STORM and all the best analytic resources and tools of the two Services analytic teams. An A9 study team under Balf Callaway, and deputies like Col Todd Hamill, with study lead Jeff Martin, coupled with a N-81 team under Robbin Beall, with study lead Commander Harrison Schramm were brilliant. This study formed the backbone for our parallel QDR wargaming efforts with A9 represented by my deputy Kevin Williams and supported by A9's Force Structure Analyses Directorate under operationally savvy O-6s like Col Mike Newman and deputy, Randy Hall. They addressed a constant issue of how to share and model highly sensitive data. At several points, DoD teams led by a Joint Staff or OSD key player would initiate highly compartmented studies with limited folks read-in and my Service counterparts and myself in a monitoring role. These efforts strained the resources of the modeling, intel, and cybersecurity community and challenged us to ensure significant outcomes didn't get buried in a locked vault or a proprietary stovepipe.

"Fireproofing Investment Decisions" was envisioned broadly during this time period. It's a very difficult area in terms of its multiple links to acquisition, cost analysis and requirements, and more broadly to the whole cost of maintaining a force; logistics, manpower, maintenance; e.g., soup-to-nuts analysis. Fortunately a small cadre of brilliant thinkers, started us on a solid path and over the years were succeeded by other experts who picked up the gauntlet. I've already mentioned a few, but I particularly want to mention Mark Gallagher, in his A9 Tech Director leadership role, who guided the integrity of our efforts and led more MORS prize winning efforts than any other MORSian I know. Also, Mike Payne, now an SES in CAPE, who once asked me if his A9

division could do their core work, but set aside 20% of their time for innovative analysis. His creative thinking, along with others like Jim Muccio, and Tim Booher worked the technological bounds of Space, Cyber, and other emerging C4ISR research area analyses and charted A9's path in building the infrastructure and partnerships to advance our sensitive classified capabilities. Thru the years current and former A9 members have maintained a rich intellectual and technical exchange network. [Especially see the MORS Award listings for various Air Force Rist and Barchi prize winners over the years.]

On the Resource Analysis Directorate side, returning to the A9 start-up period in 2006, we had already taken an opportunity to handle cuts to our nearly \$23 million annual budget that was heavily focused on contract support by returning to my focus at SAC on in-house work. We offset required Congressional budget cuts by bringing in more civilians at a lower overhead cost. This included several young civilians fresh out of college with no military experience. They had great statistical and mathematical backgrounds and we paired them with other new operational, manpower, and acquisition experienced hires (frequently prior military). We civilianized support areas such as our head of finance and budget support under Vicki White. Under the oversight of their division chiefs starting with MORSians Roy Reiss, Jerry Diaz, and Darryl Hickman, we "sheltered the young analysts" with OJT training, rotations, and structured exploration of small projects. This was all to get their feet on the ground and really begin to understand their assigned databases and work areas. They rapidly began to produce praiseworthy work. One team developed better ways to budget for flying programs and understand aircraft aging. Another worked with our ops experts on crew ratio studies and a unique approach to addressing looming pilot shortage challenges. Another developed tools to examine Force balance opportunities under the guidance of Col Bruce Johnson, in a deputy director role on-loan from the Air Force Reserves. This effort eventually supported a year-long Congressionally mandated review of Active, Guard, Reserve Force Balance for DoD. The time we spent invested in these young folks development paid off in extraordinary ways. Two of these civilians, Saiful Hannan and Brian Rose, individually won prestigious MORS Rist prizes for their groundbreaking analyses.

Bob Sheldon: Let's jump back to the transition to A9. Tell us more about it.

