

Advancing Vertical Flight: A Historical Perspective on AHS International and its Times

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ABSTRACT

This paper describes AHS's vital role in the development of the rotorcraft industry, with particular emphasis on events since 1990. It includes first-hand accounts of the formation of the Society, how it matured and evolved, and the particular influences that compelled change. It describes key events which occurred during various stages of the Society's growth, including the formation of its technical committees, the evolution of the AHS Annual Forum and technical specialists' meetings, and the creation and evolution of the Society's publications. Featured prominently are accounts of AHS's role in pursuing a combined government, industry and academia approach to rotorcraft science and technology. Also featured is the creation in 1965 of the Army-NASA Agreement for Joint Participation in Aeronautics Technology, the establishment of the U.S. Army Rotorcraft Centers of Excellence, the National Rotorcraft Technology Center (NRTC), the inauguration of the Congressional Rotorcraft Caucus and its support for the U.S. defense industrial base for rotorcraft, the battle for the survival of NASA aeronautics and critical NASA subsonic ground test facilities, and the launching of the International Helicopter Safety Team (IHST).



First Annual AHS Banquet, October 7, 1944.

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INTRODUCTION

What is the real meaning and value of AHS International, now a mature society with more than 72 years of historic accomplishments? It is a fair question to ask. Periodically, professionals, industry leaders and government agencies must frame difficult questions. Financial and human resources are never sufficient to pursue every mission, continue every project or invest in every program. The only constant in our times is change.

To respond to this question, it is appropriate to take an inventory of the Society's resources and accomplishments. That is a primary goal of this paper. The American Helicopter Society International hosts professional conferences and technical specialists' meetings. Through its publications, particularly the *Journal of the American Helicopter Society*, the *Annual Forum Proceedings* and *Vertiflite* magazine, it documents, and thus shares, significant breakthroughs and achievements. It provides a forum for technical discussions. But the question remains, is that sufficient?

If we were to listen carefully, we might hear distant voices from time to time, the ghosts and shadows of industry legends long past: Professor Alexander Klemin, Igor I. Sikorsky, Army Colonel Franklin Gregory, Frank Piasecki, Arthur Young and Bart Kelley, Stanley Hiller, Charles Kaman, Coast Guard Commander John Erickson, designer Robert Lichten, and others. Their views are both instructive and relevant.

For them, as for many of us today, participation at AHS events allows rotary-wing scientists and engineers the opportunity to exchange ideas on novel research. Society conferences were then, and remain today, vital in disseminating scientific and engineering discoveries related to rotorcraft technology. Discoveries and improvements in new materials — composites, titanium alloys, elastomers and more — are reported daily. New manufacturing technologies are reducing the costs of building aircraft structures by one-third or more. Systems capabilities are constantly evolving, improving the ability of existing airframes to address new roles and missions.

Today, as in years past, AHS's activities at the international, regional and local level help members to remain current in technical disciplines, which are undergoing constant change. Because of this, Society events provide high-quality, low-cost professional development. The contacts and direct employment recruiting facilitated by AHS have become powerful tools for attracting the best and the brightest to industry, government service and academia.

AHS is, and continues to be to be, a proven vehicle for collaboration. A few examples include the Army-NASA Joint Agreement, the Vertical Lift Research Centers of Excellence (VLRCEs), and the National Rotorcraft conferences, meetings and publications continue to tie

together a relatively small, widely-dispersed science and engineering community that is dedicated to rotorcraft technology. The Society promotes technical innovation and commercialization, accommodates peer-review of research, provides training opportunities and educational workshops, facilitates recruiting, and helps educate graduate students.

Ultimately, the history of AHS International is the story of how companies and individuals, governments and institutions, addressed changing times, embraced new concepts in aerodynamics, structures and materials, avionics and systems, propulsion and drive train systems. In so doing, they developed novel 21st century vertical lift manufacturing technologies and capabilities, thus creating entirely new, safe and affordable capabilities to meet national (and international) military and civil transportation needs.

THE AMERICAN HELICOPTER SOCIETY: THE FOUNDING YEARS

In the 21st century, rotorcraft, including helicopters and tiltrotors, perform vital missions and save lives every day. In military applications, as the wars in Iraq and Afghanistan illustrate, modern rotorcraft have become essential enablers — performing reconnaissance, aerial assault, close air support, vertical envelopment and combat medical evacuations, transporting armed forces and materiel safely and swiftly over vast and often treacherous terrain. Helicopters, particularly those designed for military applications, also perform widespread public service operations, including disaster relief and humanitarian support. Recent examples include major international crises such as United Nations relief efforts in Somalia in 1991, the 2004 Indian Ocean Tsunami, Hurricane Katrina, which struck New Orleans and the Gulf Coast in August 2005, the 2006 Hindu Kush Earthquake in Pakistan and India, and the April 2015 Nepal Earthquake, as well as search and rescue, fire-fighting, law enforcement, resource development, and priority transportation. They lift injured people off roads, rescue them from sinking vessels, remove them from burning buildings, and save them from raging floods. More than five million people owe their lives to the special characteristics of these machines.

But it was not always this way.

In the early days, as recently as the interval between World War II and the Korean War, helicopters were viewed largely as curiosities, regarded as slow, relatively unstable, frequently uncontrollable, featuring flimsy structures made of wood, canvas and metal tubing. Their engines were often unreliable and underpowered, their transmissions susceptible to failure. Nevertheless, with the advent of the Second World War, interest in these strange aircraft, their unique capabilities and yet unfulfilled promise germinated and began to grow within government agencies, private industry and academia.

Early aviation pioneers, led by Russian émigré Igor I. Sikorsky, were fascinated by the challenge of developing a practical aircraft, capable of lifting straight up and straight down, of hovering, and landing on unprepared surfaces. Others joined him, including Frank Piasecki of Philadelphia, Arthur Young and Bart Kelley at Bell Aircraft, Stanley Hiller, Jr. — a young dropout from the University of California (Berkeley) — and Charles Kaman. Many were familiar with the work of earlier European visionaries, notably Paul Cornu, Louis Breguet and Étienne Oehmichen of France, the Spanish marquis Raúl Pateras Pescara, Wilhelm Zurovec of Austria-Hungary, George de Bothezat, Emile and Henry Berliner in the United States, and Autogiro pioneers, such as the Spanish aristocrat Juan de la Cierva. Cierva's licensee, Harold Pitcairn of Philadelphia, won the Collier Trophy for "the greatest achievement in aviation" in 1930. Nearly all had learned of major breakthroughs by the two great German aeronautical engineers, Henrich Focke (and test pilot Hanna Reitsch's demonstration in 1936 of the Fa-61 at Berlin's Deutschland Halle sports arena) and Anton Flettner (and his Fl-282 Kolibri, the world's first helicopter to enter mass production).

On the horizon appeared the unmistakable signs of another European war in which the United States would become engaged. In July 1940, the same month as Germany's Luftwaffe launched the Battle of Britain, Captain Hollingsworth Franklin Gregory, a project officer for the U.S. Army Air Corps and a seasoned autogiro pilot, arrived at Stratford, Connecticut, to meet with Igor Sikorsky. His purpose was to test-fly the VS-300. Frank Gregory's findings, detailed in his test report, motivated the Army Air Corps to provide \$50,000 to Sikorsky to build an experimental aircraft — a two-seater, closed cabin version to be designated the XR-4. In the United States, the helicopter era was just beginning.

Rotary-wing pioneers were widely dispersed throughout the world and the United States. They lacked opportunities to exchange ideas and information about common design problems. There were early attempts to remedy this, including a meeting on rotary-wing aircraft design held October 27-29, 1938, at the Franklin Institute in Philadelphia, Pennsylvania. The attendees included Igor Sikorsky; his chief designer, Michael Gluhareff; Ralph McClaren; Agnew E. Larson; James E. Ray; Frank Piasecki; Arthur D. Young; Dr. Alexander Klemin; W. Laurence LePage; E. Burke Wilford; Raoul Hafner; Richard Prewitt; and W. Wallace Kellett (Harold Pitcairn was ill and unable to attend). These were the venerable pioneers of the American helicopter industry.

Among other achievements, the meeting marked a turning point from interest in autogiros to helicopters. (Ref. 1) Persuaded by testimony given by Major (later Colonel) Frank Gregory, as well as Commander William J. Kossler, USCG, and the energetic efforts of W. Wallace Kellett, the U.S. Congress passed, and President Franklin Roosevelt soon signed, what became known as the "Dorsey-Logan

Bill." (Ref. 2). In so doing, it authorized \$2 million for "rotary wing and other developments." A previous version, championed by Harold Pitcairn, requested funds for "Autogiro Research, Development and Procurement," but the language was changed at the last minute at the suggestion of Dr. Alexander Klemin.

Less than five years later, several of the participants created what became known as "The American Helicopter Society," a professional technical society to advance rotorcraft technology. In subsequent years, it was renamed "AHS International – The Vertical Flight Society" to reflect its world-based membership, though its purposes remained unchanged.

Led by a small group of engineers at United Aircraft Corporation's Sikorsky Aircraft Division in Bridgeport, Connecticut, several leaders — including Ralph Alex, Philip Blackford, Edwin Katzenberger, Chester D. Mayerson, and Clinton Strong, among others — worked together on the establishment of a Sikorsky Helicopter Club. As time passed, the group agreed that the name was too limiting to attract the attention of the entire rotary-wing industry. Accordingly, they formed a committee to explore the possibilities of creating a formal, organized scientific society modeled, in some respects, after the Institute for Aeronautical Sciences (later the "American Institute for Astronautics and Aeronautics" or "AIAA"), the Society for Automotive Engineers (now "SAE"), the American Society for Mechanical Engineers ("ASME") and the London-based Royal Aeronautical Society. Michael A. "Tony" Paradiso, then a 22-year-old Sikorsky engineer, was tasked with drafting the initial constitution.

Accounts of the Society's early beginnings vary slightly. But Harry M. Lounsbury, in his article on the Society's origins, probably summarized it best in his succinctly titled, "The History of the American Helicopter Society, Inc." (Ref. 3) On February 25, 1943, Edward Katzenberger convened a meeting at the Stratford High School to discuss the organization, aims and objectives of the new society. In his role as President pro tem of the new entity, Katzenberger reaffirmed that the primary interest of the group should be the engineering aspects of the helicopter. Alex, Blackford, Katzenberger, Mayerson and Strong, with the support of Paradiso, began immediately final drafting what would soon become the Constitution (later "the Articles of Incorporation") of the American Helicopter Society, Inc. While the primary focus would be upon the scientific and engineering aspects of helicopter design, attention would be given to operational and maintenance aspects as well. The creation of the hummingbird logo was Chet Mayerson's elegant touch. (Ref. 4)

The original "Articles of Association" filed on June 21, 1943, by The American Helicopter Society, Incorporated in the State of Connecticut, Superior Court of Fairfield County, proclaimed its purposes: "to collect, compile, and disseminate information concerning the helicopter; to hold

meetings, lectures, and discussions to present, review and examine matters pertaining to the helicopter; to publish technical papers, journals and records, and to create and maintain a library of information pertaining to the helicopter; to conduct and finance a research program pertaining to the helicopter; and to foster an interest in helicopter flying clubs.” (Ref. 5) The Society hosted its first technical meeting on February 4, 1944.

The First AHS Honors Banquet (October 7, 1944); Major Awards

Soon after its organization, AHS leaders arranged an important event, often characterized as the “First National Banquet.” It was the Society’s first AHS Annual Dinner hosted at the Ambassador Hotel, Trianon Room, located at 51st Street and Park Avenue in New York City on October 7, 1944. In attendance were more than 170 industry luminaries and their spouses. Since the meeting occurred during the war years, many attendees appeared in military uniform. Seated prominently at the head table were Ralph Alex, Igor I. Sikorsky, Colonel H. Franklin Gregory, Professor Alexander Klemin, Charles L. Morris, Arthur Young, Frank A. Tichenor (“toastmaster”) and a number of Society leaders. Distinguished attendees included James A. Bennett, Raymond Coates, then-Captain William J. Kossler, USCG, W. Lawrence LePage, Eli L. Cohen, Chester D. Mayerson, Harold Lemont, Clinton S. Strong, Frank Piasecki, Arthur Young, Wayne Wiesner, Professor Alfred Gessow, Dimitry Viner, Ren Pierpont, George Townson, John Schneider, Ken West, Michael A. “Tony” Paradiso, and Ralph Lightfoot, among others. (Ref. 6)

During this seminal event, the American Helicopter Society announced the creation of the AHS Honorary Fellow Award, described in the original AHS Constitution as given “for meritorious service in the advancement of rotating wing aeronautics.” The first recipients were Igor I. Sikorsky, for his many contributions to the helicopter industry, and Colonel H. Franklin Gregory of the Army Air Corps, for his vision and support in recognizing the importance of helicopters in military applications. This marked the beginning of the Society’s continuing effort to recognize excellence in the field of helicopter design, support and operations. In later years, organizers incorporated the awards presentations into the Society’s Awards Banquet held during the AHS Annual Forum.

In 1951, the Society established an award “for notable achievement in the advancement of rotating wing aeronautics” given by Frank N. Piasecki. Its purpose was “to honor the memory of the late Dr. Alexander Klemin, eminent aeronautical engineer, educator, author, and outstanding pioneer in rotating-wing aeronautics.” Klemin held remarkable influence within the Society. In 1925, the very early days of vertical flight, he had authored a serious technical treatise, “An Introduction to the Helicopter,” NACA-TM-340, first presented in a 1924 meeting of the American Society of Mechanical Engineers in New York. In

addition to his service as AHS chairman, he had served as head of the Aeronautics Department at MIT and later dean of the Guggenheim School of Aeronautics at New York University’s College of Engineering. Not surprisingly, the Awards Committee named Igor I. Sikorsky as the first recipient of the Alexander Klemin Award. (Ref. 7)

Another major award, the distinguished Alexander A. Nikolsky Lectureship, was created in 1981. The award is given annually to an individual who has a highly distinguished career in vertical flight aircraft research and development and is skilled at communicating his or her technical knowledge and experience. Past winners of this award have included Wieslaw Z. Stepniewski, Alfred Gessow, Bartram Kelley, Dr. Robin Gray, Dr. Richard M. Carlson, William Bousman and Dr. Robert A. Ormiston. The Lectureship is named for Professor Alexander A. Nikolsky, part of Igor I. Sikorsky’s team that developed the VS-300 and later a researcher at Princeton University. (Go to www.vtol.org/nikolsky for a complete listing of winners and their lectures.)

AHS Annual Forums

In his “History of the American Helicopter Society, Inc.,” Harry Lounsbury reported that “with the basic necessities adequately organized, the members of the Society elected Ralph Alex of Sikorsky to be the first president. Other officers elected at this time were Donald Plumb, Vice-President; William Costuck, Secretary; Eli Cohen, Treasurer; and Igor Alexis (Prof.) Sikorsky (Igor I. Sikorsky’s first cousin and chief aerodynamicist), the first Technical Chairman (now referred to as the Technical Director). The first technical meeting of the new society was held in Bridgeport, CT, on February 4, 1944.”

He continued, “The first American Helicopter Society Forum was held at the Engineers Club in Philadelphia on April 3, 1945, under the chairmanship of Paul W. Thomas. The first meeting was scheduled for one day, and covered a wide range of subjects on which some 13 speakers presented their ideas to the gathering. This was the start of the annual Forums now held regularly by the Society”

Since 1945, the Society has hosted an Annual Forum each year. During the years 1946 through 1948, the Society continued to host its Annual Forum in Philadelphia. The Third Annual Forum (1948) is of particular note since it featured the Society’s first display of rotary-wing aircraft. Under the chairmanship of Louis Levitt, the Society hosted the exhibit at nearby Central Airport in Camden, New Jersey. Almost every helicopter type, including several of historical interest, was on display. Later, at the 9th AHS Annual Forum in May 1953, AHS formally instituted a trade exposition which gave helicopter manufacturers the opportunity to exhibit their products to the general public. Since then, the exposition has been a regular feature of all AHS Forums.

AHS members arranged for the Society's 5th Annual Forum to be held in New York City in 1949. The organizers then returned to Philadelphia in 1950. From 1951 until 1981, AHS hosted all of its Forums in Washington, D.C., often at the Mayflower Hotel or the Sheraton Washington Hotel (later the Sheraton Wardman Park Hotel, now the Washington Marriott Wardman Park Hotel). The format remained unchanged. Each continued a minimum of two to three days, featuring a general session, a number of technical sessions lasting at least two full days, and the Society's now-annual helicopter display. The annual displays or exhibits featured a single exception, 1952, when a gasoline strike restricted helicopter operations.

Prior to 1981, nearly all Forums were held either in Philadelphia, New York City, or Washington, D.C. However, during the five years from 1954 through 1958, the Society also hosted the "AHS Annual Western Forums." These were in addition to the annual events on the East Coast, and their purpose was to stimulate membership in the Western states.

AHS Western Forums

1954	Los Angeles, CA (Institute of Aeronautical Sciences Building)
1955	Hollywood, CA (Roosevelt Hotel)
1956	Dallas, TX (The Hotel Adolphus)
1957	St. Louis, MO (Hotel Statler)
1958	Los Angeles, CA (Hotel Ambassador)

Since 1981, the AHS has hosted a single Annual Forum, which has rotated between the East Coast — sites such as Washington, D.C.; Virginia Beach, Virginia; and Baltimore, Maryland — and the more western states — sites such as Dallas/Fort Worth, Texas; Anaheim, California; New Orleans, Louisiana; St. Louis, Missouri; and Phoenix, Arizona.

In May 1984, the Society, then led by former Executive Director John Zugschwert, celebrated its 40th anniversary attended by many of the Society's founders. The new Hyatt Crystal City, in nearby Arlington, Virginia, hosted Forum 40. Mayor ("for life") Marion Barry, Jr. of Washington, D.C. proclaimed May 14-19, 1984, "Helicopter Week." United States President Ronald Reagan signed a formal letter of congratulations. The National Air and Space Museum hosted a reception attended by members and aerospace leaders from government, industry and academia. The event was highlighted by a session in which Society founders and industry pioneers joined to describe their experiences in designing early rotorcraft. It was a week to remember, studded with multiple events celebrating the Society's accomplishments as well as an assessment of its future directions. (Ref. 8)

At Forum 52, June 4-6, 1996, AHS reaffirmed its commitment to "powered lift," hosting a centerpiece forum on the Joint Strike Fighter (JSF), specifically the Marine

Corps' Short Take-Off and Vertical Landing (STOVL) aircraft concept variants.

The event was successful beyond anyone's expectations, with senior requirements officers from the U.S. Navy, Air Force and Marine Corps participating. Competing for the JSF program were Lockheed Martin, The Boeing Company, and McDonnell Douglas Aircraft. The exhibit hall at the Sheraton Wardman Park Hotel was brimming with displays from every prime and supplier. Personnel from the JSF Program Office (including future AHS Executive Director, Mike Hirschberg) staffed the exhibits in the atrium to explain the fixed-wing vertical lift concepts. AHS programs and sessions, with standing room only, covered all aspects of powered lift, as well as rotorcraft.

In 1999, the Society held its first international Annual Forum (Forum 55) in Montréal, Canada (the home of Bell Helicopter Canada and Pratt & Whitney Canada). This choice of location emphasized that the Society was "international" in more than name only. Based on that success, the Forum returned to Montréal in 2002, 2008 and 2014.

In 2016, AHS will host its Forum 72 for the first time in West Palm Beach, Florida, near the site of Sikorsky's Development Flight Center (DFC) facility and Pratt & Whitney's test facility (including special test stands for the JSF propulsion systems, such as the unique F-35B shaft-driven Lift Fan).

The First AHS Headquarters; The First Executive Secretary (1950-1952)

During the early years, the Society had no central office. Its affairs were conducted by AHS officers living in different parts of the country. As membership increased year by year, so did the demands on AHS leadership. The need for a centrally located office and staff support became increasingly evident. In 1949, Dr. Alexander Klemin, then-president of the Society, approached the Institute of the Aeronautical Sciences in New York City with a proposal that the American Helicopter Society become an affiliate. Dr. Klemin, joined by Frank Piasecki who became AHS president the following year, finalized an agreement with the Institute. The arrangement proved highly beneficial, yielding for the first time in the Society's short history an office and a permanent address at the New York City offices of the Institute. (Ref. 9)

In September 1952, AHS officers, with the support of the Institute, appointed Harry M. Lounsbury as the Society's first full-time Executive Secretary. Essentially, the Executive Secretary (now the Executive Director) reports to the Executive Committee and is charged with the overall, day-to-day, management of Society affairs. Lounsbury, regarded as a thoughtful administrator and a consummate gentleman with a gift for prose, was to lead the AHS for the following 22 years.

