AN AERONAUTICAL ODYSSEY

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The Early Years

My first memories of aviation were supplied by my father, a career Marine Corps officer. As a Marine, he was intent on becoming an aviator, but his eyesight failed him. However, he never lost his interest in aircraft and aviation. I can remember frequent visits to the airport just to watch the aircraft take off and land. He actually was able to arrange for a personal tour of a TWA Lockheed Constellation for my brother and me when it was introduced at Washington National Airport.

When he was assigned to Pearl Harbor, he would take us to watch the takeoffs of the Martin JRM Mars seaplane ("Hawaii Mars"), a noisily impressive flying machine bound for San Francisco.

Later, when he was assigned to Camp Lejeune, NC, we observed amphibious landing exercises at Onslow Beach, involving landing craft, fixed- and rotary-wing aircraft, and, of course, Gyrenes on foot. These memories are still very vivid for me.

High School (1958 - 1962)

In 1958, I started high school in Alexandria, VA. I was a pretty nerdy kid who wore an aloha shirt on his first day of freshman year but quickly realized that the button-down "Ivy League" look was the preferred dress code. I did well academically, especially

in math and science, but my first love was English and foreign languages. In my junior year, when college crunch time was beginning, my father counseled me that I should be looking for a college with a strong engineering program and that I should definitely consider the Naval Academy, which he attended prior to his service in the Marine Corps. I actually did apply to, and was accepted at, the Naval Academy, but I also surreptitiously applied to other schools, Princeton among many others. We actually visited Princeton during the summer, after spending some time at the Naval Academy, of course. During my admissions interview there, I admitted that my favorite instrument was the bagpipes; I am convinced that my taste in music ensured the decision to admit me to the Princeton Class of 1966. However, the next hurdle was to convince my father, who told me stories about marching through the Princeton campus with the Brigade of Midshipmen before a Navy-Princeton football game and observing young ladies carousing in the dorm rooms of this all-male institution. Despite this disturbing revelation, I secretly applied for a Navy ROTC scholarship to Princeton, was successful, and my father relented.

Off to Princeton (1962 – 1966)

Because of my father's influence, I selected an engineering course of study at Princeton. As the only person from my high school to attend Princeton that year, it didn't take me long to realize that I was not the smartest freshman of my class. My first exam in Physics 101 was a disaster; adding to the tension were some upperclassmen rolling beer cans down the stairs of the lecture hall during the exam. My resulting uncertainty about an engineering major was tempered by an open house put on by each of the engineering departments. The Department of Aerospace and Mechanical Sciences (AMS) won me over with an introductory flight in their Cessna 310, a "Learjet with propellers", to demonstrate the dynamic characteristics of that vehicle. It was either that or sitting at a lab bench doing circuit board analysis in the Electrical Engineering Department. I was convinced.

I continued to be impressed by the AMS department, especially its faculty. At the time, the Department chair was Courtland Perkins, a very impressive and internationally-respected aeronautical engineer and co-author of our "bible": "Airplane Performance, Stability, and Control". Although his credentials were of the highest caliber, Perkins was a very affable gentleman with a "hands-on" approach to engineering and a wealth of "war stories" to share with his students. Another professor, David Hazen, also spiced up his lectures with war stories; a very memorable one for me was the story of the development of the Navy's Vought F7U Cutlass, known fondly as the "Buttless Cutlass" because of its unusual tail design:

As undergraduates, our laboratory courses were conducted at the Forrestal Flight Research Laboratory (http://www.princeton.edu/~stengel/FRL.pdf). These courses included a wind tunnel project that involved the design and test of a wind tunnel model of our choice. A fellow student and I designed, built, and tested a model Rogallo Wing (a flexible, parachute-like airfoil) that successfully flew down the tunnel and was destroyed.

Most of my summers were taken up by training with the Navy that included duty on board the USS Intrepid, a WWII aircraft carrier now docked on the Hudson River in New York City, and flight training at Corpus Christi Naval Air Station, TX. I spent my one "free" summer after my senior year working at Cornell Aeronautical Laboratory at the Greater Buffalo (NY) International Airport while living in a rooming house in Niagara Falls, NY, then home of the Bell Aerospace plant. While there, I was assigned to help Jack Beilman, the developer of the LORAS (Low Range Airspeed System), with its testing. The LORAS is an omnidirectional system now in use on the Army's Apache and Coast Guard helicopters. That summer, one of the two Bell X-22A quad ducted-fan V/STOL aircraft, Bell's entry in the Tri-Service V/STOL competition, was being flight-tested near the Bell plant. The aircraft underwent a complete hydraulic system failure and crashed in a nearby field with no casualties, thankfully.