Jackie Henningsen: One of the things that Gen Moseley felt was essential from his experience in warfighting was to be able to know both vertically and horizontally who you should be talking to, using the phrase "line up the phone books" to describe his goal. He wanted to know from layer to layer who to call to get information he could count on. One element of that was the establishment of an A-Staff organizational structure starting at the headquarters and continuing through all commands. At CORONA in Fall 2005, the A-structure was approved, with an AF/A9 for Studies, Analysis, Assessments and Lessons Learned as part of that structure. At headquarters, we worked for about a year on setting up the whole A-Staff structure including building official documentation to lay out the reporting structure and responsibilities. We then proceeded to work on aligning the MAJCOM structures as well with Col Roxann Oyler in the lead. A9s at all component levels were structured to have similar divisions including Analysis and Assessments (A9A), Force Structure Analysis (A9F), Analysis Foundations & Integration (A9I), Resource Analysis (A9R) and Lessons Learned (A9L). Some of the smaller components merged the F, I, and/or R due to manning shortfalls. Note that we'd added a new aspect to the traditional Studies & Analyses called Assessments. It became an increasingly important aspect as new mission requirements and evaluation of mission and investment success became a part of the DoD mandates. We ended up doing a lot of assessment work for the global-war-on-terror as well as readiness, sustainability, and manpower drawdowns in the Air Force over time. Later A9 became responsible, in partnership with specific DCS's, for the annual Air Force Risk Assessment Program.

Bob Sheldon: Did the nature of AFSAA's work change when they reorganized under A9?

Jackie Henningsen: We took the core elements that have always been a part of what AFSAA did best; the ability to do Air Force structure down through mission-level analysis in the context of the Joint Force. We integrated studies across the spectrum by combining the talents of the best

analysts in the department with really strong technically smart operators. Together they performed as a seamless team responsible for attacking the tough problems that kept leadership "awake at night." We added Lessons Learned responsibilities and later oversight of Risk Assessment.

The plans to add more resources and staff over time did not come about due to budget cuts from 2008 on plus new manpower demands in Cyber, Space, Diversity, as well as new Warfighting and Resource Centers.

Bob Sheldon: How was the transition to A9 as compared to the previous reorganization?

Jackie Henningsen: Back in 1998, when I became AF/AXOC, I was a Tier 1 SES. In 2001, as the Director AFSAA DRU, I became a Tier 2 SES, and in 2006 as the AF/A9, I was a Tier 3 SES, which is a three-star equivalent in protocol to the A-staff Deputy Chief of Staff positions (the title DCS is not available to civilians). This meant A9, as an independent analytic advisor had the ability/opportunity to bring insights directly to senior leadership both independently and as part of advisory staff meetings and gatherings. For CSAF deliberations on major decision reviews, budget/resource discussions, and emerging crises I had a place in the room and depending on the topic, "a seat at the table." I also sat on various policy advisory bodies like the Civilian Executive Resource Board with oversight of the Air Force's SES positions, DoD Diversity Boards, Science, Technology, Engineering, and Math (STEM) Councils and other senior level task forces for the Air Force and OSD.

With the Pentagon renovation complete, including the year-long rebuild following 9-11, AF/A9 finally moved back to the Pentagon in 2009.

[An interesting story is that on the morning that I moved into my office on the E-ring (the outer ring of Pentagon offices), I arrived around 7 a.m. to find crime scene tape on the door to my office. A disgruntled military member had been taking long-range shots at military recruitment installations. That morning, he chose the Pentagon. My fourth floor window and a couple others were hit. Luckily, the inside layer of safety glass held. One of my E-ring neighbors emailed, "A9, Welcome to the 'E-hood!"]

One of my emphases (certainly linking back to Clay Thomas) has always been career development of our analysts. In about 2003, given the high pace of deployments, the CSAF let it be known that deployability was mandatory for all airmen. With A9's new ability to influence the training of analysts, we wanted to ensure that our military analysts met the deployability requirement as airmen with experiences in warfighting headquarters and Air Operation Centers. So we greatly extended the development and support of combat analysts with individuals and teams serving in deployed locations for extended tours. In addition, one of the things that MORSian Col Jerry Diaz (when he was chief analyst in 2003) and his successors, like Roxann Oyler, put in place was continued support for our network of analysts, when deployed or in separate unit locations. We didn't want any "lost patrols." Jerry established regular trips to different bases and regions. He arranged to bring in all military and civilian analysts in an area, independent of their assignment. and update them on their career field, answer questions and discuss opportunities.

[In 2020, Jerry Diaz was selected as the U.S. Space Command S9. A fitting role for him to carry on his legacy of analytic leadership and mentoring.]