AHS Forum 16 (May 11-14, 1960); The Presidential Visit

During the early history of the American Helicopter Society, no event was more memorable than the 16th AHS Annual Forum held during May 11-14, 1960, at the Sheraton Wardman Park Hotel in Washington. The guest of honor was Dwight D. Eisenhower, the 34th president of the United States. The President wished to honor his helicopter pilots at Marine Helicopter Experimental Squadron One (HMX-1), based at the U.S. Marine Corps Air Station, Quantico, Virginia. During the Honors Night program, HMX-1 received the Captain William J. Kossler Award, which was shared with the Executive Flight Detachment at Davidson U.S. Army Air Field at Fort Belvoir, Virginia. During his remarks, President Eisenhower thanked each of his Marine pilots and expressed his appreciation for the entire helicopter industry:

To the units that have been decorated this evening by your chairman, I owe a very great debt of gratitude. More than that, I owe my grateful thanks to the helicopter industry, to its presidents, its engineers, and the people that support and believe in it. (Ref. 10)

Lieutenant Colonel Victor A. Armstrong, HMX-1's Commanding Officer, and the presidential pilots must have been appreciative, as Charles Kaman read the Kossler citation, "given for the greatest achievement in practical application or operation of rotary wing aircraft, demonstrated by practical service during the preceding calendar year." Seated at the prestigious head table, along with President Eisenhower, was AHS president Ralph Alex, Forum Award Chairman Charles Kaman; David M. Shoup, Commandant of the U.S. Marine Corps; as well as the Vice Commandant, and the Secretaries of the Army, Navy and Air Force.

A nameless Sikorsky marketing officer, some speculate that it might have been Ralph Alex, was especially pleased, since located strategically on the hotel's front lawn for all to see was a full-scale mock-up of the Sikorsky S-61. In time, the S-61 would replace the Sikorsky S-55 as the "Presidential Helicopter" or "Marine One."

AHS Publications

A measure of the excitement accompanying the advent of the helicopter may be gleaned from a brief overview of the contents of the December 1955 AHS *News Letter*, which preceded *Vertiflite* as the Society's principal member publication. At the time, AHS membership dues were \$1.75, plus a \$5.00 initiation fee. The lead article covered the unveiling of Bell Helicopter's XH-40 mock-up, winner of the Army's Utility Helicopter Design Competition. It would be powered by the Lycoming XT-53, the first "free power" turbine designed for helicopter and Army use. The XH-40

was the prototype to the Bell UH-1 of Vietnam fame, one of the most successful helicopters ever designed.

Next, appeared a report on the Piasecki Helicopter Corporation YH-16A Turbo Transporter, a response to a military request for a 5-7 ton capacity cargo or troop carrying helicopter. First displayed to the public at the Philadelphia International Airport on December 6, 1955, the tandem rotor aircraft, powered by two Allison YT-38 turboshafts, was capable of lifting 16 tons with a top speed of 150 mph. At the time, it was the world's largest turbine-powered transport helicopter, with a 77.5 foot fuselage (capable of carrying three Jeeps or 40 fully-equipped troops) and rotor blades 82 feet long. Viewers were incredulous that the rotorcraft industry was capable of designing such a large machine.

A letter to the editor from Major John F. Miller, USAF, described "Operation Tampico," a flood rescue operation performed by USAF H-21As from Edward Garry Air Force Base, San Marcos, Texas. During the period September 20-28, 1955, the aircraft flew 51 missions, transporting 62,200 lbs of food and medical supplies (and medical teams) to 1,100 different locations. Another article in the 1955 *News Letter* announced a long distance record for British-built helicopters, established by a pair of Westland S-55s, which had flown a distance of 3,300 miles from England to the Persian Gulf.

Upon the arrival of the 1960s, the Society's regular publications now included the *Journal of the American Helicopter Society*, a quarterly journal featuring peer-reviewed technical papers; the *Proceedings* of the AHS Annual Forums, and the *AHS Newsletter* (formerly the *News Letter*). In 1963, the *Newsletter* was renamed *Vertiflite*, becoming the Society's official member magazine. During much of the 1980s and 1990s, AHS published *Membergram*, a newsletter on member developments. Historically, the *AHS Forum Proceedings* were published only in paper format, but that was to change for Forum 54 in 1998 with the first proceedings CD-ROM produced by Mira, Inc. In 2007, when the page count regularly exceeded 2,000 per issue and each year was a multi-volume set, AHS ceased publishing the printed proceedings for the events, though they are available through Curran Associates. Today, the proceedings are available in CD-ROM or electronically via the AHS website, including nearly every paper since 1947.

Since 1993, *Vertiflite's* format has changed significantly. Every issue is now four-color, saddle-stitch or perfect bound, and since May 1993 they have been typeset by graphic artist *par excellence* Kay Brackins, the current AHS Deputy Executive Director. In addition to the *Editors' Note* and *Commentary*, longtime regular features, the magazine has also hosted *Industry Briefs*, *AHS Update*, *Not for Members Only* (originated by Kaydon A. Stanzione, AHS Membership Chairman), *Out of the Past – Progress* (by John Schneider, until 2002), *Profile of an AHS Member*, and *Letter from Europe* (authored by Elfan ap Rees). For many

years, *Vertiflite* offered an article on helicopter technology by Raymond W. “Ray” Prouty, a recipient of the Society’s 2000 Dr. Alexander Klemin Award. Nearly all issues feature one or more articles on new military airframes, systems and technology by award-winning journalist Frank Colucci.

For many years *Vertiflite* featured highly entertaining accounts by Frank McGuire (editor of the famous “Orange Sheet,” aka *Helicopter News*) on the AHS Forum, helicopter history and recent developments. The *Directory*, of course, would not be the *AHS Annual Directory* without Forecast International’s thoughtful prognostications on future civil and military helicopter markets. Among the most well-read articles, and most commented upon, was Brenda Forman’s thought-provoking “What Killed the Cheyenne?” (Ref. 11) Another popular piece was David Lawrence’s, “Whatever Happened to Helicopter Airlines.” (Ref. 12) The most anticipated regular feature was Kim Smith’s *The Good, the Bad, and the Ugly*.

AHS Leadership Structure

From its beginnings, the Society had been managed by an elected President, an Executive Committee, which includes the President, the Secretary-Treasurer, the Technical Director, and the Executive Secretary (now the Executive Director, a non-voting member). Today, the Board of Directors, led by the Executive Committee, includes vice-presidents and directors representing each region, the AHS Membership Director, and up to three directors-at-large, all appointed by the AHS President. Effective in 1960, the Society added a new senior executive (and member of the Executive Committee), the “Chairman of the Board of Directors.” It was none other than Ralph P. Alex, the Society’s first and fifteenth president. With the exception of the appointed directors, board members are elected by ballot of the membership on an annual basis. The terms of office for the regional representatives are two years; by tradition, the members of the Executive Committee serve in each ascending office (secretary-treasurer, president, chair) for a single year.

Since AHS is, by definition, “a professional, technical society,” among the most important officers of the Society is its Technical Director, who during his or her two-year term, directs all of the technical activities of the Society through the Technical Council. The Council members include the Deputy Technical Directors who represent the Technical Committees. Typically, the Technical Director appoints a Forum Chair, who, with support from the various technical committee chairmen, prepares the Forum schedule, helps to ensure the quality of the presentations, and oversees the publication of technical papers in the *Forum Proceedings*. The Forum Chair is assisted by a Deputy Forum Chair. The technical committees centered initially on rotorcraft-unique disciplines, such as aerodynamics, dynamics, aircraft design, structures and materials, propulsion, crew stations and handling qualities, and test and evaluation.

In time, as the industry matured, the committees grew to encompass entirely new fields, such as acoustics (formerly an ad-hoc subcommittee of aerodynamics), avionics and systems, HUMS, product support, manufacturing and product assurance, civil operations, and history. Igor Alexis “Prof.” Sikorsky was the Society’s first Technical Director; there have been more than 40 distinguished technical directors through the years.

AHS Membership Growth

As of the early 1950s, the Society’s membership had grown to 1,500 people, divided into five or more geographical regions covering the continental United States. The regions were centered among notable hubs of rotary-wing research and development, including the Army Aviation Material Labs or AVLABS at Fort Eustis, Virginia, and NACA Langley in Hampton, Virginia; Los Angeles, California (the former home of Hughes Helicopters); San Francisco, California and the Bay Area (this chapter, founded later in 1973, was home to NASA Ames and the Army AVLABS (later the Aeroflightdynamics Directorate)); Stratford, Connecticut (Sikorsky Aircraft; Kaman Aircraft); Philadelphia, Pennsylvania (Piasecki Aircraft; The Boeing Company); Dayton, Ohio (Army/USAF aviation laboratories); Fort Worth, Texas (the home of Bell Helicopter Textron); St. Louis, Missouri (the previous home of McDonnell Douglas Corporation and the Army Aviation Systems Command); and Fort Rucker, Alabama.

AHS membership grew as interest in rotorcraft design and applications expanded. According to reports appearing in the bi-monthly AHS publication *Membergram*, when AHS moved in 1975 from its New York base of operations to Washington, D.C., membership increased from 2,000 in 1975 to 3,348 in 1979. By July 1, 1981, membership exceeded 4,113 and by the same date in 1983 (Forum 39, St. Louis, Missouri) membership stood at 5,635. By February 1984, membership stood at 6,000; a year later, January 1985, it rose to 6,634. To keep up with the growing membership base, AHS in October 1983 purchased a state-of-the-art CADO 20/28 System Computer with a whopping 256 kilobytes of memory. (Information technology professionals will immediately note that highly affordable “smart phones” available at local distributors offer 16 Gigabytes or more.) Introduction of the CADO System Computer represented “advanced technology,” though it had only a single work station, and filled an entire downstairs office at the Society’s new headquarters in Old Town, Alexandria, Virginia.

In subsequent years, the regions expanded, and in some cases, subdivided, as AHS matured. The rationale supporting the creation of the regions was the notion that the centers would localize and stimulate interest in the Society’s activities, allowing members to meet regularly to discuss technical advances and facilitate social events throughout the year. AHS membership had now grown to include engineers and scientists, manufacturing executives representing rotorcraft primes, engine makers, and a growing base of

industry suppliers, military and civilian operators (and pilots) and rotorcraft maintainers. AHS created special categories of memberships, including corporate and educational members, each with varying privileges and dues structures.

Most of the Society's members resided in the continental United States, but many were executives and engineers based in other countries. These included Australia, Bolivia, Brazil, Canada, Chile, Colombia, England, France, Germany, Guatemala, Holland, Ireland, Japan, Mexico, New Zealand, Switzerland, Sweden and Venezuela. In years to come, the Society's international activities would expand, with local AHS Chapters based in Montréal/Ottawa, Canada; Japan; Germany; Singapore; Poland; Australia; India; and the Peoples' Republic of China.

To accommodate these changes, the Society's programs became increasingly diverse geographically. During November 6-8, 1985, the Nanjing Aerospace Institute, assisted by AHS's John Zugschwert, hosted a conference on rotorcraft billed as the "AHS/Nanjing Aeronautical Institute Seminar." AHS established an AHS Singapore Chapter, which held major regional meetings in 1990, 1992 and 1994 (billed as the "Asian Vertiflite Seminar") in association with the Singapore Airshow, led by chapter founder Robin Viva Thevathansan and conference organizer Lim Serh Ghee. In 1992, AHS, chaired by President Edward J. Renouard of Boeing, signed a "Heads of Agreement" with leaders of the Royal Aeronautical Society in London, leading to jointly hosted events, typically at 4 Hamilton Place, London, the RAeS headquarters. Among them was the "International Powered Lift Conference" hosted in September 1998. In 1993, AHS hosted "The Vertiflite Rotorcraft Seminar" in association with the organizers of the Paris Air Show.

Beginning in 1998, a very active AHS Japan Chapter, led by President Motoi Yoshiwaka (a 1999 AHS Honorary Fellow), hosted periodic regional conferences known as Heli-Japan 1998 ("Advanced Rotorcraft Technology and Disaster Relief,") Heli-Japan 2002, Heli-Japan 2006 (attended by more than 600 individuals), and Heli-Japan 2010. The focus of the 2002 and 2006 events was "Rotorcraft Technology and Life Saving Activity;" the 2010 focus was on "Helicopter Safety." Major manufacturers such as Kawasaki Heavy Industries, Mitsubishi Industries, Fuji Heavy Industries and others alternated in hosting the events.

Student Membership/Chapters; The Vertical Flight Foundation (1967)

Over the years, the Society has attracted student members who are offered AHS membership on a discounted basis. From 1982 to 1985, the number had increased from 324 to 748, according to SCIDS, the AHS student newsletter.

With the growth in membership came AHS student chapters located at academic institutions with a focus on rotorcraft aeronautics. (Ref. 13) The first of these, recognized in 1960,

was located at Parks College of Aeronautical Technology in East St. Louis, Illinois. Today the Society has 18 student chapters. These include: Arizona State University (Tempe, Arizona); California Polytechnic State University (San Luis Obispo, California); Carleton University (Ottawa, Canada); the Georgia Institute of Technology (Atlanta, Georgia); India Institute of Sciences (Bangalore, India); IIT Kanpur (Kanpur, India); Iowa State University (Ames, Iowa); McGill University (Montréal, Canada); Nanjing University of Aeronautics and Astronautics (Nanjing, China); Pennsylvania State University (University Park, Pennsylvania); Rensselaer Polytechnic Institute (Troy, New York); University of Alabama in Huntsville (Huntsville, Alabama); University of Maryland (College Park, Maryland); University of Michigan (Ann Arbor, Michigan); University of Texas (Austin, Texas); US Naval Academy (Annapolis, Maryland); Washington State University of St. Louis (St. Louis, Missouri); and Widener University (Chester, Pennsylvania). AHS supports its student members by offering information on career and internship opportunities, scholarship availability, student educational competitions, complimentary Forum student volunteer programs, and informative chapter presentations.

In 1967 AHS created the Vertical Flight Foundation, Inc. — an IRS-recognized 501(c)(3) educational, charitable organization, as the philanthropic arm of the Society. (Ref. 13) The initiative fell to Alfred L. Wolf, a Philadelphia attorney, AHS Counsel and member of the AHS Board of Directors. He was recognized as an AHS Honorary Fellow in 1977. The VFF remains, today, the only such foundation that makes scholarships available exclusively to students pursuing degrees in vertical flight. By 1984, the Society offered eight scholarships annually, each with a value of \$2,500. Initial lifetime trustees included Alfred L. Wolf; Charles E. Lord, senior vice president and president-elect of the Hartford National Bank and Trust Company (later succeeded by Godfrey A. Rockefeller, then director of the Chesapeake and Potomac Airways); and Richard C. DuPont, a noted pilot and fixed-base operator of Summit Aviation, Inc. In 1996, Sergei Sikorsky, the son of Igor Sikorsky, became a lifetime trustee. The VFF endowment has grown steadily, and in December 2014 received a grant of \$200,000 from Bell Helicopter Textron. The VFF has awarded more than 460 scholarships, 22 in 2015 alone, with a value in 2015 exceeding \$68,000.

Change of AHS Headquarters; Successive AHS Executive Directors

Throughout its 72-year existence, AHS has enjoyed several homes. During the 1940s, the Society's base was the work address of whoever was the Society president at the time. However, beginning in 1950, the Society moved to the offices of the Institute for Aeronautical Sciences — 2 East 64th Street, New York, New York. The appointment of Harry M. Lounsbury as Executive Secretary was announced shortly thereafter. Subsequently, in 1962, the Society moved to new offices at 141 E. 44th Street, New York, New York.

After residing for more than 25 years in New York City, the Society, after a short stay at Hughes Helicopters in Washington, D.C., moved in September 1975 to new offices located in a modest one bedroom condominium at 1325 18th Street, N.W., Suite 103, Washington, D.C., near DuPont Circle. Former *Vertiflite* editor Kim Smith (1976-1978) recalls that severe space limitations required the Society to house its entire library in the bathtub. Immediately following the successful move to Washington, Harry Lounsbury retired as Executive Secretary. In recognition of his more than 22 years of service, he was made an AHS Honorary Fellow in 1976.

Lounsbury was followed by Jack A. Islin, who assumed leadership responsibilities for a two year period from 1975 to 1976. The new Executive Secretary stabilized the Washington operation and increased AHS membership by 20% during his tenure. In October 1976, Islin departed AHS for a management position at Sikorsky's West Palm Beach Facility. After a brief executive search, Lynn Kesten (1976-1981), a professional experienced in association management through her parent's organization, Army Aviation Association of America (Quad A), settled into the 18th Street, Washington, D.C. headquarters as the Executive Secretary where she led the Society's affairs for five years. Her many accomplishments included further stabilizing the Society's presence in Washington, hiring capable staff members and computerizing the Society's complex membership records.

Upon Kesten's departure, Colonel John F. Zugschwert, a retired Army officer and aviator with extensive connections and experience in military helicopter research and development, became the new Executive Director (1981-1991). One of his first acts was the purchase of a new, more spacious, headquarters, at 217 North Washington Street, Alexandria, Virginia.

Zugschwert's selection of a location in Old Town was inspired. Located on a major thoroughfare, near many other association headquarters, just minutes away from National Airport and the regional metro system, one could easily reach the National Aeronautics and Space Administration (NASA), the Department of Transportation (DOT), the Federal Aviation Administration (FAA) and the Transportation Research Board (TRB). Major associations, including the Aerospace Industries Association (AIA), AIAA and ASME, and the local offices of Boeing, Textron, Lockheed Martin, General Electric and United Technologies were close by. Another important factor, which was to play a vital role during the 1990s, was that the new headquarters was just a short drive from the U.S. Congress, NASA headquarters and the Pentagon.

With Zugschwert's departure in September 1991 for a new position in the Washington, D.C. offices of Bell Helicopter Textron, M.E. Rhett Flater, a Marine Corps aviator with combat experience in Vietnam, a former practicing attorney, and founder of a scheduled helicopter airline in Boston,

Massachusetts, assumed duties as Executive Director. Soon joined by Kim Smith, an award-winning professional journalist, the former Washington editor of *Rotor & Wing* magazine and one-time *Vertiflite* editor (1978-1979), she became the AHS Deputy Director in 1994. Flater, assisted by Smith, would remain at the AHS as Executive Director for the next 20 years.

Upon Flater's retirement on May 31, 2011, Michael J. Hirschberg, an aerospace engineer associated with the Defense Advanced Research Projects Agency (DARPA), became the new society leader. Hirschberg had a more than passing knowledge of AHS since he had served as the managing editor of *Vertiflite* magazine from 1999 under Kim Smith. Kim Smith, after a cumulative 21 years of service, departed the Society effective December 31, 2011. Three years later, in 2014 and with AHS Board approval, the Society sold its Alexandria headquarters (its mortgage indebtedness had been paid off years earlier) and moved to leased offices near the Washington beltway at 2701 Prosperity Avenue, Suite 210, in Fairfax, Virginia.

Hirschberg's major efforts in his first years were largely focused upon improving the Society's Internet presence, digitizing the AHS publications library, building international membership, and expanding *Vertiflite*, the principal communications tool for AHS members.

AHS Executive Secretaries/Directors

Harry M. Lounsbury New York, NY	1952-1975
Jack A. Islin Washington, D.C.	1975-1976
Lynn Kesten Washington, D.C.	1976-1981
COL John F. Zugschwert, USA (Ret.) Alexandria, VA	1981-1991
M.E. Rhett Flater Alexandria, VA	1991-2011
Michael J. Hirschberg Alexandria, VA; Fairfax, VA	2011-present

POST WORLD WAR II DEVELOPMENTS; HELICOPTER MILITARY APPLICATIONS

Post-World War II developments would exert an immense influence upon the world helicopter industry. Among the most important were the growth of interest in helicopter military applications and, eventually, disputes over inter-service "roles and missions," particularly as they related to "organic aviation," rotorcraft, and the "close air support" mission.

Beginning during World War II and continuing through the Korean War and beyond, the U.S. military funded modest sums for rotorcraft research and development. Interest in membership in the American Helicopter Society, now universally regarded as the world's leading professional technical society for the advancement of rotorcraft, grew quickly.

Initially, the military's primary goals were to improve helicopter range, speed and payload. But, over time, the military service branches and commercial operators broadened their focus to include other areas, such as avionics and systems, manufacturing, affordability, reliability, and maintainability. The lesson was not lost on the American Helicopter Society, which periodically extended its circle of technical committees to embrace new disciplines.

During World War II, the Army — at the urging of Colonel Frank Gregory — funded the purchase of several Sikorsky R-4s — a larger, much improved, closed cabin version of the Sikorsky VS-300. On May 17, 1942, test pilot Les Morris, accompanied by Igor Sikorsky, delivered the first aircraft to the Army at the Wright Field in Dayton, Ohio. They logged 16 flight hours during the five-day journey from Stratford. The Army was pleased, and its orders kept coming. More than 400 helicopters would roll off of Sikorsky's assembly lines by the war's end. (Ref. 14)

Though the first helicopters were viewed as flimsy and often unreliable, they quickly gained a reputation for lifesaving. The first helicopter rescue was conducted by U.S. Coast Guard Commander Franklin A. Erickson on January 3, 1944. Erickson flew blood plasma under deteriorating weather conditions to the survivors of the USS Turner, a destroyer that had sunk following an explosion off Sandy Hook, New Jersey. (Ref. 15) Erickson later founded the 1st Coast Guard Helicopter Detachment, based near Elizabeth City, North Carolina, where he trained Coast Guard airmen in rescue practices using helicopters.