Both the undamaged X-22A and the remains of the crashed vehicle were to become a major part of my professional life.

Graduate School (1966-1967)

The Navy allowed me to put in an additional year at Princeton for a Master's degree under the guidance of Prof. Edward Seckel. I did not impress Seckel as being a

stellar graduate student, but I soldiered on with a thesis project focused on the assessment of the feasibility of the use of stored energy aboard an aircraft to provide a short-term, short-field landing capability. David Ellis, a Princeton test pilot and instructor, helped me to salvage my degree by assisting and mentoring me in implementing an in-flight simulation, using the Princeton Variable Stability Navion, of the release of compressed gas during landing approach to shorten the runway requirements.

In the classroom, I was fortunate to be taught by such luminaries as Seckel, Dunstan Graham, and Howard ("Pat") Curtiss. Prof. Curtiss was especially impressive with his ability to simplify the complex dynamics of helicopter flight. He continued to have a positive impact on my career after Princeton.

Many of my fellow graduate students became valued friends and colleagues throughout my career: Jack Franklin, Vic Lebacqz, Bob Ormiston, Fred Schmitz, and Jim McCroskey appeared and reappeared throughout my life. I am very thankful for them and their support.

As the end of my graduate school program approached, I had to make a choice about my required five years in the Navy. As an aeronautical engineer and the son of an aviation enthusiast, I was naturally attracted to Naval Aviation. However, my Marine Corps veteran father counseled me with some very valuable advice. First, he was troubled by our country's participation in the Vietnam War and, second, he was concerned about how many young aviators were dying in that war. He advised me to avoid Naval Aviation as a career. I thank him for that advice to this day; several of my classmates in the Princeton Navy ROTC program died in Vietnam. Instead, I chose to enter Admiral Hyman Rickover's nuclear submarine service, a decision that was made easier by my childhood love of submarines; the "Silent Service" was one of my favorite TV shows.

Take 'er Down! (October 1967 – April 1972)

After being interviewed and accepted by Admiral Rickover and before being allowed to set foot on a submarine, I went through Nuclear Engineering training in Bainbridge, MD, and Submarine School in New London, CT. I was then assigned to the Engineering Department of the USS Mariano G. Vallejo (SSBN–658). My family and I "saw the world" with the Navy, moving with the Vallejo from Guam to Pearl Harbor to Charleston, SC (via the Panama Canal), and finally to Holy Loch, Scotland.

During my six patrols on board the Vallejo, I was able to sneak in some stability and control testing on the mid-watch to determine the hydrodynamic frequency response characteristics of this stealthy machine. In addition to the standard stern planes for attitude control and fairwater planes for depth control, her control system also included a hover control system involving depth control tanks responding to feedback of depth, vertical rate, and vertical acceleration. My Princeton education in aircraft stability and control was paying off!

My five years in the Navy also provided me with on-the-job management experience that resulted from my being put in charge of a large group of intelligent, college-educated, and experienced enlisted men who knew more about the submarine than I did and were intent on testing me: the ultimate management challenge for a 24-year-old babe-in-the-woods. I survived the challenge, and the benefits of that experience stayed with me throughout my career.

As my required time in the Navy wound down, I had to make a decision about whether to stay in the submarine service, venture out on my own, or try something completely different. I applied to, and was accepted as a graduate student by, the MIT Department of Ocean Engineering, but, now that I had a family, that option was not a realistic one. My previous connection with Cornell Aeronautical Laboratory paid off, and I was offered a position in their Flight Research Department, my old stomping grounds.

Back to Buffalo (May 1972 – June 1977)

At Cornell Aeronautical Laboratory (CAL), now Calspan, I was assigned to a team of engineers conducting flight experiments on the X-22A aircraft, now modified by CAL to be a variable-stability-and–control research aircraft. My specific initial assignment was to assist in developing a fixed-base ground simulator facility using the cockpit of the aircraft that had crashed during my 1966 summer at CAL.

Once the ground simulator was functional, I conducted piloted research to generate control system and cockpit display requirements for decelerating, descending transitions to a hover under instrument conditions. It was then that I was introduced to Bob Harper, co-developer of the Cooper-Harper Flying Qualities Rating Scale (with George Cooper, chief test pilot at NASA-Ames Research Center). This simulator research program expanded into a major flight program on the X-22A, which included the implementation of automatic duct angle control using algorithms developed in the simulator. Because of the success of this research effort, our team was asked by the Navy to develop an in-flight simulation of the Harrier aircraft using the X-22A.