Col Roxann Oyler was particularly instrumental when she served as our chief analyst in making the combat analyst role an essential career component. "Combat Analyst Panels" became a key part of the annual MORS Symposium that she helped encourage. She also worked to establish a combined ORSA-Military Applications Course (MAC) program at Fort Lee, Virginia under the existing Army structure. We provided a Lt Col level commander and an instructor. Our young Air Force analysts took initial skills training with Army captains and majors with combat experience who were transitioning into their first analytic roles. Our folks were savvy on the use of tools, computers, and analytic theory; whereas their folks had real-world combat experience. This program has since changed as educational policy and budget decisions have led our scientific airmen to go from U.S. Air Force Academy (USAFA) or other bachelor's degree programs directly into a master's degree program, often at AFIT.

[I'm conflicted as I believe the opportunity to get practical on-the-job experience and bluing before going back to grad school can be significant.]

Instrumental in developing and leading a solid program to monitor and track over 500 military and 600 civilian career analyst positions were our chief analysts, starting with Col Jerry Diaz, Col Roxann Oyler, and later Cols' Cynthia Brown, Scott Long, Jeff Lanning, Scott Williams plus A9 civilian leaders, Patti Hickman, and Pam Coleman in partnership with Barb Hunter of SAF/AQ. They were ably advised by our manpower expert, Ms. Linda Michael who trained selected 61S analysts to fill the pipeline to the Air Force assignments officer position at Air Education and Training Command (AETC). A9 also oversaw the 61S designated commander roles for AETC including the Studies and Analysis Squadron (AETC/SAS); Community College of the Air Force (AETC/CCAF), and the ORSA-MAC command role in rotation with the Army. In addition, we guided the STEM and GS-1515-14/15 A9 civilian rotational leadership assignments roles in partnership with SAF/AQ.

[In 2020–2021, under Chief Analyst Col Mike Artelli, the direct oversight of Air Force analysts successfully moved from acquisition to AF/A9 direct control for the first time, so new career path steps may also follow.]

I would be remiss if I didn't thank the terrific heads of component A9 orgs across the Air Force during my time as AF/A9. I know I will forget to mention many and truly apologize as we had some wonderful years together. I do want to highlight longtime A9 team leaders, such as Dave Merrill (AMC); John Trivonovitch, (PACAF); Harry Conley (ACC), Doug Lee (AFSPC and USAFE), Rich Freet (ACC) and Patti Hickman USAFE/A9 then A9A, who were all engaged in our journey. Along with the stellar analysts and leaders at USAFA like Brig Gen Andy Armacost, USAFA Dean of Students, and Col John Andrews, Head of Math Department, as well as AFIT MORSians like, Dr. Dick Deckro, FS, Dr. Ray Hill, and Center for Operations Analysis (AFIT/COA) principals, Dr. J.O. Miller, Dr. Steve Chambal, and Dr. Darryl Ahner. So many others contributed in developing our analytic foundations and our analysts. My thanks goes out to them and the scores of former A9 and AFSAA members over the years who continued providing support as well as sharing memories and advice.

[I hope that readers can create an addendum of others I failed to mention or get access to the A9 annual report on Air Force Awards and Recognitions which highlighted so many who had a significant role.]

Roxann Oyler: A slightly different question. How has mentoring the junior analysts evolved, now versus in the past?

Jackie Henningsen: Along with MORSS, an annual Air Force Operations Research Symposium was held each year at one of the MAJCOM A9 and Centers of Analytic Excellence. We recognized outstanding analysts, Lessons Learned members, studies and L2 reports with annual recognition awards. The awards continue, although L2 is no longer in the same program. However, with sequestration cut-backs, we were forced to greatly limit the opportunity conferences provided for analysts of all grades to present work and personally interact with others in the field.

[The advent of COVID-19 in 2020, further reduced iterations, but MORS did show great resilience in carrying on a full range of virtual meetings.]

Roxann Oyler: Also, you've done that on the civilian side as well.

Jackie Henningsen: Right. We definitely reached out to provide opportunities for the civilian analysts to work on career broadening experiences and have someone watching them through their career. The Federal Government's development of the SMART (Science, Mathematics & Research for Transformation) program provided us an opportunity to select some outstanding civilian students and pay for continuation of their science and technology education with a guaranteed position in a sponsor organization like A9. The establishment of a STEM focus in the Air Force enhanced by our ability to award these scholarship positions. Fortunately, I understand investment in the SMART program has been revitalized. When the Acquisition community held a kickoff meeting for Air Force STEM in about 2010, my conference talk titled "STEM: It's in the Air Force's DNA" focused on the technical foundations of the Air Force being a core "Competitive Strategy"! [There was once a MORS working group of that title, and I presented "The B-52 as a Competitive Strategy" to that group in about 1989.]