In the closing months of the war in the Pacific, the jungles of Southeast Asia provided a rigorous testing ground for the newly operational Sikorsky R-4 as a rescue vehicle. In April 1944, engine trouble forced down a single-engine L-1 Vigilant with its American pilot, Captain James Green of the U.S. Tenth Air Force, and three Englishmen. Lieutenant Carter Harman, a part of the 1st Aviation Commando Group piloting a YR-4, flew from his base in India to a small outpost behind Japanese lines in Burma to attempt a rescue on April 25-26, 1944. There American forces were supporting British raiders working to reopen the Burma Road, a vital supply link for the allies. The crash site was hilly and thickly forested. A small detachment of Tenth Air Force volunteers cleared a small landing area on a nearby hilltop. When the area was ready, Harman maneuvered his YR-4 to the site and extracted the passengers and the injured pilot, one-by-one, delivering them to a hospital at nearby Shinbwiyang Air Field. (Ref. 16)

This demonstration was soon followed by a notable civil rescue on November 29, 1945. A drifting barge lay stricken on the Long Island Sound, just off the Connecticut coast. High winds kept rescue vessels from the site; powerful waves threatened to sink the barge with its two crew members. Piloting a Sikorsky R-5 helicopter, Sikorsky test pilot Dimitri D. "Jimmy" Viner, with the assistance of Army Captain Jackson E. Beighle, maneuvered over the barge while Beighle lowered a hoist winch. When the winch jammed, Viner returned to land with the man dangling from the hoist and set him gently on the ground. He then did so again to rescue the second crewman. The helicopter rescue mission captured headlines throughout the U.S. media. (Ref. 17)

Post-World War II U.S. Helicopter Industry Developments

During this period, several prominent helicopter designers redoubled their efforts. By 1943, Frank Piasecki and his PV Forum had perfected a tandem rotor concept for a heavy lift transport helicopter. Designated the PV-3, Piasecki's new design made its first flight in March 1943. Within months, with contracts from the Navy, Marines and U.S. Coast Guard in hand, he was making deliveries to all three services.

That same year, Arthur M. Young, a graduate of Princeton University, assisted by Bartram Kelley, a Harvard graduate with a degree in physics, teamed to design a new machine capable of vertical flight. Together they convinced Lawrence Bell of Bell Aircraft Corporation of Buffalo, New York, to sponsor the development of the Bell 30. The aircraft made its first flight in June 1943. The Bell 30, later designated the Bell 47, became the first helicopter to win Civil Aeronautics Administration approval, on March 8, 1946, for civil use. Before it ended production in 1974, Bell was to produce more than 5,800 Bell 47 aircraft. (Ref. 18)

In the late 1940s, Charles Kaman, then head-aerodynamicist at the Hamilton-Standard Propellers Division of United Aircraft, began efforts to design a helicopter. His approach was, essentially, an adaptation of the intermeshing rotor principle employed with great success by the German engineer Anton Flettner in his *Kolibri*. After being turned down by his employer, Kaman set up a factory in a former gymnasium near Hartford, Connecticut. His prototype won accolades and soon earned production contracts from the Navy, Air Force and Marines.

Another helicopter enthusiast, Stanley Hiller, a California-based college dropout, was just 19 when he built and flew a coaxial helicopter at Memorial Stadium, University of California (Berkeley), in 1944. He later perfected a tail-rotor approach, much like the VS-300, and designed a single main rotor helicopter with similarities to the Bell 47. By 1948, the small though agile Hiller 360 had been certified by the Civil Aviation Authority (CAA). Orders flowed in and the

youthful engineering mogul was soon flooded with business from military, civilian and international customers.

By 1947, more than 70 companies, many of whose executives and engineers became members of the American Helicopter Society, were at work developing helicopters and helicopter assemblies. Government agencies were deluged with requests to set up short-haul helicopter passenger services in New York City, Los Angeles, Chicago, Miami, and Washington, D.C. Even the Belgian airline Sabena announced plans to launch service connecting Brussels, the Netherlands and France.

The phenomena known as demobilization combined with deep cuts to the military budget — what politicians regard as a “peace dividend” — inevitably follow a war. With World War II ended, America’s attention soon shifted to peacetime pursuits. Congress curtailed funding for the armed forces, including the Army, Navy and Marine Corps, and their equipment. The nation refocused upon the country’s long-neglected infrastructure — the production of automobiles, commercial airplanes, cargo ships and consumer goods. Investment in military-related science and technology dropped precipitously, including spending for helicopter development. It was a difficult period for the American helicopter industry.

Despite the helicopter’s value demonstrated during World War II, the military service branches still regarded the aircraft as a curiosity. The Army, with some success, had employed helicopters during the war for reconnaissance, observation and medical evacuation. But it also considered them as too primitive, fragile and unreliable for tactical development. However, The United States Marine Corps, had taken careful note of the emerging military applications for rotorcraft, particularly its potential role in “amphibious assault.”

The Marine Corps Defines “Vertical Envelopment”

As the Assistant Director of the Senior School of the Marine Corps in Quantico, Lieutenant Colonel (later Lieutenant General) Victor H. Krulak was fascinated by the potential role of the helicopter as an instrument of war and he instructed regularly at the Marine Amphibious School. Driven by curiosity, he went straight to the source, and in 1946 he invited Igor Sikorsky to Quantico. Based on those discussions and his experience in military doctrine, Krulak recommended that the Marine Corps establish an experimental helicopter squadron. Initially, the idea was viewed as “novel” and put on the shelf.

A short time later, Lieutenant Colonel (later Major General) Marion E. Carl, USMC, a World War II ace and now a test pilot, flew a Sikorsky helicopter, possibly an S-51 or HO3S-1, to Quantico for demonstration purposes. Carl called ahead to Krulak. “Would you like a lift?” he asked. Krulak agreed, arriving at the parade deck in mid-morning just as Carl had instructed. Carl directed Krulak to put a canvas sling over

his head and under his arms. The helicopter rose 20 feet, then hovered up and down the field with Krulak suspended in the harness below. The young student officers watched in amazement. Edward C. Dyer and Merrill “Bill” Twining, both lieutenant colonels participating in a Marine Corps board studying possible helicopter applications, watched through the window of their office.

Within weeks, Dyer and Krulak had written the first textbook for Marine helicopter pilots and war planners. These efforts were driven in part by Krulak’s belief that doctrine should drive, not follow, the development of the helicopter, though customary doctrine had it the other way around. By early 1947, Krulak and Dyer had produced a document titled, “Amphibious Operations — Employment of Helicopters (Tentative).” The Marine Corps leadership soon directed that a revised version of the document be used in all future Marine Corps classes on how to employ the helicopter in combat. (Ref. 19)

A close friend and associate of Krulak’s, Lieutenant Colonel Robert E. Hogaboom, submitted a report dated March 10, 1947, “Military Requirements for Ship to Shore Movement of Troops and Cargo.” The report, given wide circulation, stated that the Marine Corps should acquire initially an assault helicopter that could carry a 5,000 lb. payload, and would have a 200-300 nautical mile range, 100 knot cruising speed and a 4,000 foot ceiling at which it could maintain hovering flight. The now-famous “Hogaboom Report” also called for self-sealing fuel tanks, an external hook and hoist, and the ability to operate from an aircraft carrier.

Hogaboom’s and Krulak’s recommendations on military helicopter applications, supported by the USMC Commandant, General Lemuel C. Shepherd, and Colonel Twining resonated within the service. On December 1, 1947, the Marine Corps established Marine Helicopter Squadron One (HMX-1). (Ref. 20) Colonel Dyer was appointed as its first commanding officer. Its members and staff began perfecting techniques for the use of helicopters in amphibious operations. Months later, HMX-1 received its first five helicopters from Sikorsky and actual training for air assaults began. Based on the operational techniques developed by HMX-1, the Marine Corps in January 1951 commissioned HMR-161. It was the world’s first helicopter transport squadron.

Inter-Service Disputes on Roles and Missions

During the immediate post-war years, the Army launched efforts to restructure the American military service branches. It circulated a series of documents which became known as the “Army Unification Plan,” sometimes referred to as the JCS (Joint Chiefs of Staff) 1478 Papers, which found their way to the Military Affairs Committee of the United States Senate. The plan was supported by Army Chief of Staff General George C. Marshall, General Dwight D. Eisenhower, and General Carl Spaatz, commander of the Army Air Forces. President Harry Truman, a former

member of the Senate committee, endorsed it. In the papers, Eisenhower recommended that the Marine Corps be limited to 50,000 men; Spaatz viewed Marine amphibious landings as “patently an incursion” into the roles of the Army and the Army Air Forces; neither Eisenhower nor Spaatz saw any use for Marine Corps aviation, which should be absorbed into the proposed new Air Force. (Ref. 21)

The responsibility to defend and preserve the Marine Corps fell to Marine Corps Commandant General Alexander A. Vandergrift, the hero of the “Solomon Islands Campaign” and a Congressional Medal of Honor recipient. On May 10, 1946, accompanied by Colonel Merrill “Bill” Twining and Lieutenant Colonel Victor Krulak, Vandergrift traveled to Capitol Hill. In his testimony, largely prepared by Twining and Krulak, Vandergrift gave his famous “bended knee” speech:

The Marine Corps thus believes it has earned this right – to have its future decided by the legislative body which created it – nothing more The bended knee is not the tradition of our Corps. If the Marine as a fighting man has not made a case for himself after 170 years, he must go. But I think you will agree with me that he has earned the right to depart with dignity and honor, not by subjugation to the status of uselessness and servility planned for him by the War Department. (Ref. 22)

Over the next few days, the Army plan would be ridiculed by the media, which recalled the Marine’s exceptional exploits at Belleau Wood, France, during World War I and, during World War II, at Guadalcanal, Bougainville, Saipan, Iwo Jima, Okinawa and elsewhere during “the Pacific War.” House and Senate leaders were incensed, announcing that the proposal would not pass if it meant stripping the Marine Corps of its historic functions.

Congress passed Public Law 416, the “Douglas-Mansfield Act,” on June 28, 1952, thus preserving the Marine Corps against future reorganization efforts. The legislation amended the National Security Act of 1947 to state that the Marine Corps would never be smaller than three active duty divisions and three active duty air wings, and the necessary support services. (Ref. 23)

The Key West Accords (March 1948)

However, in the post-war world beyond Washington, D.C., the Army, Navy and Air Force (now a separate military service) continued to engage in disputes regarding service roles and missions. The debate would impact budgets, manpower levels, as well as equipment issues. To resolve these problems and to carve out the new Department of Defense, the Secretary of Defense, James Forrestal, summoned the Joint Chiefs of Staff to Key West, Florida, for discussions in March 1948.

The meeting was of critical importance, since funds were tight and the outcome would impact the budgets for each branch of the military. Of all the service branches, the Marine Corps was not invited; it would have no voice in what became known as the “Key West Agreement.” (Ref. 24) It was signed by the President on April 1, 1948. And, while the Accords spelled out key mission differences among the service branches, the effort fell short. Neither the roles of “close air support” nor helicopter aviation were sufficiently defined. The Army was allowed only “organic air assistance in ground combat” within a narrowly defined combat zone. A supplemental understanding, the Bradley-Vandenberg Agreement, signed May 20, 1949, restricted Army helicopters to an empty weight of 4,000 lbs. Later, Secretary of Defense Charles E. Wilson, in a memorandum, “Clarification of Roles and Missions to Improve Efficiency of the Department of Defense, November 26, 1956,” increased the Army’s helicopter empty weight restriction to 20,000 lbs. The close air support mission was not further clarified, however.

The election of Dwight D. Eisenhower as United States president in 1953 led to historical changes to the defense establishment. Eisenhower issued his (Defense) Reorganization Plan No. 6, which included adding the Marine Corps Commandant to the Joint Chiefs of Staff, validating the Defense Secretary as head of the Department of Defense, and clarifying the chain of command. The order, with some modifications, was subsequently reissued as Department of Defense Directive (DoDD) 5100.01. Still, the military services, particularly the Air Force and the Army, continued to dispute the meaning of organic roles and missions.

Helicopters in the Korean War

Events far from U.S. shores would soon have a major impact on the helicopter community. On June 25, 1950, North Korean troops pushed across the 38th Parallel, then the dividing line between the Communist People’s Republic of Korea and the Republic of Korea to the south. United Nations Security Council Resolution 83 declared that North Korea was the aggressor. Supporting its right of self-defense, the South Korean army was joined by the military forces of the United States and 14 other nations. The allies moved swiftly. Led by General Douglas MacArthur, the Army checked the North Korean advance at the port city of Pusan. Several Army helicopters — mostly Sikorsky S-51s — were successfully deployed throughout the operation to transport injured soldiers from front lines to hospitals. (Ref. 25)

Months later, in December 1950, the Army deployed an entirely new concept — Mobile Army Surgical Hospitals (MASH), using modified Bell 47 helicopters — to transport wounded soldiers to MASH units located near the front lines. (Ref. 26) Compared to ground transport across mountains, hills and valleys, in the face of rain, snow and storms, Army pilots could deliver wounded servicemen to

MASH units in an hour or less. Soldiers quickly learned that their lives depended upon the availability of the small helicopters.

On September 13, 1951, the Marines launched Operation Windmill I using seven helicopters, the Marine's version of the Sikorsky S-55 (the Army H-19 Chicasaw). The aircraft transported men and materiel into battle on Korea's rugged mountains and razorback ridges, an area known as the "Punchbowl." It was the first recorded use of helicopters in aerial assault. By the close of 1951, the Marine helicopters were lifting 2,000 men and 75 tons of materiel to the front lines every month. (Ref. 27)

Throughout the Korean War, the Army, Navy and Marine Corps, and the Air Force employed helicopters in an expanding array of missions. The Navy's HU-1 Detachments, the Air Force 3rd Rescue Squadron, the Army's MASH Units including the 2nd, 3rd and 4th Helicopter Detachments performed aerial reconnaissance, observation and medical evacuation. Marine Corps squadron HMR-161 (flying the HRS) and VMO-6 (flying Sikorsky HO3-S1s) supported troop inserts, resupply, reconnaissance and medical evacuation. The helicopter's successes in Korea, however, were not always viewed as decisive. Many older hands still regarded the machine as too limited. Within a few years, though, the issue would be settled beyond any doubt, in a distant conflict which became known as the Vietnam War.

A major improvement in engine technology would soon change how many within the military regarded the helicopter. The advent of lightweight turboshaft engines — capable of sustained high power output — proved to be a critical factor, ultimately leading to larger, faster and higher performance helicopters. The turbine engine had several advantages over reciprocating (piston) engines: high reliability, increased performance, small size and light weight, less vibration, and ease of operation. The French engine firm, Turbomeca, designed the first true turboshaft engine for helicopters (a later version, the Artouste, powered the popular Sud Aviation Alouette II); but the Kaman K-225 on December 11, 1951, was the first turboshaft-powered helicopter to fly. By the mid-1960s, nearly all military and most civil helicopters would be powered by turbine engines. (Ref. 28)

Vietnam — "The Helicopter War"

One of the principal doctrinal developments of the Vietnam War was the U.S. Army's employment for the first time in history of helicopters as the primary method of maneuver. Helicopters supplanted foot and road vehicle mobility for large combined arms formations. The Marines may have been the original pioneers of airmobility, or "vertical envelopment" as they referred to it, but as we shall see airmobility doctrine was perfected by the Army.

Army Air Assault Doctrine — 1st Air Cavalry Division (Airmobile)

During the years immediately following the Korean War, the U.S. Army began in earnest to develop a doctrine for use of helicopters in "air assault." On February 1, 1955, the Army established the U.S. Army Aviation Center and School at Fort Rucker, commanded by Brigadier General Carl I. Hutton. At the same time, the Army established the Army Aviation Staff Division in the Pentagon, headed by Major General Hamilton H. Howze. The first embodiment of the air assault concept was the 11th Air Assault Division (Provision), later the 1st Air Cavalry Division (Airmobile), essentially an Army division radically restructured to achieve air mobility. Conceived during the early 1960s, the 16,000 man-division had 470 aircraft — five-times the usual number of helicopters. Its aircraft component included the Army's first four Sikorsky CH-54 Skycranes, dozens of CH-47 Chinooks, and scores of Bell UH-1 Hueys. Its 1,500 ground vehicles, all sized for helicopter transport, were half the number employed by a regular division; much of its heavy artillery was discarded since armed Hueys and, later, Huey Cobras, would perform elements of that mission. On March 1, 1966, the 1st Aviation Brigade, with 11,000 officers and men and 850 aircraft, became the first aviation brigade in Army history. The 43 companies of the Brigade were located from Hue in the North to Soc Tran in the South. (Ref. 29)

President John F. Kennedy, who deeply appreciated the need for U.S. armed forces to develop skills in counterinsurgency warfare, believed with some justification that communist doctrine would proceed under the guise of "wars of national liberation." He soon acted on this. In November 1963, Kennedy authorized an increase in the Military Assistance Advisory Group (MAAG) — Vietnam from 3,205 men to 16,300. MAAG-Vietnam became the "U.S. Military Assistance Command Vietnam." MACV would serve as a high-level advisor to the government of the Republic of Vietnam.

"Operation Starlight" (August 1965)

On March 8, 1965, elements of the 9th Marine Expeditionary Force landed at Danang, South Vietnam, to provide protection for the air base supporting MACV at Danang. Their mission was dramatically expanded on April 6, 1965, when President Lyndon Johnson authorized the use of ground troops for offensive combat operations in Vietnam. The Marines would be given primary responsibility for what became known as I Corps, the northernmost region encompassing the provinces from the Demilitarized Zone south to Quang Ngai. In response, the Marine Corps over the next several years deployed 24 infantry battalions, two tank battalions, two antitank battalions, three amphibious tractor battalions, two reconnaissance battalions, 10 artillery battalions, and 26 helicopter and fixed-wing squadrons. (Ref. 30)

Within four months, the Marines on August 12, 1965, conducted the first major U.S. ground operation of the Vietnam War, known as “Operation Starlight.” (Ref. 31) It was a combined amphibious/helicopter assault. About 12 miles south of the airfield at Chu Lai, and four miles inland in an area called “Elephant Valley,” helicopter-borne Marines landed next to the basecamp of the Vietcong 60th battalion, entrenched on nearby Hill 43. After a bitter fight, the hill was soon overrun. The Marines suffered 45 dead and 120 wounded, while Vietcong casualties were at least 12 times greater. The 1st VC Regiment had been rendered ineffective and the 60th Battalion destroyed. In this and subsequent battles, the helicopter proved itself indispensable in assault, transport and evacuation of the wounded.

In I Corps, which was the northern-most region, the Marines engaged the Vietcong and the North Vietnamese forces in a series of battles. They included, among many others, the Siege of Con Thien, the 1968 Tet Offensive, the Battle for Hue, the Siege of Khe Sanh, the Battle of Dai Do, and the Evacuation of Kham Duc. In 1968, the Army and Marines conducted a combined offensive at “Hamburger Hill” in the A Shau Valley. Nearly all USMC helicopter operations were conducted from Marine Corps air facilities located along the South China Sea coast: Marble Mountain, Phu Bai, Quang Tri, Dong Ha and from newly designed helicopter assault carriers such as the *USS Tripoli* just offshore. Initially, the Sikorsky CH-34 and, beginning in 1967, the more powerful tandem rotor, twin turbine, Boeing CH-46A Sea Knight provided medium lift; the Bell VMO squadrons operating UH-1Es and -1Gs provided reconnaissance and light attack; the Sikorsky CH-53 Sea Stallion met Marine requirements for heavy lift. It proved to be an effective combination of USMC aviation assets.

The Battle of Ia Drang (October-November 1965)

The Army’s new air assault concept received its baptism of fire during the Battle of Ia Drang, which took place October 27, 1965, through November 17, 1965, in the Central Highlands of South Vietnam. The battle derived its name from the Drang River, which runs through the valley of Plei Me, where the engagement occurred. It was later to be made into a book and an award winning Hollywood epic — *We Were Soldiers Then*, starring Mel Gibson, Sam Elliott and Greg Kinnear. (Ref. 32)

The Army’s 1st Battalion, 7th Cavalry Regiment, 1st Air Cavalry Division (Airmobile) soldiers, led by Lieutenant Colonel Harold G. Moore, were members of an elite, experimental combat division trained in the new art of airmobile warfare. Helicopters performed troop insertions, resupply missions, and constant medevacs, while UH-1 gunships protected the landing zones and provided a margin of protection from NVA counter attacks. It was the first large scale helicopter assault in history. The battle lasted for days and casualties, on both sides, were severe. When it was over, both sides declared victory. It was apparent, however, that the major enemy fighting force was not the Viet Cong

guerrillas, but the regular forces of North Vietnam. The Americans, with considerable success, used helicopter mobility and artillery, fire and close air support to achieve their objectives. The NVA, at considerable cost, learned it could neutralize American firepower by quickly engaging U.S. forces at very close range. The 1st Air Cavalry, with its mass of helicopter aircraft, went on to a series of battles, including the 1968 Tet Offensive, the Battle of Hue, the A Shau Valley campaign, and the 1970 campaign in Cambodia. (Ref. 33)

Army Medevac “DUSTOFF” Helicopters

Helicopters specialized in aeromedical evacuation (MEDEVAC), where they distinguished themselves throughout the Vietnam War. Flying into an active landing zone to pick up wounded was a dangerous business. Air ambulance operations suffered three times the casualty rate of other air operations. The most prominent of these were the Army’s 57th Medical Detachment (Helicopter Ambulance), flying Bell UH-1 helicopters. (Ref. 34) Their tactical call sign was “Dustoff” — a heroic name for a humanitarian endeavor. They began performing medical rescues throughout South Vietnam as early as 1963. For wounded soldiers and Marines, the benefit they provided was extraordinary. Dustoff operations contributed to a 90.6% casualty survival rate, far superior to the survival rate in any previous war.