Unbeknownst to me, many of my friends and colleagues at CAL would re-appear in succeeding chapters of my odyssey, including Dave Key, Bob Chen, Vic Lebacqz, Warren Hall, Bob Till, John Wilson, and Irv Statler. On the West Coast, we were to be known as the “Calspan Mafia”.

The Blizzard of 1977 in Buffalo sent my family and me a message that we should be moving on. So, onward to warmer climes:

T for Texas (and Training) with Singer-Link (June 1977 – July 1978)

Singer-Link, a developer of training flight simulators headquartered in Binghamton, NY, had recently expanded its software development operation in Houston, TX, adjacent to the NASA Johnson Space Center. This new organization was responsible for the development of the software for the UH-60 Black Hawk training flight simulator, and I was in charge. One of my first assignments, of course, was to travel to Binghamton in winter to assist in the development of a program plan, since I had significant previous experience with, and the proper clothing for, winter weather in upstate New York.

Our Houston adventure lasted only a year, and, thanks to my old friend from Princeton, Jack Franklin, now a NASA Branch Chief, and others, I was offered a position working for Dave Key and the Army at Ames Research Center, Moffett Field, CA. My family and I were very happy to see Texas in our rear-view mirror.

Go West, Young Man!: Army/NASA Ames Research Center (July 1978 – May 1985)

One of my first research projects as an Army Aeromechanics Laboratory researcher at Ames was to develop a mathematical model of the AH-64 Apache attack helicopter which could be used in future piloted simulation investigations. Using this model, I designed and conducted a simulator experiment, using the old S.01 six-degree-of-freedom simulator, to investigate the effects of variations in control system characteristics and cockpit display format and symbol dynamics on a pilot's ability to perform target designation and weapon delivery tasks during a nighttime attack helicopter mission. I was assisted by LTC Bob Merrill, whose piloting capabilities and sense of humor, helped make my initial research project at Ames an enjoyable and fruitful one.

Using this same mathematical model, Chris Blanken and I undertook a piloted simulator investigation of means to minimize transient aircraft motions that might occur as a result of engaging the Apache's Back-Up Control System, accomplished by breaking a shear pin at the pilot's controller.

Because of the Army's interest in freeing up cockpit space by implementing small, side-stick controllers rather than the conventional center stick and collective controllers, we conducted a piloted simulator investigation using the Ames Vertical Motion Simulator. This experiment assessed the effects of side-stick controller characteristics and the level of stability and control augmentation on handling qualities for several low-altitude control tasks. We were one of the first rotorcraft simulations to use the four-window computer-generated imagery provided by the VMS facility. The results of this experiment formed the basis for the controllers and control laws eventually implemented in the Army/Boeing Advanced Digital-Optical Control System (ADOCS) demonstrator aircraft.

Assisting in these side-stick controller experiments were Katie Hilbert, a new Princeton-educated engineer, and Boeing engineers, Ken Landis and Phil Dunford. At the time, Dunford was a fresh-faced, junior engineer with Boeing, recently arrived from England. He was soon to become VP, Boeing Military Aircraft!

Together with Mike Lewis, a newly-arrived engineer from Princeton, we developed a mathematical model and established a helicopter air combat simulation capability, again using the VMS.

As a result of the true "jointness" of the Army/NASA Agreement at Ames, I was able to take advantage of the opportunity to become a Group Leader within Jack Franklin's Flight Dynamics and Controls Branch.

NASA/Army Group Leader (May 1985 – September 1987)

As Group Leader, I worked with Doug Watson, a young, enthusiastic NASA engineer, to investigate control cross-coupling effects and control-display effects for a precision hover task using simulation and flight. A most memorable event was the opportunity to work with friends and colleagues at the German Aerospace Research Establishment (DLR) in Braunschweig to design and conduct the first flight experiment using the variable stability capability of their Bo-105 research helicopter. I vividly remember being embarrassed (and honored) at a technical meeting that included Peter Hamel, DLR Director, by being served a bottle of excellent German beer by my friend, Juergen Pausder. NASA test pilot, Ron Gerdes, and I traveled south to the flight test facility at Manching (near Munich) with Pausder at the wheel, blazing along the Autobahn.