Bob Sheldon: Let me jump back into the MORS venue. As far as I can tell from my database, you're unique in transitioning from a MORS VP to an OSD MORS Sponsor's rep to an Air Force MORS Sponsor, which gives you a unique vantage point. How did you see MORS - going from — an insider to a Sponsor's rep to a Sponsor?

Jackie Henningsen: MORS has been part of my life in the way that I've learned to be both an analyst and analytic leader. It's my home base, with lifelong colleagues like the Fellows as personal friends who have shared so many experiences over the years. Through MORS, I learned about career development outside of my current job. Members can start by giving presentations, go up through the working group level and the associated networks, and on to the symposium viewpoint and the special meetings. The growth opportunities from serving as a working group chair on up allow members to demonstrate leadership and practice organizational skills.

MORS provides an incredible service to its members and all its Sponsors with its emphasis on advancing knowledge thru development of junior and senior analysts, educational leaders, and industry partners while focused on key issues of national security. Later as a Sponsor, I could identify a challenging emerging topic and in partnership with others have 100 or more talented folks, including leaders and experts in the field come together and work on that problem. The return on investment was extraordinary. For instance, when the Services were interested in tools and analysis techniques for nontraditional warfighting areas, and had resources to invest, MORS stood up to the challenge thru the participation of highly motivated experts who gave their time to develop, sift and sort through dozens of different options and ideas that were condensed for us. MORS provided me as a Sponsor a multifold return on investment, but it was my responsibility to ensure that the meetings were timely. I think that's exactly what's happened through the years.

I also want to mention what a joy it was to be the Air Force Sponsor, especially whenever USAFA hosted MORSS. The USAFA analytic community always ensured the 1,100 plus attendees had an unparalleled experience. In 2012, I gave my final "Sponsor's Welcome" as we entered a difficult period when attendance at conferences of all nature were curtailed. In 2019, I was thrilled to once again attend a MORSS at USAFA during a ceremony to present the *Air Force's Jacqueline Henningsen Lifetime Analyst Award* to Brig Gen Andy Armacost and the *Lt Gen Glenn Kent Leadership Award* to Retired Gen James McCarthy. [I was also able to attend retirement and change of command ceremonies for several of our incredible analysts who had risen to leadership positions ensuring the tradition of "setting the gold standard for analytic excellence" will go on.]

Bob Sheldon: As a closing question, what advice do you give to young analysts?

Jackie Henningsen: I've had a great career. I would advise folks to "go all in" and fully immerse yourself in your work. Be passionate about what you do and be sure it shows. I was known for years as "the lady in red" because I wore red, not because I came from Nebraska, but to remind folks that "I'm passionate about the power of analysis!" At the same time, be open for the threads that you can pull to improve your contributions and your capabilities. Never stop learning and growing. The analytic world opens up lots of choices for you, and I don't think at any one time you can say, I'm going to do this now and 10 years from now I'm going to be doing that . . . the pace is too fast and the world changes too rapidly. I didn't have a clue at any given point where I would arrive next, but I did have a moral compass and framework for what I considered to be important. I had the opportunity to help put together a Certificate Class on "Skills for Analytic Professionals" for MORS in 2018. My section was on "Ethics in Analysis." It is one of the most important issues of our careers, but often not consciously considered until a problem arises.

When we first formed the revitalized AFSAA structure, we took the whole organization to a special showing of the documentary *Endurance: Shackleton's Incredible Voyage.* Based on the book by Alfred Lansing, it tells about a 1915 attempt to cross the Antarctica via the South Pole. Shackleton's leadership and the teamwork demonstrated during the disaster of losing their ship far from any hope of rescue, and the amazing fortitude it took to get home nearly two years later,

led me to prepare a guide called "Lessons Learned from the *Endurance*." I hope you will read the story to understand how it provided me a blueprint for building a successful organization. Here are the main points:

- 1. Find and surround yourself with the very best people;
- 2. Be sure these people are multi-talented and adaptable;
- 3. Set clear ethical guidelines, mission goals and objectives;
- 4. Consider carefully when to act and when to wait to act;
- 5. Be adaptive to changing conditions; and
- 6. Commit fully to bringing everyone "home."