Major (later Major General) Patrick H. Brady, USA, who commanded the 54th Medical Detachment during his second tour of duty in Vietnam in 1967-1968, was the first Dustoff pilot to receive the Congressional Medal of Honor. He developed an innovative technique during Vietnam’s monsoon weather of flying sideways to blow away sufficient fog that he could follow the mountain trails below him. On January 6, 1968, he used this technique during four separate missions to rescue 39 men, many badly injured, under conditions which might otherwise have resulted in certain death for each of them. Many years later, General Brady, now retired, attended the Society’s Forum 69 in Phoenix, Arizona, where he recounted his exploits and those of other Dustoff pilots.

The Beginning of the End

U.S. troop strength surged in Vietnam from 23,000 on January 1, 1965, to 184,300 by year’s end. It would peak at 543,400 in April 1969 before drawdowns were to begin. (Ref. 35) As battlefield losses increased, American support for the war waned. The U.S. military, driven by political imperatives, changed tactics and engaged in a process known as the “Vietnamization” of the war. (Ref. 36) The U.S. drew down its forces, though still promising support. They eventually departed altogether. It was a season of broken promises. The South Vietnamese fought valiantly, but during Gerald Ford’s presidency the U.S. withdrew every vestige of former support. After protracted negotiations, U.S. and North Vietnam representatives signed

the Paris peace accords in January 1973, though the North Vietnamese never intended to abide by its provisions. More than 20 North Vietnamese divisions were unleashed in early 1975 on the south, now largely defenseless. The war ended in April 1975 with the fall of Saigon.

From time to time, some individuals question why the Vietnam War is referred to as “the Helicopter War.” The answer is evident to any historian. In the Vietnam War, 11,827 helicopters were committed to action. Of these, no fewer than 5,086 were destroyed. A total of 4,906 persons participating in helicopter flight were killed in action. Of those, 2,202 were pilots (not counting MIAs). As author and former Air Force officer Walter Boyne observed, the United States military service branches, particularly the Army and the Marines, found the services of the helicopter to be so valuable in fighting the war in Vietnam that it was willing to accept losses which would have been considered catastrophic in any previous war, or in any service. (Ref. 37)

Many American soldiers, Marines and sailors returned home embittered. The country that had sent them off to war was not there to welcome them home. U.S. forces had won the war, without question, but at home the nation lost it politically and in the media. As Lieutenant General Harold Moore and Joseph Galloway later noted, “Not one of us left Vietnam the same young man he was when he arrived.” Lieutenant General James M. Gavin, however, as far back as the summer of 1954, had foreseen the difference helicopter aviation would mean. His dream was that someday bigger, faster and better helicopters (than those which had seen duty in Korea) would carry the infantry into battle, forever freeing it of the tyranny of terrain, and permitting war to proceed at a pace considerably faster than a man walking. The helicopter, Gavin firmly believed, “held the possibility of making the battlefield truly a three-dimensional nightmare for an enemy commander.” (Ref. 38) His vision was vindicated at the Battle of Ia Drang, the 1968 Tet Offensive, the Battle for Hue, the Siege of Khe Sanh, and Hamburger Hill (the A Shau Valley campaign).

The Johnson-McConnell Agreement (April 6, 1966)

In retrospect, the Vietnam War demonstrated the essential utility of the helicopter in combat. Rotorcraft operations, including air assault and medical evacuation, now figure prominently in the battle doctrine of every country. The war, moreover, resolved a lingering dispute between the services regarding the responsibility for helicopter development. This resolution became known as the Johnson-McConnell Agreement, signed April 6, 1966, by Army Chief of Staff Harold K. Johnson and Air Force Chief of Staff John P. McConnell. (Ref. 39) It set the stage for one of the most crucial agreements ever reached by the Army and the Air Force, one which would have a major impact on the helicopter’s role in changing modern warfare.

The agreement eliminated the Army’s interest in heavier fixed-wing aircraft (specifically the CV-2 Caribou), but

conclusively established the Army’s rights to develop a vastly expanded capability in rotary-wing aircraft. The Air Force agreed to relinquish all claims on rotary-wing aircraft designed for intra-theater movement, fire support, supply and resupply of Army forces, though it retained the right to use helicopters in the critically important CSAR (combat search and rescue) role.

In effect, the Air Force gave up any claims relating to the design of, and all research and development relating to, rotary-wing aircraft. The National Security Act of 1947, as amended, and the Johnson-McConnell Agreement would have an important impact on the future of military helicopter operations, as well as helicopter research and development. Ultimately, it would have a major impact upon the focus and interests of American Helicopter Society. Unfortunately, the Key West Accords and the Johnson-McConnell Agreement, notwithstanding, disputes over roles and missions issues would continue to plague rotorcraft development.

The Army AH-56A Cheyenne (1966-1972)

During the mid-1960s, the Army sought a fast, armored and heavily armed helicopter to support the escort-attack role. Specifications called for a top speed of 220 knots, the ability to hover at 6,000 feet on a 95 degree day, and a ferry-range of 2,415 miles. In 1966, the Army’s Advanced Aerial Fire Support System Program (“AAFSS”), as it was called, was awarded to the Lockheed CL-840, later renamed the AH-56A Cheyenne. (Ref. 40) Lockheed designed the aircraft using a four-blade, rigid rotor system and configured the aircraft as a compound helicopter. It featured low-mounted stub wings with a span of 27 feet, a tail-mounted thrusting propeller, and a single General Electric T64 turboshaft engine. The landing gear was retractable, reducing aerodynamic drag. The first prototype flew on September 22, 1967. Despite early stability problems (three aircraft crashed during flight tests), those problems in time appeared to be solved. Performance was excellent, with a maximum speed of 240 mph, a climb rate that approached 3,300 feet per minute, and a range of 1,300 miles. Success was at hand.

At this time, the Air Force voiced serious objections to the Army’s development of the Cheyenne, since they believed it violated the Key West Accords. Specifically, the Air Force — always sensitive to issues relating to close air support — objected to the AH-56 on the grounds that because it had stub-wings, in addition to its rotors, it was actually a compound aircraft and not a helicopter at all. Faced with technical problems and cost issues, and now Air Force concerns, the Army eventually cancelled the Cheyenne in 1972. Soon thereafter, on August 9, it launched a new attack helicopter competition based on a pure helicopter design known as the Advanced Attack Helicopter (AAH) program. This eventually led to the development of the AH-64 Apache.

In 1996, *Vertiflite* published an article by Dr. Brenda Forman, titled “What Killed the Cheyenne.” (Ref. 41) The

AH-56A Cheyenne program, and the Forman article, stirred more comments than any other in the issues of Society publications. Among the many “Letters to the Editor” and follow-on articles were pieces by former Lockheed chief test pilot Don Segner; former Lockheed Director of Technology Dr. Richard M. Carlson (an Army employee at the time of the writing); and Lockheed engineer/chief marketing officer Al Yackle. (Ref. 42)

U.S. ARMY AND NASA ROLES IN ROTORCRAFT SCIENCE AND TECHNOLOGY

During the 1900s and continuing today, two U.S. government agencies — the U.S. Army and NASA — have played vital roles in rotorcraft research and development. As a result, they have shaped, and in many ways, sharpened, the Society’s goals and objectives. The Army’s experience with rotorcraft in Korea, and particularly Vietnam, demonstrated that the Army’s future would depend, to a significant degree, upon the agility and improved mobility offered by rotorcraft. Though helicopters offered great promise, they still had many limitations, however. To fulfill their potential, rotorcraft would require improvements in speed, range and payload. Of equal importance, helicopters would have to become more reliable, safer, crash resistant and affordable.

Early Army aviation research and development, dating to 1917, was largely performed at Wright-Patterson Air Force Base (the former McCook Field and Wilbur Wright Field) in Dayton, Ohio, which housed aeronautics test facilities, laboratories and skilled aviation systems technicians. Dr. Alexander Klemin, then an Army sergeant, had served in 1917 as Research Chief at McCook Field. During the 1940s through the 1960s, much of the Army’s (and the Air Force’s) early work on aeronautics research, short field take-off and landing technology, propulsion systems, advanced structures alloys, and composite materials occurred here. Later, during the period from the early 1960s to 1970, the Army performed the bulk of aviation research and development at the U.S. Army Aviation Materiel Laboratories (AVLABS) located at Fort Eustis, Virginia. During these years, Fort Eustis served as the Army’s principal center for rotorcraft research.

In his 1975 *Vertiflite* article, Augustine identified several technical challenges facing the helicopter industry and the U.S. Army in particular. The Army’s most driving need, he reported, was to be able to fight under low-level, nighttime operational conditions (now often referred to as “all weather, day-night, low level operations”). The primary obstacle during low level operations and fully-instrumented flight was then, and continues to be, low visibility. “We must reduce our detectable signature and be able to survive when we are detected.” (Ref. 43) Augustine’s concerns remain valid today: flight in degraded visual environments (DVE) is a principal area of technical interest within Army and Marine Corps aviation.

Augustine emphasized a wide range of technology areas where the Army was seeking improvement, particularly product improvement programs embodied in three programs: UTTAS, AAH and HLH (heavy lift helicopter). In these and follow on programs, aircraft survivability and crash safety would figure prominently, as would new materials, such as composites and elastomers. New turbine engines must reflect reductions in specific fuel consumption, improvements in power and reductions in weight. New helicopter structures would reflect a renewed emphasis on improved structural design criteria and structural efficiency, improvements in manufacturing technology and processes leading to improved reliability and reduced costs. The American Helicopter Society heard Augustine’s message. Future Forum and technical specialists’ meetings would reflect the Army’s concerns, as would the Society’s evolving technical committee structure.

NASA, and its predecessor organization NACA, was the second agency to have a major impact on rotorcraft research and development. Since its dedication as the first NACA research center in 1920, researchers at Langley Memorial Aeronautical Laboratory, which exists today as NASA Langley Research Center, had been making important contributions to rotorcraft development.

At Langley, during the 1920s and 1930s, NACA personnel studied autogiros and developed the fundamental groundwork for rotor analysis. One of the first NACA reports, Technical Note No. 4, 1920, was entitled “The Problem of the Helicopter,” and provided a mathematical treatment of autorotation. During the 1940s and 1950s, NACA ground and flight experimental research contributed to an improved understanding of flying qualities, ground resonance and performance prediction methods. Maintaining modern aeronautical research and technology facilities and staff with superior technical skills formed the core of NACA and NASA’s role in aeronautics. Another account, authored by Frederick B. Gustafson (former Head, VTOL Branch, NASA Langley Research Center, and AHS Southeast Vice President), was titled “History of NACA/NASA Rotating Wing Aircraft Research, 1915-1970, Part III.” The report appeared in the September 1970 issue of *Vertiflite* and highlighted many contributions by Langley scientists and engineers in the rotary-wing field.

NACA researchers supported the development of professional societies and provided much support to conferences, meetings and workshops, where the objective was to disseminate technical information. NACA (later NASA) Langley Research Center was established at Hampton, Virginia, in 1917. Ames Research Center was established at Moffett Field, California, in 1939. NACA research expanded from Langley and Ames as Lewis Field (now NASA Glenn Research Center) opened in Cleveland in 1947. In 1977, NASA made the decision to locate the majority of its helicopter research at Ames, with Langley and Glenn in supporting roles.

The Army-NASA Joint Agreement (February 1965)

In the early 1960s, with the Army assuming the lead role for rotorcraft research and development and the Air Force eliminating efforts in that area, the Army needed to develop facilities to address much-needed research. NACA had become NASA in 1958 and had been reducing much of its aeronautics focus. In February 1965, the Army and NASA signed a joint agreement that recognized the agencies' mutual interests in aeronautics technology. (Ref. 44) In effect, it allowed NASA and Army researchers to work side by side "to achieve tangible economies and promote efficiency with respect to continuing research and development of aeronautical vehicles." The Army agreed to staff and operate certain facilities located at NASA Ames at Moffett Field, California. NASA agreed to supply technical and personnel support and the use of its test facilities.

In fact, NASA's commitment to rotorcraft research and development increased with the formalization of the cooperative program with the Army, from approximately \$5 million at the start of the 1970s to approximately \$30 million in subsequent years. (Ref. 45) This agreement worked so well that the Joint Agreement was expanded in 1970 to include similar activities at NASA Lewis (now Glenn) in Cleveland, Ohio, and NASA Langley in Hampton, Virginia. To manage this expanded activity, the Army Aviation Systems Command created the Air Mobility Research and Development Laboratory (AMRDL), with its headquarters located at NASA Ames. AMRDL Directorates were established at Ames, Langley, Glenn, and the former Aviation Material Laboratories (AVLABS) at Fort Eustis, Virginia.

Both agencies shared a common concern in the need for investment in rotorcraft technology. Within the aerospace community rotorcraft technology has long been regarded as relatively immature because of the fundamental complexity of rotorcraft aeromechanics. Therefore leaders at both agencies agreed that the future would hold great potential if they could join in pursuing critical fundamental and advanced technology. Recent developments suggested that new technologies, including composites, smart materials, and sensors, might facilitate fundamentally new approaches to rotorcraft design.

New computer capabilities would be capable of solving scientific issues of rotorcraft. The agencies agreed to collaborate in several key areas, including rotorcraft dynamics and control, vehicle structures, propulsion, avionics, aeromechanics, safety and air space management. The agreement was designed to ensure the free exchange of research information, reduce duplication and enhance long-term research planning for both organizations.

The benefit to the U.S. Army was significant. Because of their design complexity, rotorcraft development is highly dependent on sub-scale and full-scale testing, requiring elaborate subsonic wind tunnels and simulators. NASA had

both, as well as the trained technical personnel to operate them. Among these are the Transonic Dynamics Tunnel (TDT), the 14 x 22 foot Subsonic Tunnel, and the Landing and Impact Research Dynamics (LandIR) facility, all located at NASA Langley; the National Full-Scale Aerodynamics Complex (NFAC), the Vertical Motion Simulator and the 7 x 10 foot wind tunnel, at NASA Ames; and the Icing Research Tunnel (IRT), along with multiple engine and drive system test cells, located at NASA Glenn.

One of the best-known Army/NASA collaborations was the 1970s joint development of the XV-15 Tiltrotor, which proved it was possible to have an aircraft that could both hover like a helicopter and fly like an airplane. In this effort, the agencies also collaborated with the Navy, Air Force and Bell Helicopter. (Ref. 46) After a period, the Army withdrew from the partnership, though the Department of the Navy increased its investment. Because of the success of the XV-15, the United States Marine Corps developed a much larger, full-scale tiltrotor variant, the MV-22 Osprey, now in service with the Marines and Air Force.

The collaboration proved to be a great success. "Progress in the Vertical Lift arena as applicable to Army missions has been substantial indeed during the past two decades," wrote Norman Augustine in a 1980 report titled "Vertical Lift Technology Review." He explained "The NASA/Army relationship addressing this area is probably not exceeded anywhere in the realm of interagency cooperation in terms of mutual support and efficiency. The effort to truly integrate the assets of these organizations has been highly successful; should be furthered; and has almost certainly been of substantial benefit to both the Army and NASA." (Ref. 47)

The achievements of the Army NASA Joint Agreement have been extensive. Representative rotorcraft technologies developed by the Army/NASA teams include control systems for fully automatic flight, improved rotors and blades for better performance, advanced fly-by-wire flight controls for improved agility, advanced cockpit displays and communications systems, lightweight composite structures, new transmission and gear designs with higher strength and longer life, and improved engines with better fuel efficiency. Full-scale crash testing at the NASA Langley Landing and Impact Research (LandIR) Facility has improved restraints, seats, structures and wire strike protection. Additional efforts reduced helicopter noise and improved efficiency.

The Rotorcraft Centers of Excellence (1982)

The Army's increasing dependence on rotorcraft for mobility or "maneuver" required the service to make significant investments in rotorcraft research, development, testing and evaluation. Changes in mission requirements required constant improvements in technology. For upgrades and modifications, the Army had the full support of the rotorcraft industry, and its scientists and engineers. But to create entirely new designs and new capabilities, the Army

needed a plan capable of research and development, including long term basic research.

In a September, 1975, *Vertiflite* article, "Helicopter Technology and Today's Army," Norman R. Augustine, then-Under Secretary of the Army addressed the importance of helicopter technology. (Ref. 48) Assisting Augustine in its preparation were two acknowledged professionals in the field, Dr. Richard Carlson at the Army Air Mobility R&D Laboratory and Richard L. Ballard, then Deputy Chief of Staff for Army Aviation Research, Development and Acquisition. Augustine argued, persuasively, that the use of helicopters represented the "sole" major quantitative advantage held by the Army of the United States over the Army of the Soviet Union. Reflecting on the helicopter's role during the Vietnam War and the need to invest in new rotary-wing technology, he stated:

The combat effectiveness of the U.S. Army is dependent on the helicopter. The helicopter has revised the concept of the modern battlefield, reducing troop exposure and enhancing economy of force. Helicopters have been made practical and reliable and are now as much a part of the tactical maneuver capability of the ground Army as 2 ½ ton trucks were in 1944. . . . Helicopter medical evacuation of wounded troops in Vietnam perhaps did more to increase the soldier's chance of survival in Vietnam than all the advances in medical science of the past two decades. . .

Thus, the helicopter has proven beyond doubt its utility on the battlefield. It is here to stay, but in order for it to maintain its usefulness and fulfill its true potential, the technology associated with it must not be neglected. (Emphasis added) (Ref. 49)

In his writings and public statements, Augustine made a powerful case for prioritizing Army investment in rotary-wing technology, and in both basic and applied research.

The Army, of course, has long collaborated with the academic community in areas of basic research. Beginning in 1982, the Army Research Office in Raleigh-Durham, NC established the Rotorcraft Centers of Excellence or RCOEs. Their purpose was to perform long-term, high-risk basic research in areas of interest involving rotary wing vehicles and to provide for the education of the next generation of rotorcraft engineers. Following a competition, three universities were selected: The Georgia Institute of Technology, Rensselaer Polytechnic University, and the University of Maryland. In 1995, management of the RCOE program was transferred to the National Rotorcraft Technology Center (NRTC) at NASA Ames. Coincidentally, there was a 1995 re-competition resulting in Pennsylvania State University replacing Rensselaer. Following another re-competition in 2006, the program was renamed the Vertical

Lift Research Centers of Excellence or VLRCOEs. In recent years, both NASA and the U.S. Navy have joined with the Army in supporting the VLRCOEs. Their contributions in the areas of rotary wing design, materials research, and unmanned aerial vehicles have received extensive recognition in both the *Journal of the American Helicopter Society* and through multiple AHS awards.

Project Reliance and Base Closures (1987 -2006)

With the passage of time and several Command realignments, the Army's Air Mobility R&D Laboratory or AMRDL (1970-1978) functions were absorbed into the Aviation & Missile Research Development, and Engineering Center or AMRDEC (effective in 1997). The Army's Aviation Material Laboratory (AVLABS) became the Eustis Directorate and later became the Army Aviation Applied Technology Directorate or AATD (1985), and the Lewis Directorate became the Army Propulsion Directorate (1985) and later in 2011 the Glenn Field Element of the Army Research Laboratory Vehicle Technology Directorate located at NASA Glenn Research Center. The Army Research Lab (ARL) is primarily located at the Army's Aberdeen Proving Ground in Maryland. ARL and AFDD both have research staff located at Langley Research Center.

"Project Reliance," conceived in 1987 by the Department of Defense, was intended to create a more condensed, corporate and cooperative approach to laboratory and T&E management. It sought to accomplish this by establishing areas of Research, Development, Test and Evaluation (RDT&E) capability and "lead" military departments for Lab/T&E focus areas. Within the Department of Defense, the U.S. Army was identified as the "lead" for all rotorcraft research and development.

Project Reliance was timely. Defense-wide RDT&E funding declined by \$9.7B in the decade beginning in 1987 and the number of RDT&E military and civilian personnel would decline by more than 29%. Nearly 30 years later, the Army's role as "lead service" continues under "Reliance 21," the current iteration of the DoD's science and technology joint planning and coordination process. (Ref. 50) The Army had then, and continues to have, the requisite critical mass in rotorcraft engineering expertise and, given its 1965 joint agreement with NASA, it has access to a full array of test facilities and NASA scientists.

Political pressures and budget demands brought about a series of unprecedented defense base closures in 1988, 1990-91, 1993, 1995 and 2006. These actions had the combined effect of forcing greater efficiencies in military acquisition, laboratories and test facilities.

Key Military Helicopter Programs (1960s and 1970s)

With the exception of the MV-22 Osprey, no new military rotorcraft has been developed and fielded for the U.S. armed services since 1990. The AH-64 Apache was the last new

helicopter to enter service. Standard designs have become (by default) the basic helicopter of choice. The American military helicopter of contemporary production is a combination of decades-old basic design and thoughtful improvements in equipment, including particularly avionics, reliability and maintainability. Several leading examples are described in the following paragraphs.

These aircraft — the UH-1, the CH-47, the UH-60, the CH-53 and the AH-64, heavily upgraded and modified — remain the backbone of U.S. military aviation today, literally decades after their original design.