After almost ten years at Ames, I was ready for a change. Because of my recent association with Boeing Helicopters, I was offered a job with Boeing in Philadelphia, PA, which I accepted.

Go East, Young Man!: Boeing Helicopters (October 1987 – December 1989)

Bruce Blake, the Director of Research and Technology at Boeing Helicopters, a man whom I admired and respected, hired me as the Manager of the Flight Simulation Laboratory (FSL). As the FSL Manager working with Ken Landis, Flying Qualities manager, I oversaw a significant upgrade in the capability of that facility including a high-performance motion base and two dome visual systems. I provided technical leadership and guidance in the development of a unique simulation system that included a cab and six degree-of-freedom motion base located inside a fixed dome used for outside visual cueing. Major programs that used the facility included the Bell/Boeing V-22 Osprey and the Army's ADOCS program.

It was a privilege for me to work with the team of engineers and managers at Boeing, but my family and I decided that we were not really "East Coast people" and were anxious to return to Northern California. That opportunity came in the form of an offer from Greg Condon, the NASA Ames Aviation Systems Division Chief, prompted by Jack Franklin.

Home Again!: Ames Research Center (December 1989 – January 2005)

The Army at Ames was in the process of acquiring the Army/Boeing ADOCS demonstrator aircraft, a highly-modified UH-60 Black Hawk, for use as an "in-flight simulator", a flying laboratory for piloted investigations, and a Program Manager was required. I was very happy to be considered and enthusiastically accepted the offer. During my two years as the Program Manager, I was ably assisted by such team members as Bob Jacobsen and Michelle Eshow, NASA engineers; Court Bivens, Army pilot/engineer; and Bill Hindson, NASA pilot/engineer. My two major personal contributions to the program were: 1) the concoction of an acronym for the aircraft which typified the personality of our team: Rotorcraft-Aircrew Systems Concepts Airborne Laboratory (RASCAL) and 2) negotiations with Warner Brothers for the use of my favorite cartoon character, the Tasmanian Devil, in our RASCAL logo:

In March of 1992, I was fortunate to be selected as the Chief of the old NASA Flight Dynamics and Controls Branch, now known as the Rotorcraft and Powered-Lift Branch. During my service as Branch Chief, Branch members made significant technical contributions, including: 1) the successful completion of the V/STOL Systems Research Aircraft (VSRA) flight program and the transfer of flight-validated control/display technology to the Joint Strike Fighter Program and contractors, 2) the development, in simulation and flight, of effective and safe low-noise procedures for both helicopters and tiltrotor aircraft, and 3) completion of the acquisition and development of the unique rotorcraft flying laboratory, the Rotorcraft-Aircrew Systems Concepts Airborne Laboratory (RASCAL), a UH-60 Black Hawk helicopter modified to include a high-performance, full-authority, programmable flight control system.

In October of 1995, my NASA bosses strongly suggested that I become NASA's first Flight Simulation Facility Group Director, responsible for the strategic management of all of NASA's piloted flight simulation facilities, located at four NASA field centers.

There was some understandable opposition from the other Centers to an Ames manager taking over their simulation facilities, but, in the end, I was able to convince them that "I come in peace". But, as Jack Franklin's idol, Yogi Berra, reminded us, "When you come to a fork in the road, take it."

As a natural extension of the Joint Agreement, the Army and NASA at Ames joined forces to create a new organization at Ames co-managed by Army and NASA employees: the Army/NASA Rotorcraft Division. In March 1997, I was selected to head up this new Division, with Wendell Stephens, followed by Mike Rutkowski, as Army Deputy Division Chief. This reorganization process included the development of a "strategic vision" for joint NASA/Army rotorcraft research that resulted in a funded rotorcraft research and technology program.

However, these were bleak days for the NASA rotorcraft program, with minimal support from the Center and from NASA Headquarters. The Army and the US rotorcraft industry came to our rescue, with Andy Kerr, Army Aeroflightdynamics Director and fellow Princetonian, and Rhett Flater, American Helicopter Society Executive Director, joining forces in support of the NASA Program. Of particular concern to me was the potential loss of a rotorcraft flight research capability at Ames.