I think that you've got to be prepared for the unknown, and our analytic background gives us the capability to be open to plotting various paths. You have to have intellectual curiosity and you have to have integrity. You have to be willing to stand up to leadership and say, "I'm sorry, I can't analytically fireproof you on that decision." and you have to be able to accept the fact that there may be other reasons for them making the decision anyway. You need to be able to lay out alternatives and consequences. That doesn't mean you have to change your advice; you just have to frame the message to convey the nature of the risks you have identified, and the differences in outcome that come with different choices.

I particularly want to thank all the amazing folks I have worked for who had the intellectual curiosity and confidence to appreciate an analytic approach, and who trusted our organization and me to provide them scientifically solid, data reliant insights. I also want to thank all the staff and partners from MORS, as well as my counterparts across DoD who walked this journey with me. We were steadfast in our efforts to make a collaborative foundation the essence of DoD's analytic endeavors. Despite many roadblocks, we knew where true North lies and hopefully have taught and inspired our successors on how to stay focused as well.

I am forever indebted to the AFSAA and A9 team members who truly walked the walk, worked the hours, joined joyfully in the evenings-out and sports days, and celebrated both successes and sorrows that come to any group of closely tied people. They brought the knowledge and creativity to bear on the tough problems we were entrusted to explore. I can't name them all here, but I remember them all and especially those who started with me in the early years at SAC and returned to contribute to A9's successes in later years,

I also owe a special debt to Kevin Williams who succeeded me in November 2014 after nearly five years as my deputy A9. He brought his own special strengths and operational knowledge to the position after leading STRATCOM's Innovation Center. He ensured a tight knit band of former Strategic Studies Group team members met regularly to discuss ways to strengthen the Air Force. It was with great sorrow that I spoke at Kevin's memorial service in December 2019, citing the victories he achieved with his wife Joyce at his side. His efforts to continue defending the role of analysis were highly valued by the leaders A9 served. Lynne Baldrighi, who started with me at SAC, was his deputy. She had a broad and successful career as a military analyst and served as my Director of Staff. She was selected as an SES in OSD and later became Kevin's first Deputy Director of A9. She was followed by Chan Swallow, former Technical Director for the Joint Warfare Analysis Center, who served as Acting A9 for nearly 18 months. With Tech Director, Dr. Angela Giddings' support, he continued to ensure analytic talent was applied to the tough Air Force problems of the day and guided the team in the difficult days of COVID.

[In May of 2021, Maj Gen (ret) Rowayne A. "Wayne" Schatz was appointed as the new AF/A9. He retired in Aug 2016 as Vice Commander, Air Mobility Command and since has been an SES serving as the Associate Deputy Chief of Staff for Operations, Headquarters USAF. Wayne is a 1983 graduate of USAFA in economics and OR, and served as a division chief in AFSAA in 2000–2001.]

Most of all, I thank Carl for being with me throughout this journey; for his enthusiasm, sacrifices, confidence in me, and unwavering love. I seldom encounter one of our former students, friends, or colleagues from SAC, the Pentagon, or MORS without them asking, "What is Carl up to

these days!" Known as "a man with much patience" he inspired loyalty through the deep personal interest he took in longtime friends, as well as each person he taught, coached, or just encountered. I also want our family, especially son and daughter-in-law, Jeff and Stacey, as well as our grand-children and great-grandchildren to know how much joy they all have brought us and what pride we take in each of their accomplishments.

[Being A9 gave Analysis, Assessments, and Lessons Learned an ability to "analytically fireproof" the major decisions of the Air Force. As I always note, leadership has many considerations in making a decision, but ensuring that they will not be blindsided by externally or even internally biased analysis is best prevented by ensuring that its principal analytic component is mandated "to openly speak truth to power."]

... Dr. Jacqueline Henningsen, FS (April 2021)

"FIREPROOFING doesn't mean the fire will never come, it means when the fire comes that you are able to withstand it."

... Lt Michael Simmons in Fireproof