In 1955, the Bell Model 204 won a U.S. Army design competition for a utility helicopter suitable for combat casualty evacuation and troop transport. (Ref. 51) Designated the HU-1 (which was the basis for the “Huey” nickname for this series of helicopters), later the UH-1, the official U.S. Army name for the series was the “Iroquois.” The UH-1’s maximum gross weight was 8,500 lbs. It featured a two-blade all metal teetering main rotor with interchangeable blades, and a two-blade all metal tail rotor of honeycomb construction, with a tubular skid-type landing gear. The crew, with dual controls, sat side by side. The standard model had bench seats for eight passengers. The original powerplant was a single 1,100 shp AVCO Lycoming T53-09A turboshaft engine mounted above the fuselage aft of the cabin. A major contributor to the engine design team was Dr. Anselm Franz, a German aeronautical engineer trained at the Technical University in Berlin, who consulted (as part of Operation PAPERCLIP) at Wright Patterson Air Force Base in Dayton, Ohio. (Ref. 52) His remarkable reputation in gas turbine engine design was established during World War II, when Dr. Franz designed the axial-flow turbojet engine, which powered the Messerschmitt ME 262, the world’s first operational jet fighter. He received the Society’s Dr. Alexander Klemin Award in 1967.

A Marine Corps assault support version of the UH-1, designated the UH-1E, was procured beginning in March 1962. Later versions for the Army, Marine Corps, the Navy and the U.S. Air Force featured increased performance. In March 1965, Bell initiated a company-funded development for an armed helicopter for attack missions to fill the void left by the cancellation of the AH-56A Cheyenne. The aircraft used the dynamic components from the UH-1C with a new, tandem-seat, “skinny” fuselage with stub wings. The production version became known as the UH-1G HueyCobra. A twin-engine version was subsequently developed for the Marine Corps (originally the AH-1J SeaCobra), which was subsequently upgraded to the AH-1T Improved SeaCobra and AH-1W SuperCobra. In 2000, Bell began the development of an entirely new rotor system, including a hingeless, bearingless rotor with four all-composite blades. This rotor system became the basis for the AH-1Z Viper (an upgrade to the AH-1W) and UH-1Y (an upgrade of the UH-1N utility helicopter). Both were

powered by twin General Electric T700-GE-401 turboshafts, each rated at 1,723 shp. (Ref. 53)

Over the years, more than 8,983 variants of the UH-1 were delivered to American and other aviation service branches across the world.

During the 1950s, the Army selected the tandem rotor, Boeing Vertol CH-47 due to its size and lifting ability as its all-weather, medium to heavy lift transport helicopter. Actual design began in 1956, followed by first flight on September 9, 1961. Deliveries of the CH-47B began on May 10, 1967, just in time for service in Vietnam. Over the next several years, Boeing would produce 735 CH-47 A/B and C model aircraft, with 479 conversions to the D/E specification. It would also export 166 additional aircraft to U.S. allies for a total of 1,192 aircraft. Powered by two AVCO Lycoming T55 turboshafts of 3,750 shp each, it had a maximum speed of 178 mph and a payload of 17,000 lbs. (Ref. 54)

The Department of the Navy in the 1960s sought a medium lift transport for the U.S. Marines to replace the H-21 “Flying Banana.” They selected another Boeing Vertol product, the CH-46 Sea Knight which, like the CH-47, offered significantly greater range, speed and payload, though, powered by two GE T-58 turboshafts of 1,900 shp each, its payload was just 9,000 lbs. It was decidedly a medium lift machine by comparison to the Army’s CH-47. Both aircraft played important roles during the Vietnam War beginning in 1967. With modifications and upgrades, the venerable Sea Knight continued in service as the Marine’s primary medium lift transport until replaced by the MV-22 Osprey nearly 50 years later. (Ref. 55)

At approximately the same time, the U.S. Navy was pursuing the development of a heavy-lift assault transport capable of vertical take-off and landing. On August 27, 1962, the service selected Sikorsky to produce the aircraft for use by the U.S. Marine Corps. First deliveries of the CH-53A/D occurred in mid-1966 and it has continued in service through today. The Model S-65 CH-53 eventually served as the HH-53 Jolly Green and later as the MH-53 Pave Low. In 1973, the Navy/U.S. Marine Corps upgraded these to the CH-53E Super Stallion configuration, powered by three GE T-64 turboshafts of 4,380 shp each, for amphibious assault, transport of heavy equipment, and recovery of disabled aircraft. (Ref. 56)

Meanwhile, the U.S. Army launched, in 1972, a competition for the “Utility Tactical Transport Aircraft System” or UTTAS. Sikorsky concentrated its design efforts around several technologies just entering the flight-test evaluation phase. These included the new titanium-spar rotor blade with cambered airfoil, highly optimized twist distribution and swept tips. Also proposed was an all-new elastomeric, bearingless, main rotor head. Finally, the design featured a canted tail rotor, as well as high levels of ballistic tolerance and crashworthiness. The YUH-60A performed a successful

first flight on October 17, 1974. Two years later, on December 23, 1976, the Army selected the UH-60 Black Hawk as the winner of the UTTAS competition. It carried a two-man crew and eleven personnel. Two General Electric T-700 turboshaft engines powered the aircraft driving a four-blade main rotor, providing sufficient power to allow the aircraft to cruise at 175 mph. The aircraft could handle 3,000 lbs. of freight internally and, when necessary, could be transported long distances in the hold of a C-130 aircraft. Today, the Sikorsky Black Hawk is one of the world's most successful helicopter aircraft of all time, produced in more than 50 different configurations for various missions and customers. (Ref. 57)

At nearly the same time in 1978, the Navy selected the Sikorsky SH-60B as part of a U.S. Navy LAMPS Mark II (LAMPS) Competition. The decision was based on the fact that Sikorsky offered significantly lower operating costs as a result of parts commonality with the UTTAS. In 1998, based on the Seahawk's successful performance, the Navy announced a plan to remanufacture all SH-60 B/F models to the 60R/S designation. This would reduce all the Navy's requirements into two basic helicopter configurations that would enhance mission capabilities and reduce training and support costs. (Ref. 58)

Having cancelled the AH-56A Lockheed Cheyenne program, the U.S. Army quickly launched a competition for a conventional armed attack helicopter. It became known as the Armed Attack Helicopter (AAH) Competition. It was won eventually by the Hughes Model 77 (now the AH-64 Apache) in December 1976. A four-bladed, twin engine helicopter, powered by a pair of GE T700 turbo shafts of 1,820 each, with a tailwheel-type landing gear arrangement, the Apache has a tandem cockpit for a two-person crew. It featured a nose-mounted sensor suite for target acquisition and night vision systems, and, as befitting an attack helicopter, it was armed with a 30 mm M-230 chain gun carried under the aircraft's forward fuselage. Its four "hardpoints" typically carry a mixture of AGM-114 Hellfire missiles and Hydra-70 rocket pods. (Ref. 59)

The Army approved the Apache for full production in 1982 and deliveries began in January 1984. After purchasing Hughes Helicopter in 1984, McDonnell Douglas continued AH-64 production and development. The first production AH-64D Apache Longbow, an upgraded Apache variant with an advanced, mast-mounted radar targeting system, was delivered to the Army in March 1997. Boeing Defense, Space and Security Group has continued production since its acquisition of McDonnell Douglas. As of 2015, more than 2,000 AH-64 Apaches had been delivered to the U.S. Army and other customers. The Apache is today the primary attack helicopter of the U.S. Army, the United Kingdom (where it is built under license by AgustaWestland), Greece, Japan, Israel, the Netherlands, Singapore and the United Arab Emirates. Boeing's latest challenge is an upgrade to the AH-64E Apache Guardian standard of which 599 deliveries are planned. (Ref. 60)

Based on their experiences during the Afghanistan and Iraq Wars (2001 to present), the Marines sought an entirely new heavy lift helicopter, launching a program in 2006 to replace the CH-53E. It chose the same basic Sikorsky design, but pursued a much larger, more modern, more powerful aircraft now designated the CH-53K King Stallion. The program, still in development, calls for the purchase of 200 new-build aircraft derived from the CH-53E, with an initial operating capability in 2018. The aircraft features advanced fly-by-wire electronic flight controls, as well as a large increase in range and payload (about three times greater than the CH-53E in the same conditions). The program will reportedly benefit by a 23% reduction in operations and support costs, a 68% reduction in maintenance hours per flight hours, and increased survivability. The CH-53K fuselage and rotors will be constructed using composites and an elastomeric rotorhead. To fit the aircraft on Navy carriers, the blades may be folded hydraulically. Three state-of-the-art GE-38-1B engines each produce 7,500 shp (a significant improvement over the CH-53E's 4,380 shp engines) while reducing specific fuel consumption by 20%. (Ref. 61)

THE AHS MATURES — 1990 AND BEYOND

Forces that Changed the Rotorcraft Industry (and AHS)

During the period 1990 through 2010, the Society became increasingly focused in three areas — all of which would have immense impact upon the rotorcraft industry. These included, first, dramatic changes in the vertical flight industrial base. To a large extent, this was brought about by post-Cold War changes in Federal budget priorities; changes in DoD acquisition policies; rapid industry consolidation; and, finally, changes in the industry management model. Second, the period witnessed significant changes in NASA priorities. Prominent among these priorities were decreased funding for aeronautics and fundamental aeronautics research, and attempts to eliminate the rotorcraft program. Combined, all of these directly threatened the Army-NASA Joint Agreement, NRTC, and the RCOE/VLRCOE Program and, indirectly, industry's efforts to modernize rotorcraft technology. Finally, critical aeronautics test facilities, particularly the National Full-Scale Aerodynamics Complex (NFAC), would be threatened with closure as a result of NASA's changing accounting practices and assessment methods that caused test costs to skyrocket. At this point, AHS partnered with government agencies and other aerospace associations to champion NFAC restoration.

The United States has long had to face the challenge of determining to what degree it wants to participate in global peacekeeping efforts. Events in Somalia between 1992 and 1994 put that debate into sharp relief. "Operation Provide Comfort," later "Operation Restore Hope," was a humanitarian mission in Somalia supported by United Nations Security Council Resolution 751. It offered an opportunity to demonstrate the role of rotorcraft aviation in remote environments devoid of infrastructure. The U.S.

Army 10th Mountain Aviation Brigade, comprised of more than 40 UH-60L Black Hawks and 20 OH-58 Kiowa Warriors, responded to the mission, arriving in early January 1993 along with a Marine Air Group Task Force. To better access the interior of Somalia, both services located their aviation units at a former Soviet Union airstrip at Bela Dogle, near Baidoa, about 40 miles west of Mogadishu, Somalia's capital.

Because the operation was considered "humanitarian," at least initially, the Department of Defense offered an opportunity to journalists to participate as embedded visitors. Among them was M.E. Rhet Flater, the AHS Executive Director, who traveled with the 10th Combat Aviation Mountain Brigade, first to Mogadishu, then to Baidoa, then south to Kismayo — not far from the border of Kenya. Tribal warlords controlled the country, denying medicine and food (provided by the United Nations and non-governmental organizations, or NGOs) to competing clans and their supporters. An entire generation of children had succumbed to death by disease and starvation; hence U.N. intervention was necessary. Flater was interested in witnessing modern Army and Marine Corps aviation operations in settings which displayed the particular strengths of modern rotorcraft in disaster relief. His observations (and photographic images) of the essential roles played by rotary-wing aviation in providing food, water and medical support to the people of Somalia appeared in multiple articles in *Defense News* and *Vertiflite* throughout 1993. (Ref. 62) AHS also produced a seven minute documentary on helicopter operations in Operation Restore Hope, later distributed to each of the AHS chapters. Operation Restore Hope proved that modern military rotorcraft had an important role in both humanitarian relief and low-intensity conflicts.

The message affirmed the value of the rotorcraft industry and its capabilities, but it came at a difficult time.

Industry consolidation gained prominence during the period of 1993 - 1998. The number of U.S. defense firms capable of developing and producing major platforms and weapons systems declined, in many areas, to three or less. (Ref. 63) This was no accident; it was brought about by a precipitous 40% drop in DoD investment, defined as procurement, research and development, plus construction. Martin Marietta and Lockheed merged in 1993. In 1996 Lockheed Martin acquired Loral, which by then owned IBM Federal Systems and Goodyear Aerospace. Northrop merged with Grumman; they bought Vought Aircraft in 1994 and Westinghouse Defense Electronics in 1996. McDonnell Douglas acquired Hughes Helicopters, then relocated to Mesa, Arizona, in 1984. Twelve years later, in 1996, Boeing acquired McDonnell Douglas, including McDonnell Douglas Helicopter Corporation. Boeing retained the attack helicopter assets, but promptly resold MDHC's civil division.

Allison Engine Company, owned for many years by General Motors, was sold to Rolls-Royce in 1995. Textron acquired Lycoming Engines and subsequently resold it to AlliedSignal Corporation, which then merged it with Garrett Engine Division as part of AlliedSignal Engine Division. It was, in turn, sold to Honeywell Aerospace in 1999. Boeing purchased Litton Precision Gear, which manufactured transmissions. But the consolidation process came to an abrupt end in 1998. That was when the Departments of Defense and Justice, suddenly awakened, became concerned about the impact of industry consolidation on competitiveness. The DoD turned down Lockheed Martin's proposed acquisition of Northrop Grumman. In the same year, it opposed General Dynamic's acquisition of Newport News Shipbuilding.

Then, many years later, the agencies reversed themselves.

Though Sikorsky Aircraft had long been a key asset, many would say the "crown jewel," of United Technologies Corporation since 1929, in late 2014 and early 2015 UTC's management reassessed the company's value. On the one hand, Sikorsky was the world's leading manufacturer of military helicopters with annual revenues in 2015 exceeding \$7.5 billion. Its UH-60 Black Hawk, SH-60 Seahawk, CH-53E Sea Stallion, and its S-92 (now selected as the Presidential Helicopter) were state of the art. Its CH-53K, designed for the Marine Corps Heavy Lift Replacement, and its highly promising X-2 technology placed the company second to none in terms of internally-funded new development. On the other hand, the Teal Group, Forecast International and armchair Wall Street prognosticators were publishing reports that Defense acquisition of rotorcraft would decline by 50% or more during the ensuing 10 years. And, though Sikorsky's revenues were the highest in the industry, its operating profits were just 2.9% — perceived as below average by comparison to other UTC assets.

UTC's board made the decision to sell Sikorsky. The successful bidder, at \$9.1 billion, was Lockheed Martin, the world's largest defense company, which had partnered with Sikorsky in supplying systems and subsystems for many of its platforms. In November 2015, Lockheed Martin announced it had closed on its acquisition of Sikorsky. (Ref. 64) Though the Departments of Defense and Justice raised no antitrust objections (the U.S. still had three military rotorcraft platform suppliers in Bell, Boeing and Sikorsky), senior leaders within the DoD expressed dismay over the prospect of reduced competition among second tier suppliers and the electronics industry.

Changes in Rotorcraft Industry Management Practices

Over the years from 1960 through 1990, a subtle change in industry management practices took place, and the changes would have long-lasting implications. Most of the original industry pioneers, all rotorcraft engineers, had passed away or left the scene. The industry was now controlled not by risk-takers such as Igor Sikorsky, Frank Piasecki, Arthur

Young and Bart Kelley, but by conglomerates such as United Technologies Corporation, The Boeing Company and Textron, all of which were publicly held, all of which were required to file financial reports both annually (Securities and Exchange Form 10-Ks) and quarterly (SEC 10-Qs).

The companies began focusing more and more attention on improving their financial performance and making decisions that better served their investors' short-term (and long term) interests. Internal decisions were based on budgets. In this arena, rotorcraft companies were (and continue to be) required to compete for resources with divisions selling consumer goods, such as elevators, heating and air conditioners, civil transport aircraft, and electronics. This would lead to major changes in industry's approach to risk.

During the post-Cold-War period following 1991, Department of Defense investment in production, modernization, research and development was declining year by year. The Army would cut its operational helicopter airframes from 8,819 in 1987 to just 3,500 in 2007, with the bulk of the reduction occurring prior to 1999. (Ref. 59) Production funding during FY96 dropped by more than 60%; total DoD research and development accounts declined by more than 28%. Major rotorcraft manufacturers and the supplier base found themselves competing in the domestic and international marketplace for fewer business opportunities. During the same period, European defense budgets fell also. Finally, the long-anticipated boom in commercial rotorcraft failed to materialize. These events combined to precipitate "a perfect storm."

According to George T. Singley, III, the Society's then secretary-treasurer and Deputy Assistant Secretary of the Army for Research and Technology/Chief Scientist and later Deputy and Acting Director, Defense Research and Engineering, a major change had occurred that was to continue throughout much of the next two decades. This was characterized by a shift in emphasis from platforms and performance to systems, systems affordability, sensors and information systems. In a *Vertiflite* article, Singley confirmed these changes with a fair warning to AHS and its members:

The Pentagon's emphasis has shifted from development of new evolutionary systems offering incremental increases in capability to extending the life of existing systems; mission equipment upgrades; the development of a small number of new systems offering revolutionary capability increases exploiting breakthrough technologies; . . . and improving affordability, particularly operating costs. (Ref. 66)

These changes were to have monumental importance.

Singley's observations became increasingly apparent in several ways. First, the DoD and the service branches would be unable to sustain any "new starts," and existing programs

were subject to cancellation. Second, layoffs at major rotorcraft companies, even among its prized engineering components, would become an all-too-frequent ritual as industry eliminated excess capacity. Third, NASA's emphasis on aeronautics, as well as all other government funding for rotorcraft research and development, would be threatened, continuously, year after year

The vertical flight industry needed an advocate, an organization which would support the need for rotorcraft R&D and increased investments in science and technology. To address these challenges, AHS would have to reinvent itself, retaining its focus as a professional technical society for rotorcraft, but making significant changes in programs, committee structures and its approach to advocacy.

The AHS Charter Committee (1992-1993)

As early signs of these changes became apparent, the AHS Board of Directors in June 1992 authorized the creation of an ad-hoc Charter Committee. The Board gave it broad powers and appointed Colonel Emmett Knight, USA (Ret.), a former Commander of the Aviation Applied Technology Directorate or AATD, as Chairman. The Board charged the committee with responsibility for reviewing the Society's charter and changing industry conditions, and recommending any changes within the Society needed to address those conditions. Senior representatives of the Society, nearly all Board members with diverse experience and background, filled out the committee. They included Dr. Dev Banerjee (Boeing), Evan A. Fradenburgh (Sikorsky), Larry Jenkins (Bell), John Macrino (U.S. Army), Dr. John Shaw (Boeing), George T. Singley III (U.S. Army), Gary P. Smith (Sikorsky), Kaydon Stanzione (AHS membership chairman), Carroll W. Suggs (chair of Petroleum Helicopters, Inc.), and C. Rande Vause (Sikorsky), as well as the Society's Executive Director. (Ref 67)

The committee's first task was to fashion a "vision" for AHS. In doing this, Knight's committee paid heed to the experience of other, successful associations. Good associations, he noted, whether they regarded themselves as professional, scientific or trade associations, share common functions. First, they work to create a favorable attitude toward their industry or profession. This effort typically includes the media, the general public and consumers. Second, associations keep abreast of change. They advise their members of what is happening, and what is likely to happen. Moreover, they make an active effort to create favorable change. Third, they work to maintain high ethical standards in their industry or profession.

As defined by Knight's committee, AHS' vision was "to achieve worldwide recognition as the premier technical and professional society for vertical flight, promoting its applications and benefits to humanity." And, consistent with this vision, the Committee defined AHS' mission "to satisfy the technological, educational, informational and advocacy

needs of the world wide vertical flight community.” The inclusion of the term “advocacy” was deliberate. (Ref. 68)

To dispel any doubt regarding who (or what) constitutes the world-wide vertical flight community, the committee stated that the American Helicopter Society serves the needs of those individuals and groups, world-wide, with a common interest in vertical flight. They included manufacturers and suppliers; engineers, scientists and other professionals; executives and managers; government and civil/commercial interests; and owners and operators. These were considered the customers of AHS and the membership base of the Society.

The committee also endorsed a series of recommendations. First, the Society is international in scope and membership and its programs should reflect that. The Society would become known as “AHS International: The Vertical Flight Society.” Second, the Society, when and where appropriate, should serve as the industry’s advocate before the Executive branch, including government agencies such as the Department of Defense, NASA, and the Department of Transportation, the United States Congress, and the media. And, finally, whereas the Society’s focus had historically been on platform and platform-related disciplines, more attention, particularly in the Society’s programs, committee structures, forums and meetings, must address the growing role of avionics and systems.

AHS NASA Testimony before Congress (April 27, 1993)

There are various approaches to changing government policy, particularly as it affects national security. First, an association or industry can approach the agencies involved directly, in the case of helicopters the DoD and NASA. Second, if that fails, they can approach members of the U.S. Congress, particularly the leaders, members and staff members of the committees (and subcommittees) in the House and Senate, which authorize and appropriate funds for the two agencies. This approach is time-consuming and expensive. Finally, when all else fails, industry may take appropriate action to make its voice heard by senior representatives of the Administration, including the White House, the Office of Management and Budget, and other agencies, as well as the public. During the two ensuing decades, as funding declined precipitously for NASA aeronautics, and DoD support for rotorcraft RDT&E programs waned, Society advocacy on behalf of rotorcraft would engage in all three approaches.

Beginning in April 1993, AHS International testified before the United States Congress on multiple occasions. The first occurred April 27, 1993, when the Executive Director was invited to appear before the House Subcommittee on Technology, the Environment and Aviation in support of the NASA Advanced Tiltrotor Transport Technology (ATTT) program. The Society strongly endorsed a \$211 million/six year program recommended by the High Speed Rotorcraft Technology Task Force, supported by NASA Associate

Administrator Dr. Wesley L. Harris. The testimony stated that the program would advance knowledge of accurate, robust and reliable analytical prediction methods much needed by the civil and military rotorcraft community. It also emphasized the increasingly important roles played by civil and military rotorcraft. (Ref. 69) The presentation was well received and Congress ultimately funded the ATTT program as part of NASA’s FY94 budget.