In 1996, NASA determined that all NASA-owned research aircraft stationed at its various field installations should be consolidated at the Dryden Flight Research Center (DFRC) located at Edwards, California. This directive required that all aircraft located at NASA's Ames Research Center in northern California including associated personnel and selected ground support equipment were to be moved several hundred miles to southern California. This directive also involved mothballing facilities at the Ames location and deactivating support for aircraft located at Ames. The U.S. Army Rotorcraft research activity located at Ames and the associated fleet of aircraft were impacted by this decision. Before the NASA decision to consolidate its aircraft assets, the Army aircraft located at Ames shared NASA provided support resources. The Army elected to keep its aircraft at the Ames location and was faced with the loss of facilities and ground support. As the senior manager associated with the Army/NASA relationship at Ames, I assumed the responsibility of finding a way to support the Army rotorcraft located at the Ames facility. We were able to acquire the resources and coordinate the necessary logistical operations for the Army to be able to keep its rotorcraft aircraft at the Ames facility with full ground support and appropriate hangar facilities. The current Army Flight Projects Office is an extremely productive unit and has received many commendations and awards for its outstanding efforts.

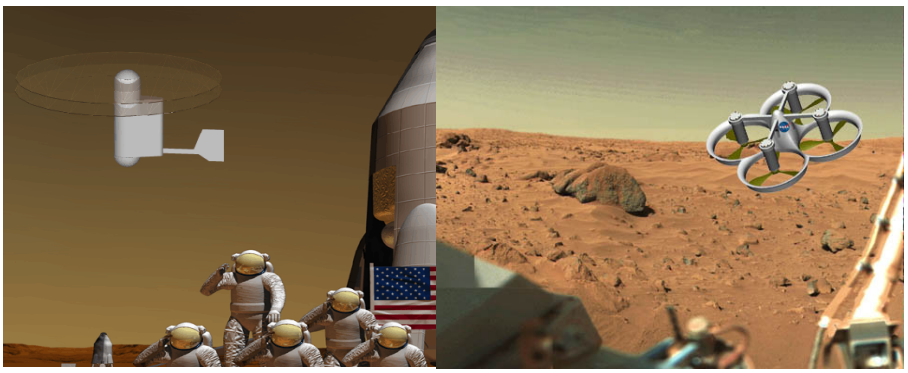
I am particularly proud of the significant contributions made by our Division to US industry. These accomplishments include the development of a unique ground test device for tiltrotor designs, the Tilt Rotor Aeroacoustical Model (TRAM), which received the 1998 American Helicopter Society (AHS) Grover E. Bell Award, and an integrated flight control law design tool, Control Designers' Unified Interface (CONDUIT), which has been readily adopted in both the fixed- and rotary-wing industry as a means of improving the efficiency of the flight control system design and testing process.

We also initiated an effort to develop the application of "intelligent autonomy" to small Unpiloted Air Vehicle (UAV) rotorcraft. Matt Whalley, an Army engineer, has developed these concepts and has created an extremely successful and productive

research program, now including the use of the RASCAL research helicopter as a test platform.

Integration and near-Earth flight demonstration of autonomous agent architectures

I am also proud of our planning and advocacy efforts for a true "Future Directions" effort in NASA rotorcraft research and technology. Together with NASA engineer, Larry Young, we developed the concept for a Martian Autonomous Rotorcraft to assist in NASA's planned planetary exploration programs and collaborated with the Ames Information Systems Directorate and Center for Mars Exploration. I am convinced that, one day very soon, we will see an autonomous rotorcraft in operation on Mars



There is one person who has been with me through thick and thin at Ames Research Center. I first was introduced to Linda Vollenweider in 1978 when I arrived at Ames as a newly-arrived Army engineer in Jack Franklin's Flight Dynamics and Controls Branch, and she was serving as Branch Secretary. Linda, with her sense of humor and ability to network throughout the Center, continued to provide me with the moral support and some necessary prodding throughout my career as Group Leader, Branch Chief, Simulation Facility Group Director, and Division Chief. She even was there to convince me to return to Ames from Boeing Helicopters. She was, and is, a true treasure and the secret behind my success and enjoyment.

At some point early in my career, I was advised by a wise person to try different varieties of organization conducting aeronautical research: government, industry, and university. Although not part of any grand plan, I did exactly that and have thoroughly enjoyed my "aeronautical odyssey" and the colleagues and good friends I have made on the journey.

I retired from NASA in January 2005 and am convinced that our Army/NASA organization is in excellent hands. Barry Lakinsmith, the Army Director, and Bill Warmbrodt, the NASA Chief, are outstanding leaders and are continuing to forge new directions for our unique NASA/Army organization.

In closing, these words of advice from another Princetonian:

When you look at yourself from a universal standpoint, something inside always reminds or informs you that there are bigger and better things to worry about."