Meanwhile, the White House Office of Science and Technology Policy (OSTP) and the Congress were leading aggressive moves relating to technology transfer. The goals of the DARPA Technology Reinvestment Program provided four important insights into the strategic direction of the administration: encourage non-defense uses for defense technologies; create a larger industrial base for the defense sector to draw upon; foster long-term economic growth that creates jobs and protects the environment; and enable the U.S. to assume world leadership in basic science, mathematics and engineering.

Phrased differently, technology transfer, a broadened industrial base, economic growth, and U.S. leadership in the sciences, mathematics and engineering would be key directions. At the same time the federal government was emphasizing that industry must now share the burden of R&D costs. In exchange, government agencies would be more willing to form technical alliances with industry.

National Rotorcraft Technology Center (NRTC) (1995)

Senior leaders at NASA and the U.S. Army during late 1993 understood this message and began initial discussions about public/private partnerships for joint development of pre-competitive rotorcraft technologies. They would be led by government, but would engage and help focus industry investment in independent research and development. Leading these discussions within their respective agencies were George T. Singley, III, Deputy Assistant Secretary of the Army for Research and Technology/Chief Scientist, and Dr. Wesley L. Harris, NASA Associate Administrator for Aeronautics.

In late 1994, Singley and Harris met to discuss a possible merger of their respective programs. In later meetings, they included Dean C. Borgman, then AHS Chairman (and President of McDonnell Douglas Helicopter Corporation), and other industry leaders in their discussions.

What emerged in 1995 was a government, industry and university partnership called the National Rotorcraft Technology Center (NRTC). Its purpose was to identify and develop high-payoff technologies for near and long-term application to commercial products and rotorcraft weapons systems. The program would be executed through a two-prong approach: the Rotorcraft Industry Technology Association (RITA) program and the Rotorcraft Center of Excellence (RCOE) program. The RITA program would develop technology for the near term — transition and

payoff — in two to four years. The RCOE program would conduct the supporting basic research for the long term (five to 15 year technology horizon), focused on fundamental rotorcraft issues aligned with NRTC goals and directly relevant to DoD and industry needs. (Ref. 70)

Government participants in NRTC included NASA, Army, Navy and the Federal Aviation Administration. Industry participants in RITA included the four major airframe primes, Bell Helicopter, Boeing, McDonnell Douglas and Sikorsky, and several key industry suppliers, and the RCOEs, then Georgia Tech, the University of Maryland, and Rensselaer Polytechnic Institute (later replaced by Penn State University).

The initial focus of NRTC was on improved affordability. From a DoD perspective, the government sought to pursue technologies which would improve weapon systems performance more affordably. And both DoD and NASA sought cost reductions that would reduce the acquisition, operation and maintenance costs of military and civil rotorcraft systems.

Over time, variable funding resulted in FAA, Navy and NASA financial support for NRTC fluctuating, although the Navy and NASA consistently provided support through personnel and other resources. In terms of budget, the heavy lifting has been performed by the Army, with NASA support for many years and, in recent years, support from the Navy. What NRTC did accomplish, however, was twofold: it acted as a clearinghouse for competing RDT&E projects, thus avoiding duplication of effort; second, it brought industry into the picture. Industry, through RITA, would match investments by the government partners. Also, industry could propose projects of interest, which NRTC would prioritize in terms of value to the rotorcraft community. And NRTC's leadership would insure the various projects were not duplicative. Though the Army continued to fund the RCOEs, they would benefit through a shared Army/NASA/Industry approach to those science and technology projects that would be of greatest support to rotorcraft R&D.

As some say (with humor), no good deed goes unpunished. On December 20, 2000, the White House and the Department of Defense awarded the NRTC Vice President Al Gore's "Hammer Award," the term "hammer" referring to the \$400 tool that was cited in the previous decade as an indication of inefficiency in government. Key partners recognized in the DoD ceremony included Andrew W. Kerr, U.S. Army; Dr. Henry McDonald, NASA; John C. McKeown, U.S. Navy; Steve Zaidman, FAA; John F. Ward, NASA; and Dr. Daniel P. Schrage, Dr. Inderjit Chopra, and Dr. Edward Smith for the Rotorcraft Centers of Excellence. Also recognized was M.E. Rhett Flater, AHS Executive Director, for the Society's support in creating both NRTC and RITA. NRTC collaboration, according to the citation, had led to a set of strategic thrusts which had improved

quality of life, cut the cost of critical military systems, and achieved affordable air travel. (Ref. 71)

The AHS 50th Anniversary (May 10-12, 1994, Washington, D.C.)

The American Helicopter Society celebrated its 50th anniversary in grand fashion at the Sheraton Wardman Park Hotel in Washington, D.C. on May 10, 11 and 12, 1994, with industry leaders from nearly all of the Society's 26 domestic and international chapters in attendance. Presentations by major company CEOs on the future of rotorcraft technologies shared top billing with sessions on "The Digital Battlefield" and "Helicopter Technologies of Japan." The technical program, crafted by Boeing's Dr. John Shaw and Colonel Emmett F. Knight, included special sessions on "Affordability," "Virtual Prototyping," and "Integrated Process Design," and featured overall more than 120 papers on cutting-edge design and manufacturing issues. The Vertical Flight Foundation reception, attended by more than 1,500 members and guests, was held at the prestigious Corcoran Art Gallery, which AHS had reserved exclusively for the occasion. (Ref. 72)

But it was a gathering of Society founders and industry pioneers — Stanley Hiller, Jr., Frank Piasecki, Ralph P. Alex, Bartram Kelley, Charles H. Kaman, and Chet Mayerson — who stole the limelight with an "industry critique," moderated by Dr. Richard M. Carlson. Interspersed with accounts of the early entrepreneurial days, the risks inherent in testing early designs (Leonardo da Vinci, who could not be present, recommended that his device be tested over water), and the trials and tribulations of building helicopters in the late 1930s and early 1940s, the founders offered opening day registrants sage advice on industry's goals in these changing times ("improved affordability, reliability and safety," for the record). And though the three day event was billed as AHS's Forum 50, it could have easily been another time and place, such as the First AHS Dinner held October 7, 1944, at New York's Hotel Ambassador.

Preparations for the anniversary celebration had begun soon after Flater's arrival at AHS. During 1992 and 1993, AHS representatives had met on multiple occasions with the senior staff of the National Air and Space Museum (NASM). The museum curator and staff had an interest in replacing the existing helicopter exhibit (a restored Marine Corps UH-34 Choctaw) with a Vietnam jungle scene depicting a Dustoff (UH-1) rescue. AHS proposed a more futuristic alternative, a 19-passenger civil helicopter capable of simulating a picturesque flight down the Washington mall from the Capitol to the White House. AHS's C. Harry Parkinson, president of Advanced Technologies, Inc. prepared detailed plans, drawings and a model mock-up which Flater and Smith presented to NASM. For a while, it appeared the plan might be successful, though NASM officials were concerned whether and how industry would cover the high costs required by NASM. Before long, a

decision within NASM was made, instead, to install the restored WWII *Enola Gay* in what used to be the rotorcraft gallery. And, after a considerable amount of effort, that was the end of it. To this day, rotorcraft are not represented in the galleries of the main museum building on the Washington Mall and have only a small display area in a corner of the Udvar-Hazy Center.

But the Society found an alternative, which was the publication of *From da Vinci to Today and Beyond: The Top Technology Achievements in Vertical Flight History*. (Ref. 73) Conceived, published and edited by Kim Smith, in collaboration with, and at the direction of, George T. Singley, III, then-Deputy Assistant Secretary of the Army Research and Technology/Chief Scientist, AHS Board Member and later Chairman, supported by Dr. John Shaw, then-Boeing Chief Scientist and AHS Technical Director, the publication presented a collection of papers by aviation leaders detailing the history and importance of vertical flight achievements. Contributors included a “Who’s Who” of the vertical flight technical community: Dr. Richard M. Carlson, Franklin D. Harris, Raymond W. Prouty, Andrew W. Kerr, Dr. Francis X. Hurley, Henry “Hank” Lee Morrow, George T. Singley III, Anton J. Landgrebe, Euan Hooper, Peter J. Arcidacomo, Bartram Kelley, Evan A. Fradenburg, Bernard Lindenbaum, John J. Schneider and Dr. Alfred Gessow. Schneider constructed a fascinating timeline sidebar putting each chapter into historical perspective.

AHS Industrial Base (Congressional) Testimony before Congress (March 7, 1995)

On April 1, 1995, AHS distributed the first issue of *AHS Executive Briefs*, a discussion of major policy and technical developments impacting the world rotorcraft community. (Ref. 74) Distribution, however, was limited to just 100 persons, including the CEOs and Engineering Vice Presidents of the Society’s Class A and B corporate members. It was an early attempt to engage industry leaders in advocacy. The first issue focused on specific testimony on the rotorcraft industrial base given March 7, 1995, by AHS before the House Committee on National Security, chaired by Representatives Duncan Hunter (R, CA) and Curt Weldon (R, PA). Because it was a “joint committee,” it was attended by the powerful House Armed Services Committee Chairman Floyd Spence (R, SC) and Representative Don Dellums (D, CA), the Ranking Minority Member.

At the hearings, Flater profiled changes in employment levels and gross revenues of the major U.S. helicopter airframe manufacturers. For example, total employment had dropped from a peak of 37,017 in 1987 to a current level of 27,368, a drop of more than 26%, while revenues during the same period had declined 9% from \$5.86 billion to \$5.34 billion. At the same time, industry had become more efficient, with revenues per employee increasing more than 30% in constant terms from \$150,000 in 1989 to \$195,200 in 1994.

In response to a question from Representative Dellums, Flater explained that the industrial base might appear adequate in the short-term, but within five to ten years, without additional investment in R&D and new production programs, it would not be sufficient to meet future national security requirements. Nor, without further investment, would the U.S. industry continue to be competitive in world markets. It was an early warning regarding the declining state of the U.S. industrial base.

AHS Technical Specialists’ Meetings

AHS’s chapter programs, more specifically their emphasis on AHS Technical Specialists’ Meetings, began assuming increasing importance. The AHS Hampton Roads Chapter, as befitting a chapter collocated next to NASA Langley and Fort Eustis, had for many years supported well-attended programs focused on military operations, propulsion and structures. The San Francisco/Bay Area Chapter, given its proximity to NASA Ames and AFDD, had long supported highly popular specialists’ meetings focused on aeromechanics and aircraft design. For years, these meetings had dominated the Society’s Technical Specialists’ Meeting agenda. Timely and topical meetings have also been hosted by AHS chapters in Stratford, Philadelphia, Fort Rucker, Ft. Worth, Los Angeles, Phoenix, Montréal, etc.

In October 1998, the Society’s Federal City Chapter, based in Washington, D.C., planned and hosted a carefully-conceived program focused on future rotorcraft requirements. Its subject was timely and appropriately titled “The First Joint Future Rotorcraft Program: Requirements and Technologies,” and it was led by Chapter President David S. Ferrell. (Ref. 75) The program provided an opportunity for all the military service branches to share their respective vertical flight visions with the Pentagon leadership, as well as industry and technology developers. It was attended by all of the major service aviation leaders, industry and engineering leaders, and senior representatives and leaders from the government acquisition and technology community. Ferrell carefully framed the key issues: What are the various services’ perspectives on the most likely mission profile for a Joint Transport Rotorcraft (JTR), including range, payload, speed and other unique characteristics; what other joint rotorcraft programs did the service branches envision and why; what were the top five enabling technologies critical to the JTR; and, finally, what commercial, off-the-shelf technologies currently existed that might be leveraged.

The meeting marked the beginning of a serious, long-anticipated (many would say, “long overdue”) discussion concerning future military rotorcraft requirements and programs. The issues raised and discussed would later be embodied in a DoD-wide “Joint Vertical Aircraft Task Force (2004),” whose purpose was “to define a path forward for vertical aircraft science and technology investment, infrastructure, research and development and procurement

for manned aviation,” and, eventually, “The Future Vertical Lift Study (2011).”

NASA Aeronautics in Crisis (1990-2005)

Beginning in the early 1990s, it was becoming increasingly evident that NASA’s commitment to space exploration and other priorities was overwhelming its limited \$13.665 billion budget and eclipsed the agency’s historic interest in aeronautics. By 1999, it was readily apparent that the agency’s trend away from aviation was accelerating. In fiscal year 1999, NASA’s investment in aeronautics research and technology declined to \$768.9 million, less than 5.6% of the total budget. NASA then submitted a fiscal year 2000 budget in which two key aeronautics programs (high speed research and advanced subsonic technology) were zeroed out. As a result, aeronautics would represent less than 4.8% (\$620 million) of the agency’s proposed \$13.578 billion budget, a reduction of nearly \$150 million. The Office of Management and Budget, supported by NASA’s senior leadership, had applied these funds to the international space station.

The proposed program eliminations would directly impact NASA Ames scientists, engineers and technical staff who, with modest resources, were working on a concept for a 40-passenger civil tiltrotor, an aircraft that might dramatically alleviate airport congestion. It raised the question, highlighted in a 1999 Commentary by M.E. Rhett Flater titled “NASA Aeronautics: In Breach of Promise,” “How important are aviation safety and capacity enhancement to NASA’s (and America’s) leadership?” Based on the agency’s funding priorities, it appeared clear that the international space station and similar priorities had completely displaced aviation as a NASA concern, the article concluded. (Ref. 76)

On July 9, 1999, Dr. Kenneth M. Rosen of Sikorsky, in his role as chair of NASA’s Rotorcraft Advisory Committee, sent a letter to NASA Administrator Dan Goldin expressing his alarm about proposed reductions to the rotorcraft base program. In his message, Dr. Rosen commented that the subcommittee had previously concentrated on providing positive program guidance to (NASA Associate Administrator for Aeronautics) General Armstrong and the NASA Directors “and had steered away from criticizing previous budget reductions.” He added, “But we can no longer be silent.” (Ref. 77)

Meetings with NASA Senior Leadership and DDRE Dr. Hans Mark (1999)

On Monday, July 12, 1999, AHS and industry representatives met at NASA headquarters with senior NASA officials to discuss the proposed reductions in the FY00 NASA budget impacting rotorcraft programs. Attending for NASA were General Jack Dailey, NASA Deputy Administrator, General Sam Armstrong, NASA Associate Administrator for Aeronautics, and Mike Mann,

Deputy Associate Administrator for Aeronautics (Finance). In addition to Flater, industry was represented by George Price (Sikorsky); David Snyder and Gordon Thomas (Bell Helicopter); John Shaw and Pat Shondel (Boeing).

General Dailey expressed his appreciation that industry was united in expressing support for rotorcraft programs and observed that since 1998 aeronautics funding had declined by one-third. He urged AHS to work as a coalition with other associations — such as AIA, AIAA, AOPA — to remedy the problem, and offered his support in arranging a meeting with senior officials at the White House Office of Budget and Management. He indicated that NRTC was a “model joint program” between the Army and NASA and offered his support, and he encouraged AHS and members of industry to support, jointly and publicly, the need to preserve NASA’s “core competency” in rotorcraft. (Ref. 78)

Two days later, on July 14, 1999, AHS and industry representatives met at the Pentagon with Dr. Hans Mark, Director, Defense Research and Engineering, and Dr. A. Michael Andrews, Deputy Assistant Secretary of the Army for Research and Technology/Chief Scientist. In addition to Flater, industry was represented by Dr. John Shaw and Pat Shondel (Boeing), David Snyder and Gordon Thomas (Bell), and Dr. Kenneth Rosen, George Price and Robert E. Kenney (Sikorsky). Dr. Mark expressed his concern regarding the proposed NASA budget cuts and offered his support.

Dr. Mark suggested an argument along the following lines: “The U.S. won the war in Kosovo because of airpower; the aircraft were designed 20 to 30 years ago, when NASA played an important role in military aircraft design; today, NASA’s investment in aeronautics has declined by more than 50 percent; without further investment, it is questionable whether U.S. airpower will win future wars as handily.” He stressed that arguments based on national security would resonate far better than those based on civil/commercial issues, such as capacity throughput or industry competitiveness. Dr. Mark concluded that there was much that DoD, Industry and Congress could do together to create an appropriate future climate for NASA aeronautics. (Ref. 79)

In Hans Mark, AHS and industry had found within the DoD an expert on the subject of NASA aeronautics. In a previous life (1969-1977), he had served with distinction as Director of NASA Ames Research Center. He was thoroughly familiar with the history of DoD/NASA cooperation, and had assisted in implementing the Army-NASA Joint Agreement and the development of the XV-15.

On the same day, July 14, Congressmen Curt Weldon and Joe Barton jointly forwarded a letter to Daniel Goldin, NASA Administrator, expressing their concern about the FY00 budget reduction impacting rotorcraft base programs for research and development and the importance to national security that NASA maintain its “core competence in rotorcraft.” (Ref. 80)

White House OMB Meetings — NASA Aeronautics (1999)

Many of the problems rotorcraft programs at NASA were encountering had their origins in directives from the White House Office of Management and Budget. Accordingly, on September 9, 1999, an AHS delegation met with OMB representatives Steve Isakowitz, Chief, Science and Space Programs Branch, and Brant Sponberg, Program Examiner. The AHS delegation consisted of George Price, Director, Advanced Projects, Sikorsky Aircraft; Dr. John Shaw, Chief Scientist, The Boeing Company; David Snider, Vice President — Engineering, Bell Helicopter Textron; Gordon Thomas, Director, Legislative Affairs, Textron, Inc.; and M. E. Rhett Flater. They presented to OMB a formal “White Paper” on “NASA Aeronautics and the Importance of Continued National Investment in VTOL Research and Development.” (Ref. 81)

In response to the question, “should NASA still be assisting with rotorcraft research,” the AHS team stated that “continued support was imperative, that individual companies could not afford the non-recurring investment to explore all potential technology advances. This is especially true for fundamental research, which leads to large improvements but involves risks and gestation times that cannot meet commercial investment criteria.” They also cited examples of NASA-sponsored research successes, including the agency’s co-sponsorship of the XV-15 tiltrotor experimental aircraft which led directly to the V-22 Osprey, the Model 609, and future tiltrotors including Sikorsky’s variable diameter design.

NASA’s predictive models for rotor noise have led to much quieter rotorcraft and important design tools used by industry to design new aircraft. NASA’s research skills are complemented by important unique facilities to support VTOL research, among them large wind tunnels capable of full scale tests, a motion simulator, and specially configured and instrumented test aircraft. NASA research and facilities also support the NASA-Army Joint Agreement on Cooperative Rotorcraft Research, which leverages and coordinates the investments by the two agencies.

The team’s key concern was to insure that, for FY00, net funding for rotorcraft R&D would be established at \$15 million or more and that for FY01 and beyond funding for all aeronautics programs be increased to historic levels. Ultimately they succeeded in gaining Congressional support for a measure boosting FY01 NASA rotorcraft research to \$30.6 million.

Despite AHS’s and industry’s combined efforts, the Administration and NASA leadership continued to oppose funding for aeronautics in general, and rotorcraft R&D in particular. The Administration’s proposed budget for fiscal year 2002, known as the “Budget Blueprint,” virtually eliminated all funding for NASA rotorcraft research and technology. The cause was a projected \$4 billion cost

overrun on the NASA Space Station, a high priority for the administration and NASA Administrator Dan Goldin.

If successful, NASA’s action would remove all NASA support for the 36-year-old Army-NASA Joint Agreement and the National Rotorcraft Technology Center. According to John Karmark, the majority staff director for the Senate appropriations subcommittee which oversees NASA, “the members can’t trust their (NASA’s) numbers any longer. This is an agency in distress.”

Bell, Boeing and Sikorsky mounted last-ditch efforts to reverse the Administration’s FY02 decision. They were prepared since the decision had already been disclosed to the Army in early March 2001. AHS Executive Director Rhett Flater and Boeing Phantom Works vice president Andy Logan met with White House transition chief and associate of President George W. Bush, Courtney Stadd, at NASA headquarters to press the case for continued rotorcraft research.

Soon thereafter, an AHS/industry delegation carried the same message to senior government officials at the White House Office of Budget and Management. The high level delegation included Roger Krone, Vice President for Army Programs at Boeing and AHS Chairman; John Murphey, Bell Helicopter President; Rene Beauchamp, Sikorsky Washington Vice President; Walter Sonneborn, Bell Helicopter Vice President; Dr. John Shaw, Boeing Chief Scientist; Gordon Thomas, Textron Vice President; and Flater. The plan was to describe to OMB program reviewers the value of helicopter aviation research and development and NASA’s vital role through its test facilities and partnership with the Army in insuring RDT&E was performed on advanced rotorcraft technology. These efforts, however earnest, ultimately proved unsuccessful.

AHS’s “Letter to the President,” — *The Washington Post* (March 27, 2001)

Finally, with unanimous support from the AHS Executive Committee and the CEOs of Bell, Boeing and Sikorsky, the Society published a message titled “Letter to the President” in the *Washington Post* on March 27, 2001, as a one-fourth page, paid advertisement in the early pages of the newspaper. (Ref. 82) The letter, in bold print, began,

Dear Mr. President:

Aeronautical Research in this country is in crisis. Under the ten year leadership of Dan Goldin, NASA’s aeronautical research programs have been scaled back to the point of non-existence. A case in point – the NASA Administrator’s plan to eliminate ALL funding for rotorcraft research and technology in the FY02 budget. We believe this represents a precarious leap in the wrong

direction and respectfully urge you to reverse this decision.

The message listed the many accomplishments of rotorcraft in civil and military arenas, the Army-NASA partnership, and the high national security value of NASA's test facilities. It was signed by M.E. Rhett Flater, AHS Executive Director, though it had the approval of (and funding from) all major U.S. rotorcraft platform industry CEOs.

Appearing prominently in the first news section of the *Washington Post*, the letter was immediately read by senior White House advisors to the President, including the Office of Science and Technology Policy, the Office of Management and Budget, Department of Defense and service branch leaders, as well as NASA's leadership. It was also noted by Congressional members and staffers of the authorizing and appropriations committees which fund NASA and the DoD. Until this time, NASA's and OMB's gradual dismemberment of NASA aeronautics was barely visible to most. Few in government power were actually aware of the extensive, and costly, implications of NASA's internal policy to reduce or eliminate "aeronautics" from the agency's charter.

The letter succeeded in rallying support from government and industry, receiving immediate endorsement by key Congressional members and staff. In the week following its publication, an *Aviation Week and Space Technology* report highlighted the decline in funding for NASA aeronautics and rotorcraft programs. The NASA alumni league, composed of powerful supporters of NASA aeronautics, were energized, and many aerospace and professional technical associations published the letter in their online and printed media. The strategy to expose — publicly — NASA's failure to fund aeronautics ultimately proved highly successful. Dan Goldin, the longest serving NASA Administrator, who for nine years presided over the decline of NASA aeronautics, resigned on November 17, 2001. For the many who believed in NASA aeronautics, it was not a coincidence.

Creation of the Congressional Rotorcraft Caucus (June 2001)

During this time, AHS leaders and advisors (including Michael Barbera, former-Representative Curt Weldon's chief of staff) conceived and created a "Congressional Rotorcraft Caucus" composed of Congressional leaders from districts with significant rotorcraft industry. At the request of AHS, on June 6, 2001, Representative Weldon, whose district included Boeing rotorcraft, signed and circulated a joint letter to Congressman James T. Walsh, the powerful chairman of the House Appropriations Subcommittee for VA, HUD and Independent Agencies (the subcommittee which governs NASA appropriations).

Citing the vital role of the Army-NASA Joint Agreement and NRTC, the letter requested restoration of \$39 million in funding for NASA rotorcraft R&D base programs. Its

phrasing closely paralleled the Society's "Letter to the President." The letter was co-signed by Representatives Joe Barton, Robert E. "Bud" Cramer, Jr., Jo Ann Davis, Steny Hoyer, Mike Pence and Dennis J. Kucinich, several of whom were powerful subcommittee chairs. All expressed support for the Society's position. The letter marked the first formal act of the "Congressional Rotorcraft Caucus." (Ref. 83)

On October 2, 2001, AHS submitted a letter request to Senator Ted Stevens, a conference member of the Joint House Senate Conference Committee considering the FY02 budget, and specifically an augmentation of \$15 million for NASA rotorcraft research and technology. Though the Senate had previously approved the appropriation, the Conference Committee was required to approve the Senate mark or it would not be part of the FY02 budget submitted to the President. The letter, signed by Roger Krone, John R. Murphy, Dean C. Borgman and M.E. Rhett Flater, made its point effectively and the final bill sustained funding for NASA rotorcraft programs. Congress earmarked \$12.5 million for NASA rotorcraft research in fiscal year 2002. Subsequently, NASA agreed to allocate \$15 million within its overall Vehicle Systems Technology line item in fiscal years 2003 and 2004 for rotorcraft research. (Ref. 84)

The Administration and key NASA officials tried again to reduce or eliminate funding for aeronautics in the fiscal year 2005 bill. Again, the House Appropriations subcommittee restored funding for NASA at \$15.1 billion (\$1.1 billion below the President's request). The committee report commented, "While the committee is supportive of the exploration aspect of NASA's vision, the committee does not believe it warrants top billing over science and aeronautics." (Ref. 85) The subcommittee earmarked funds for both aeronautics research, an area NASA sought to cut, and materials research in space.

Despite this success, funding for NASA aeronautics would continue to be a major issue within the administration and senior levels of NASA. Funding for NASA aeronautics declined over 12 fiscal years from a high of \$1.54 billion in FY94 to \$852.3 million (the figure requested in the President's FY06 Budget Request or PBR). During this time, aerospace employment had declined from 1.3 million highly skilled people in 1990 to just 600,000 in 2004.

The 2006 PBR proposed a reduction in spending for NASA aeronautics in 2006 from \$956.7 million (as outlined in the FY05 President's Budget) to just \$852.3 million — a \$104.4 million cut. NASA aeronautics had sustained the largest budget cut of all the NASA directorates. The Budget Request, moreover, completely eliminated funding for rotorcraft research in FY06 and beyond.

AHS Letter (NASA Aeronautics) to Senate Appropriations (May 3, 2005)

AHS prepared and forward a letter dated May 3, 2005 to Senator Mike DeWine (and similar letters to all other members of the Senate Appropriations Committee) pointing out that within NASA aeronautics, the Vehicle Systems Budget — which covers nearly all of NASA basic rotorcraft research — had been reduced \$147.3 million from \$606.4 million to just \$459.1 million. (Ref. 86) In FY07, Vehicle Systems would be reduced an additional \$85.5 million to just \$373.6 million, as shown below:

Year	2005	2006	2007
Total Aeronautics	919.2M	852.3M	727.6M
Total Vehicle Systems	606.4M	459.1M	373.6M
Rotorcraft Research	~30.0M	0.0M	0.0M

The Vehicle System budget line, however, supported almost all of the basic, long-term, high-risk, innovative research in the aeronautical disciplines. NASA’s Vehicle Systems program supported government, university and contractor researchers, and the national test facilities, such as wind tunnels and propulsion test facilities at the NASA Research Centers.

The letter requested support for restoring the NASA Vehicle Systems budget to \$606.4 million. Of this sum, AHS requested that 20 percent of this sum, or \$29.46 million, be allocated to basic rotorcraft research — the historic average prior to 2006. The letter noted that this work had historically been performed by NASA Ames Research Centers at Ames (California), Glenn (Ohio) and Langley (Virginia). The rotorcraft engineering community at each of these sites had been placed on the “transition workforce,” just a step away from termination. The letter noted the adverse impact on the Army — NASA Joint Agreement to Collaborate on Rotorcraft Research, the National Rotorcraft Technology Center, and the academic “Rotorcraft Centers of Excellence,” including Penn State University, the University of Maryland and Georgia Institute of Technology, plus many other universities, all of which were threatened by the proposed FY06 PBR.

In this effort to restore funding for NASA aeronautics, AHS was joined in a coalition with other well-respected aerospace and professional technical societies. Participating organizations were Aerospace Industries Association (AIA), American Institute of Aeronautics and Astronautics (AIAA), the Society of Automotive Engineers (SAE), and the American Society of Mechanical Engineers (ASME). The letters were delivered by hand to members of Congress and staff. The FY06 effort to restore NASA aeronautics proved successful and both NASA aeronautics and rotorcraft programs would live another day.

Congressional Rotorcraft Caucus — FY07 Funding Increase for NASA Aeronautics

The Congressional Rotorcraft Caucus once again came to the aid of the U.S. helicopter industry on May 8, 2007, when ten members of the Caucus endorsed a letter to NASA Administrator Dr. Michael D. Griffin requesting that \$102.5 million of a \$166 million plus-up for the NASA budget be allocated to Fundamental Aeronautics, a key program that includes rotary-wing research. In a letter response to Caucus members, Dr. Griffin confirmed that the agency had allocated \$93.1 million of the FY07 increase to Fundamental Aeronautics Programs. The subsonic rotary-wing project received an additional \$12.8 million. These funds, according to Dr. Griffin, would be used to modernize key facilities of interest to the rotary-wing community, enhance opportunities for evaluation, validation and testing of novel rotor and rotor control approaches, and to enhance existing partnerships with the Army, DARPA, the Air Force, and industrial collaborators. (Ref. 87)

Historic NASA Aeronautics Test Facilities Threatened (2003 – 2006)

During the same period, NASA faced yet another threat.

The 40 x 80 foot wind tunnel located at NASA Ames, Moffett Field, California had been in continual use since its June 1944 dedication and had long been regarded as one of Ames’s most important facilities. As low-speed Vertical/Short Take-off and Landing (V/STOL) work gained in importance, the huge tunnel was operated continuously to accommodate the many demands on it. In 1973, it was refurbished and a few years later an extension was added to create a second test section, an 80 x 120 foot offshoot attached to the original tunnel. This increased the versatility of the tunnel, now known as the National Full-Scale Aerodynamics Complex (NFAC), and greatly expanded its applications in testing full-scale rotor systems.

Cooperation with the Army for joint research in VTOL studies was greatly expanded in 1969, when Army personnel at Ames doubled. And in 1970, the Army consolidated its aviation research and development as the Army Air Mobility Research and Development Laboratory (AMRDL) with headquarters at Ames, supported by Fort Eustis. But this was to change with the declining NASA budget for aeronautics.

In the spring of 2003, NASA announced its decision to inactivate three subsonic wind tunnels at the Ames Research Center in California. Two of those tunnels, the 40 x 80 foot tunnel and the 80 x 120 foot tunnel that comprise the NFAC, are the largest and second largest wind tunnels in the world that supported industry’s requirements for scale and full-scale rotorcraft testing. The third tunnel is known as the 12-Foot Pressure Wind Tunnel. NASA argued that if sufficient workload did not materialize by the end of fiscal year 2004 to allow those tunnels to remain open on a self-sustaining basis, the agency would close them permanently. This

decision took place at a time when NASA was implementing a policy of recovering the full costs of operating and maintaining test facilities from customers of those facilities worldwide (the practice became known as “full-cost accounting”).

The full-cost accounting system was a clear departure from previous NASA financial practices. Prior to launching the full-cost initiative in 1995, NASA provided wind tunnel services to various government agencies, particularly the Department of Defense, without charge.

In meetings and correspondence with senior DoD and NASA representatives, AHS pointed out the deleterious impact on DoD aerospace programs and national security of the closure of NASA’s full-scale wind tunnels at the NFAC, and in particular the impact on rotorcraft research in the United States. And this was occurring at a time when new rotorcraft missions and requirements were emerging in both the national defense and homeland security sector. AHS and others also pointed out that a provision of the Code of Federal Regulations (CFR) provided that no fee will be charged for industry work on Government projects in NASA wind tunnels. That provision was inconsistent with NASA’s implementation of full-cost recovery accounting.

Institute of Defense Analyses Report — NFAC (2004)

The Institute for Defense Analyses, in April 2004, took note of these developments and published a study for the DoD’s Office of the Director, Operational Test and Evaluation, titled “Effect of the Proposed Closure of NASA’s Subsonic Wind Tunnels: An Assessment of Alternatives.” (Ref. 88) Dennis O. Madl served as Project Lead; he was supported by Terrence A. Trepal, Alexander F. Money and James G. Mitchell. The report strongly supported the reopening of the NFAC, citing the impact NASA’s closure would have on rotorcraft research, and added cautionary words:

Other effects, related to both the NFAC and the 12-Foot Pressure Wind Tunnel, are that aircraft developers will need to use foreign facilities for development of advanced military systems requiring low speed testing. Dependence on foreign facilities can jeopardize timely and affordable access to testing and sometimes could result in lesser test capability. In addition, foreign exposure will place our newest and most technologically advanced systems at risk for the compromise of design information.

As a result of the inactivation of the subsonic wind tunnels at the Ames Research Center, both Government and contractor personnel have been either reassigned or separated. The resulting loss of expertise in research, development and test and evaluation, on the one hand, and wind tunnel

maintenance and operations, on the other, will make recovery difficult and time-consuming.

The report concluded, “We found that the decision to close the tunnels appears to be inconsistent with the “Financial Management” portion of NASA’s 2003 Strategic Plan, which reads in pertinent part, ‘NASA is responsible for complex and high-value systems such as . . . wind tunnels . . . that are unique in the world. These activities represent large investments by the American public.’”

It added that NASA’s decision to mothball the NFAC and the 12-Foot Pressure Wind Tunnel at NASA Ames Research Center was the result of multiple factors: the decline in aeronautical research in the United States, the lack of new aircraft development programs, the diversion of some wind tunnel testing work to alternate test facilities (including those in foreign countries) (this was a reference to Lockheed Martin’s decision to conduct Joint Strike Fighter testing at DNW in The Netherlands, rather than incur the large costs of using the NFAC), the decision to curtail NASA funding for rotorcraft research and development, and the implementation of full-cost accounting and full-cost recovery.

Cumulatively, these factors had created a situation in which the subsonic wind tunnels at NASA Ames would be unable to generate sufficient workload (at fully burdened rates) to operate on a self-sustaining basis.

The preferred solution, according to the IDA study, was for the Department of Defense to “assume ownership of or lease the NFAC (and possibly the 12-Foot Pressure Wind Tunnel), assume operational responsibility, and upgrade the facilities to meet current and future needs.” Under DoD management, the facilities could be operated in a high-production mode, providing products on a more cost-effective and timely basis. Under NASA operation, the facilities were operated more as laboratory facilities; this was reflected in higher cost per data point and longer time to deliver test results. DoD management would also place the pricing of tests in the tunnels under the partial cost-recovery model of the Major Range and Test Facilities Base, which would provide some relief to the customer. (Ref. 89)

Within the Army, Andrew W. Kerr, then Director of the Army Aeroflightdynamics Directorate at NASA Ames, provided the DoD and the Army guidance, information and leadership critical to a solution of the threatened closures. Supporting Kerr’s arguments and the IDA conclusions were the Society’s leadership, particularly John Murphy, CEO of Bell Helicopter Textron, along with other industry leaders, including CEOs and engineering vice presidents. All met at various times with the study’s authors to provide essential information.

The NFAC and the 12-Foot tunnels were officially closed on May 16, 2003. Such was the pervasive impact of “NASA full-costing” that on February 17, 2005, Thomas Irvine, then-Deputy Associate Administrator of the NASA

Aeronautics Research Mission Directorate (ARMD), issued an internal NASA memo listing additional national testing facilities about to be closed. Among them were the 10x10 Supersonic Wind Tunnel, the Hypersonics Test Facility, the Engine Research Building and the Propulsion Systems Laboratory — all located at Glenn Research Center. At Langley, the list included the 14x22 Subsonic Tunnel, the Low Turbulence Pressure Tunnel, the Vertical Spin Tunnel, the National Transonic Facility, the Transonic Dynamics Tunnel, the Unitary Wind Tunnel, and other facilities. (Ref. 90)

This directive would effectively close all major aeronautics ground test facilities used by the aviation and rotorcraft industries. This marked a new low-point for NASA aeronautics and NASA rotorcraft programs.

Fortunately, several years later NASA Administrator Michael D. Griffin (2005-2009) and Lisa Porter, Associate Administrator for Aeronautics, announced in 2006 a new directive that attempted to correct mistakes committed in the name of full-costing years before. Effective in fiscal year 2007, the allocation of work to the respective centers would become a strategic responsibility of NASA headquarters. And it would become the agency's responsibility to maintain key national test facilities — not the centers and not the projects that perform work at the centers. It was an important step in the right direction, the first in many years. (Ref. 91)

Soon thereafter, as the IDA study (and AHS) recommended, it was announced that the Department of Defense would lease the National Full Scale Aerodynamics Complex (though NASA would retain ownership). DoD would place the NFAC under the operational leadership of the U.S. Air Force and the Arnold Engineering Development Center (AEDC), and proceed with a massive \$14 million upgrade funded by the DoD. The decision, in which both DoD and NASA concurred, saved not simply the test facilities, but the jobs of many NASA and contractor engineers, scientists and technical personnel. The newly refurbished NFAC reopened in 2010, using marginal rather than full-costing. USAF Colonel Vincent Albert assumed leadership of the NFAC with a civilian deputy provided by the Army Aeroflightdynamics Directorate.

Today the NFAC is one of the most utilized of all NASA (now managed by the DoD) test facilities, particularly by the DoD and its contractors. It is yet another instance in which AHS advocacy supported and, ultimately, preserved the rotary-wing industrial base and RDT&E infrastructure.

THE ROTORCRAFT INDUSTRIAL BASE, POST-RAH-66 COMANCHE

Growing Concerns about the State of the U.S. Industrial Base

Within the Department of Defense, many senior officials were not convinced that the industrial base was in jeopardy.

In a study on the rotorcraft industrial base, “Industrial Assessment for Helicopters,” prepared during the 1994-1995 period under the direction of John Goodman, Deputy Assistant Secretary of Defense (Industrial Affairs), the Department concluded that it “intends to allow the natural forces of the market to determine the make-up of the helicopter industry. Industry consolidation is occurring in response to declining DoD requirements, increased international competition, and excess capacity. To date, most helicopter consolidation has occurred in the subsystems/component portion of the base. Many industry observers believe that consolidation at the prime level may occur. This process will eliminate excess capacity, reduce attendant overhead costs, and thereby reduce costs to DoD. . . . DoD expects that helicopter industrial capabilities will be retained after consolidation and will be ample to meet DoD requirements.” (Ref. 92)

One highly knowledgeable *Vertiflite* reader, Dr. Richard M. Carlson, warned in a letter to the editor, “it is the writer’s view that it is not timely (five years late) and it’s not responsive to its charter. . . . The report contains little, if any, useful data relating to the dramatic shift that has occurred in the U.S. share of the domestic and international commercial market, and it makes only a minimal effort to consider the future requirements and potential, both military and commercial, of the foreign marketplace The appropriate question to ask is, ‘What will the capability and economic viability of the U.S. helicopter industry be if the U.S. military abandons its traditional role as the primary natural force and principal customer?’” (Ref. 93)

AHS Congressional Testimony (HASC) (March 12, 2003)

In discussions with Rep. Curt Weldon at his Congressional offices, Flater, joined by other AHS leaders increasingly expressed their views on the post-Cold War decline of the U.S. rotorcraft industrial base. On March 12, 2003, with the support of the AHS Board, Executive Director M.E. Rhett Flater testified before the House Armed Services Committee, Subcommittee on Tactical Air and Land Forces. The subject was “The U.S. Rotorcraft Industrial Base.” In that testimony, Flater observed that during the period from 2001 to 2003, rotorcraft research performed by the Department of Defense and NASA had declined from \$113.6 million to \$56.3 million, largely because of NASA’s failure to fund rotorcraft research.

Long-term cooperative efforts between NASA and the DoD in rotorcraft research, in particular the Army-NASA Joint Agreement, were in serious turmoil. Should the trend continue, Flater warned, the DoD may eventually become dependent on non-U.S. suppliers for future mobility requirements. To remedy the situation, the U.S. government, specifically the DoD and NASA, should work toward providing sustained and predictable investments in basic aeronautics research, including rotorcraft. (Ref. 94)

DoD Establishes Joint Vertical Aircraft Task Force or JVATF (February 14, 2004)

On July 11, 2003, Under Secretary of Defense for Acquisition, Technology and Logistics (Acting) Michael W. Wynne directed the leaders of the four military service branches, as well as the Commander of the Special Operations Command and the Chief of the National Guard Bureau, to create a “Joint Vertical Aircraft Task Force (JVATF) to define a “path forward” for vertical lift aircraft science and technology investment, infrastructure, research and development and procurement for manned vertical aviation. In the same directive, he asked the JVATF to develop a roadmap addressing recommended courses of action. Dr. Glenn F. Lamartin, Director for Defense Systems, was given oversight of this initiative. Subsequently, Dr. Lamartin, by letter dated January 13, 2004, requested AHS International to provide its views on a range of questions of interest to the task force.

AHS moved quickly to address Dr. Lamartin’s request, hosting a meeting at Boeing’s conference facility in Rosslyn, Virginia, on February 23. The meeting was attended by representatives from Bell Helicopter Textron, Lockheed Martin, Sikorsky Aircraft, The Boeing Company, and government (among the government representatives was Michael Walsh, representing Dr. Lamartin). The outcome of the meeting was an AHS written brief on the topics of interest outlined by the JVATF, captioned “Representative Views of AHS International and the U.S. Rotorcraft Industry.” (Ref. 95)

The Society’s formal response, dated February 23, 2004, outlined key features of heavy lift aircraft that should dominate the Department’s thinking and the importance of a joint DoD/Industry focus on advancing air vehicle technologies, such as structures, rotors, interactional aerodynamics, vehicle management, power (including drivetrain and engines) and payload interface. AHS recommended two approaches: first, a flying technology demonstration program featuring two or more different concepts; and, second, funding of technology base programs critical to rotary-wing development.

On the following day, February 24, 2004, the Department of Defense and the Department of the Army announced the cancellation of the RAH-66 Comanche program, long the centerpiece of Army aviation planning for the future. This was due, largely, to changing requirements, resulting program delays, cost overruns, and budget limitations. The nation was engaged in fighting (and funding) two wars simultaneously in Iraq and Afghanistan. Despite the negative connotations relating to the program’s termination, General Richard A. “Dick” Cody, Deputy Chief of Staff for the Army, offered high praise for the Comanche. During a press conference on the day the cancellation was announced, Cody complimented both major contractors, Boeing and Sikorsky, saying “They built a tremendous aircraft. It is the most flexible, most agile aircraft that we have produced in this

country, and the people that built it ought to be very, very proud (of its) tremendous flying characteristics and leap-ahead technology.”

But General Cody left no doubt that the Army’s budgetary needs, specifically its conduct of the wars in Afghanistan and Iraq and the need to upgrade its entire aviation fleet, took a higher priority.

Access to International Markets; Economic Offsets

With the prolonged decline in U.S. defense spending throughout the 1990s, the lack of any rotorcraft program “new starts,” outright program cancellations, and an anemic civil/commercial market, the major U.S. rotorcraft primes were compelled increasingly to turn to international markets in Europe, the Middle East and Asia. Without access to those markets, Bell, Boeing, McDonnell Douglas and Sikorsky, and the major turbine engine primes, General Electric, Honeywell and Pratt & Whitney, would sooner or later be forced to close major production lines with the loss of thousands of skilled workers. Competition from European manufacturers, such as Agusta, Westland (now AgustaWestland Finmeccanica) and Eurocopter (the former Aerospatiale and MBB, now Airbus Helicopters) and Russian manufacturers Mil and Kamov was fierce.

To win international business, U.S. firms were compelled to offer “economic offsets,” often in the form of international licensing agreements, technology transfer, workshare and the purchase of local content. (Ref. 96) On some occasions, the U.S. primes would be required to make direct investments in the local economy of the purchaser. With the passage of time, and support from the Department of Defense, the strategy succeeded: the major military production lines would remain open, but unquestionably many jobs would be sent overseas, generating genuine concern within the U.S. labor market. Of course, with benefit of hindsight, international trade and economic offsets are a two-way street. To better access U.S. markets, Eurocopter Airbus, AgustaWestland Finmeccanica and many other international defense firms have established production facilities and employed American workers in Grand Prairie, Texas, and Columbus, Mississippi (Eurocopter Airbus), Philadelphia, Pennsylvania (AgustaWestland Finmeccanica), and elsewhere.

AHS Congressional (HASC) Testimony (March 4, 2004)

With the cancellation of the Comanche, Congress’s attention quickly returned to the state of the U.S. military rotorcraft industrial base. Congressman Curt Weldon, who then chaired the House Armed Services Committee, Subcommittee on Tactical Air and Land Forces, announced a hearing on March 4, 2004, specifically on “The Aviation Industrial Base and the Department of Defense Rotorcraft Investment Programs.” A letter, signed by Weldon as the subcommittee’s chairman, invited AHS Executive Director Rhett Flater to testify “on the fiscal year 2005 national

defense authorization request, review United States rotorcraft programs, the supporting industrial base and future technology initiatives.”

It was an opportunity to reprise and expand on the Society’s testimony before the same committee on March 12, 2003. Invited witnesses included senior administration representatives, a who’s who of the defense department aviation R&D and procurement leadership — the Honorable Dr. Ronald M. Sega, DDRE; Joseph H. Bogosian, Deputy Assistant Secretary of Commerce; Flater; Major General James D. Thurman, Director, Army Aviation Task Force; Dr. Tom Laux, PEO, Department of the Navy; Rear Admiral Andy Winn, USN, Deputy Aviation Requirements Officer for Helicopters; and Brigadier General Samuel T. Helland, USMC, Assistant Deputy Commandant for Aviation. (Ref. 97)

The testimony initially defined the existing industrial base as including the three major primes, Bell Helicopter Textron, The Boeing Company, and the Sikorsky Aircraft Division of United Technologies; the major engine primes, GE Aircraft Engines, Honeywell, Rolls-Royce Allison; large system integrators, such as BAE Systems, Honeywell, Lockheed Martin, Northrop Grumman, and Raytheon; and the supplier base for materials and assemblies, such as Kaman Corporation, Lord Corporation, Moog, Inc., Smiths Industries, and Hamilton Sundstrand. It also included the Army aviation research establishment, and NASA and DARPA, whose engineers and scientists supported rotorcraft research; and the NASA aeronautics test facilities located at Ames, Glenn and Langley. The base also included the broad academic community which supported rotorcraft research, including the RCOEs — Penn State University, University of Maryland, Georgia Institute of Technology, and others.

Recent world military forecasts were “upbeat,” predicting that production of new-build rotorcraft would rise in 2004 and continue to rise through 2011. The value of military production of rotorcraft in 2012 was expected to be \$9.9 billion, compared with \$4.4 billion in 2004. During the 2004-2013 time frame, Forecast International projected a total of 3,950 new-build military rotorcraft would be produced with a combined value of \$73.7 billion. (By comparison, Wall Street analysts valued civil production for the same period at \$18.8 billion.) Major modification programs over the same 10-year period were expected to add \$12.1 billion in revenues.

The Society’s testimony, however, listed a series of warning signs. First, the rotorcraft industry had seen no new starts since the 1970s (the V-22 program). This meant that the military industry was surviving solely upon upgrades and remanufactures of existing aircraft. Second, with the termination of the Comanche, most existing programs, including the V-22 Osprey, the UH-60L (later -M) Black Hawk, the SH-60 Seahawk, and the H-1 modification program would mature in the early 2010-2016 timeframe. The CH-47 Chinook and AH-64 Apache upgrades would

continue a short while longer. But upon achieving maturity, these production lines would close.

Over the past 50 years, the number of major U.S. aerospace prime contractors had shrunk from more than 50 to just five. Within the U.S. helicopter market, only Bell, Boeing (which had acquired McDonnell Douglas in 1996) and Sikorsky survived. In Europe, Aerospatiale and MBB had merged, as had Agusta and Westland. The U.S. aerospace industry was consolidating to maximize resources, eliminate excess capacity, and, hopefully, access new market segments. Critical parts suppliers had undergone a similar contraction.

Department of Defense spending on research, development, test and evaluation (RDT&E) and procurement are the portions of the annual defense budget that affect defense firms most directly. Aerospace procurement by the military fell nearly 53% from 1987 to 2000. Industry funded aerospace research and development had been reduced 37% from \$8.1 billion in 1986 to \$5.1 billion in 1999. The DoD had cut its overall investment in research, development, testing and evaluation by nearly 20% from 1987 to 1999.

Most notably, during the past 13 years the nation had lost over 600,000 scientific and technical aerospace jobs. The process had begun as a result of reduced defense spending following the end of the Cold War, but industry had contracted even further since the events of September 11 because of mergers and acquisitions. Most of the nation’s RDT&E infrastructure, Flater testified, was 40 to 50 years old and marginally maintained. This infrastructure is essential to ensure that the country’s research programs can be performed successfully.

Flater then quoted a passage from a recent article in *Aviation Week and Space Technology*:

The decision to terminate Comanche is a high-stakes gamble on the Pentagon’s part. And riding along on the roll-of-the-dice will be the future of the U.S. rotorcraft industry. While the Pentagon’s plan calls for a slew of programs, most are upgrades or refurbishments. These alone will not provide the engineering challenge to keep a robust helicopter industry alive. The U.S., in recent years, has shown little support for its helicopter industrial base, but it may be too early to discard the notions of future helicopters altogether – unless Congress wants to buy them in Europe. (Ref. 98)

The rotorcraft industrial base is currently sound, Flater concluded, but the situation will quickly deteriorate unless the nation makes the necessary investments in RDT&E for development of next generation vertical lift aircraft and technologies for use by all of the DoD’s Military Services. He concluded by noting the large disparity in R&D investment between tactical fixed-wing R&D and rotary-wing; government investment in tactical fixed-wing aircraft

R&D, since the Vietnam War, had been nine times greater that devoted to rotary-wing R&D. During the preceding 20 years, rotary-wing R&D funding had declined from \$7.9 billion to \$2.3 billion.

Within the Pentagon, the Joint Vertical Aircraft Task Force or JVATF, commissioned in 2003 by then-Under Secretary of Defense for Acquisition, Technology and Logistics Michael W. Wynne, listened carefully, took note and continued work quietly though effectively on a long-term strategic plan for rotorcraft defining a “path forward” for vertical lift science and technology (S&T) investment and research and development for manned vertical aviation. Its goal, admittedly ambitious, was a roadmap for “Future Vertical Lift,” which had the potential to become the first “new start” military rotorcraft program in more than 20 years.

Little more progress — at least publicly — was made until January 18, 2008, when Senator Kay Granger and Congressman Joe Sestak, the leaders of the Congressional Rotorcraft Caucus, signed a letter to Secretary of Defense Robert M. Gates and Chairman, Joint Chiefs of Staff, Admiral Michael Mullen. The letter requested a “capabilities-based assessment” or CBA outlining a joint approach to the future development of vertical lift aircraft for the military services. The CBA, according to the letter, should include the development of a strategic plan that would cover several key issues: an emphasis on the development of common service requirements; a technology roadmap; a detailed science and technology investment and implementation plan and the resources required to implement it; and a detailed plan to establish a Joint Vertical Lift Aircraft Office based on lessons learned from the Joint Advanced Strike Technology (JAST) Office. (Ref. 99)

On May 16, 2008, Congress passed the Duncan Hunter National Defense Authorization Act for FY09 (the “NDAA”). Section 255 of the NDAA incorporated, word for word, the Caucus’s request for a CBA outlining a joint approach for future development of vertical lift aircraft and rotorcraft. On May 21, 2008, Secretary of Defense Robert M. Gates sent written responses to Senator Granger and Congressman Sestak, stating “In response to your request, I have directed the Joint Advanced Concepts Directorate, Office of the Under Secretary of Defense for Acquisition, Technology and Logistics, to lead the development of a CBA that will outline a joint approach to the future development of vertical lift aircraft for all Military Services.” (Ref. 100) The results of the CBA would be provided “no later than the 3rd quarter of Fiscal Year 2010.”

DoD Publishes “Future Vertical Lift Strategic Plan” (August 2010)

On August 27, 2010, the DoD issued its Report on Future Vertical Lift Strategy, as mandated by Section 255 of the NDAA. The findings of the Plan (Ref. 101), though phrased differently, addressed many if not most of the points made

by AHS in its 2004 Congressional testimony relating to the aging industrial base:

- More than 20 years have provided near-term “as needed” vertical lift capability advancements in an incremental approach. The Department will adopt a more balanced, transformational strategy and will invest in and enable next generation technology development in order to address war fighting requirements.
- The need for break-through technology is consistent with previous requirements studies on vertical lift, overarching commonality studies, safety and survivability studies, and mishap causal factors studies.
- Forecasts of the future Joint Operating Environment offer global predictions of environments and conditions that will challenge the capabilities of the current vertical lift aircraft fleet.
- The aging of the current DoD rotary-wing fleet, accelerated further by high tempo current operations, warrants near-term consideration to ensure necessary capabilities tomorrow.
- The focus on Warfighter-supported incremental improvements, combined with the downward trends within the U.S. vertical lift scientific, technological, engineering and industrial base pose significant risks in addressing future DoD requirements and industrial base trends.
- The operating and sustainment costs of the aging current fleet at necessary levels of capacity and effectiveness will continue to rise and become increasingly burdensome unless significant design improvements are made.
- The development of next generation vertical lift aircraft will require significant increases in budget authority (“BA”) 6.2 to 6.4 resources. The current S&T base of approximately \$110M/year is marginal and is predominately directed toward technology upgrades to the current aircraft fleet.
- The success of this strategy relies on a Departmental partnership with industry and academia that integrates the activities of the FVL technology base and DoD. Critical contributions are needed from the national vertical lift technology base, including government, academia and industry resources.

The JVATF had performed its work well. In essence, many of its findings echoed the Society’s industrial base testimony before the House Armed Services Committee hearings in March 2003 and March 2004. The requisite infrastructure was now in place for an Army-led “Future Vertical Lift Strategy.”

Members of the U.S. Congress and industry leaders expressed immediate support for the “Future Vertical Lift Strategic Plan.” By letter dated September 19, 2011, to Secretary of Defense Leon E. Panetta, AHS International

and the newly-created Vertical Lift Consortium expressed its support for the DoD's Future Vertical Lift Strategic Plan. It was signed by the four officers of VLC and the CEOs of AgustaWestland North America, Bell Helicopter Textron, EADS North America, Boeing Military Aircraft, Sikorsky Aircraft and, on behalf of AHS International, Michael J. Hirschberg as Executive Director. (Ref. 102)

Several months later, on February 10, 2012, 11 members of Congress signed a similar letter to Secretary Panetta, encouraging the Department of Defense to "validate and deliver" to Congress the Future Vertical Lift Strategic Plan, mandated by Sec. 255 of the Duncan Hunter National Defense Authorization Act. It was effective. The plan was promptly validated and submitted to Congress in accord with the FY09 National Defense Authorization Act (NDAA). (Ref. 103)

Additional legislation supporting the rotorcraft industry followed. The then-Congressional Rotorcraft Caucus, now led by Senator Kay Bailey Hutchinson (R, TX) and Representative Joe Sestak (D, PA), negotiated passage of an "Advanced Rotorcraft Initiative" as part of the NDAA for fiscal year 2013. In the initiative, the 112th Congress (2011-2012) directed the use of integrated platform design teams and agile prototyping approaches for the development of advanced rotorcraft capabilities, considering such teams as "critical national assets." (Ref. 104)

The Senate Report accompanying the legislation stated with characteristic bluntness:

One area of the defense industrial base that has not seen significant new innovations is rotorcraft. Over the past decade, rotorcraft have been crucial in our war-fighting operations. The committee believes that among the various industrial base sectors, the preservation of integrated platform design teams and the use of agile prototyping is most needed in this sector. *The committee observes that it has been over two decades since the last completely new DoD rotorcraft, the V-22, was developed. . . . The committee continues to express concern over the overall state of DoD's rotorcraft science and technology programs. . . .* Specifically, the committee strongly believes that the DoD is not engaging to the maximum possible extent in a coordinated fashion with its limited resources with the broadest range of industry and academia to foster innovative concepts for the next generation of rotorcraft. (Ref. 105) (*emphasis added*).

In retrospect, several accomplishments may be attributed, at least in part, to the Society's DoD-related advocacy efforts with the Congressional Rotorcraft Caucus. Within the Defense sector, Congress recognized the contributions of military rotorcraft in the wars in Iraq and Afghanistan. It

also recognized that the bulk of RDT&E funding was being applied to upgrades and refurbishments, not in new platforms with improved capabilities. Congress therefore mandated a disciplined, and funded, strategic plan, including focused science and technology investments, to pursue Future Vertical Lift to insure that U.S. forces in future conflicts would maintain a competitive edge. This resulted in the DoD's Report to Congress, the Future Vertical Lift Strategic Plan, which soon gave rise to the DoD's Joint Multi-Role (JMR) Technology Demonstration program, the Science and Technology component of Future Vertical Lift.

The Vertical Lift Consortium (2010)

There remains an additional footnote to the U.S. rotorcraft industrial base concerns. At the direction of the Department of Defense, the major rotorcraft platform, engine and system prime contractors agreed in April 2010 to create a non-profit association for the purpose of exchanging information with the Department on issues, particularly industrial base issues, relating to the rotorcraft industry. Its name was the "Vertical Lift Consortium, Inc.," and it replaced the Center for Rotorcraft Innovation or CRI, created in 2007, which replaced the Rotorcraft Industry Technology Association (RITA), created in 1995. The VLC, on September 10, 2010, endorsed the AHS letter to Leon Panetta supporting the Future Vertical Lift Strategic Plan, the VLC's first significant action.

Since its creation, the DoD has made few demands of the VLC. Eventually, however, the DoD invited the VLC to respond to a July 16, 2013, "Request for Information" relating to the state of the rotorcraft industrial base. The information would be applied to a sector-by-sector, tier-by-tier assessment of the rotary-wing sector of the defense industrial base. Performed under the direction of Brett B. Lambert, the then-Deputy Assistant Secretary of Defense for Manufacturing and Industrial Base Policy, the study was intended to be technically comprehensive and "aligned with the Future Vertical Lift Strategic Plan." (Ref. 106)

Several VLC representatives, including M.E. Rhett Flater, now retired from AHS, but representing Airbus Helicopters, Inc., met with DoD officers in early September 2013 to review the submissions. Though the findings of the study were never published or released to the public, it was readily apparent that the rotorcraft defense industrial base was both "critical" (characteristics that make a specific product or service difficult to replace if disrupted) and "fragile" (characteristics that make a specific product or service likely to be disrupted). The terms "critical" and "fragile" were DoD-DASC terms for industrial base measurements to be managed, reduced and mitigated.

Given the absence of any "new starts" during the preceding 20 years and the decline in both the defense and NASA budgets for rotorcraft research and development, it was clear that by any measurement, the industry's condition as of 2013 was fragile. The Budget Reform Act of 2011 and the ensuing

“Sequestration” in 2013 had further reduced the military budget, including funding for rotorcraft research. The immediate result was the elimination of any new starts, such as the Army’s Armed Aerial Scout, and further program delays for all military aviation programs. Unless resolved, the national budget impasse — which continues to threaten the nation today — could easily delay the launch of “Future Vertical Lift,” the DoD’s strategic plan to replace its existing inventory of aging light, medium and heavy lift rotorcraft.

It should be stressed that the U.S. defense industrial base for rotorcraft is not presently in a “state of crisis.” The industry remains innovative, relatively strong, and is capable of supplying the military service branches, as well as the civil/commercial market, with world class rotorcraft and systems. Nevertheless, the extent to which the industrial base will continue to be an enduring source of “strategic advantage” to the United States depends, in part, on whether the federal government, and particularly the DoD, embraces a more consistent, thoughtful and longer term strategy to support the structure and capabilities of the rotorcraft base. That plan, embedded in the DoD’s Future Vertical Lift Strategic Plan issued in June 2011, now exists. The Society’s hope, and expectation, is that it will be supported programmatically and financially by the DoD, the Service Branches, and the U.S. Congress.

Positive Developments

Interspersed with reports concerning the conduct of the foreign wars and related budget limitations, there have been occasional positive reports within the rotorcraft industry. First, at Heli-Expo 2006, Franklin D. “Frank” Robinson announced his company — Torrance, California-based Robinson Helicopters — had established in 2005 a new record — an unprecedented 806 deliveries of the firm’s popular R22 and R44 helicopters. During the preceding year, Robinson had also completed delivery of the company’s 4,000th R22. Robinson deserved the accolades. He had launched his engineering career at Cessna working on the Cessna CH-1 four-place Skyhook. Later, he worked at Bell and Hughes before founding his company in 1973 in his home garage where he designed and assembled the first “Robbie.”

Robinson’s engineering accomplishments were well known. At the American Helicopter Society’s 1993 Awards Banquet in St. Louis, AHS President Dean C. Borgman had honored Robinson with the Alexander A. Klemin award, “the highest honor the AHS bestows on an individual for notable achievement in advancing the field of vertical flight aeronautics.” Robinson’s products — all designed for civil operators — were viewed as reliable, safe, quiet and uniquely affordable. (Ref. 107)

Frank Robinson was again recognized at the AHS Awards Banquet in 2013, with the award of the joint AIAA/ASME/AHS/SAE Guggenheim Medal, accepted by his son, Kurt Robinson, now CEO of the company.

Formation of IHST (2006)

A second event, also occurring in 2006, deserves mention. Helicopter safety, both within civil markets and the military sector, had long been a major concern to the rotorcraft industry. In late 2004/early 2005, Somen Chowdhury, president of the AHS Montréal/Ottawa Chapter and a member of the AHS board, wished to do something about it. AHS leaders in Washington, D.C., concurred and agreed to address the issue. The result was the “International Helicopter Safety Symposium 2005,” held in Montréal, Canada, at the Omni Mont-Royal Hotel, and presented jointly by AHS International and the AHS Montréal/Ottawa Chapter.

It was a “first” in helicopter safety, a comprehensive symposium covering all aspects of civilian and military helicopter flight safety, an opportunity to address safety as a central issue. Attended by leaders within government, including ICAO, Transport Canada, the Transportation Safety Board, the U.S. Army Safety Center, and the Federal Aviation Administration, industry and the civil helicopter community led by Helicopter Association International, the meeting proved to be a major success. (Ref. 108)

Returning to the Society’s Alexandria headquarters, Flater obtained the charter documents for the Civil Aviation Safety Team or CAST and, during a meeting at AHS headquarters, invited representatives of the FAA and the civil helicopter industry to team together in creating the International Helicopter Safety Team or IHST. Initial team members included Somen Chowdhury, Bob Sheffield (Shell Aviation), Fred Brisbois (Sikorsky), Roy G. Fox (Bell), Joseph A. Syslow (Eurocopter), Matt Zuccaro (HAI), David Downey (FAA), Dr. Michel A. Masson (EASA), and many others. While CAST was entirely focused on the commercial aviation community, IHST would focus on all aspects of helicopter safety — private and public, commercial and military. At a subsequent organizational meeting at HAI, participants elected as co-chairs Matt Zuccaro, and Dave Downey, and as “Secretariat” M.E. Rhett Flater of AHS. AHS would maintain all records, conduct periodic meetings of IHST, establish meeting “agendas,” and provide needed follow-up for approved IHST initiatives.

The formation of the new entity was announced with great fanfare on February 25, 2006 during HAI’s Heli-Expo. Its announced goal was to reduce the helicopter accident rate by 80% over the next 10 years (*see* <http://www.isht.org>). European operators and its regulatory community soon announced a parallel effort known as the European Helicopter Safety Team (EHEST), led by Dr. Michel A. Masson. Since 2006, the IHST and the EHEST has hosted annual meetings and issued safety and “best practice” recommendations based on empirical data, NTSB findings, and accident studies. Today, more than 40 countries support the efforts of IHST. Early indications are that the IHST recommendations are being heeded by operators and governments throughout the world, and the helicopter safety

record, measured by accidents and accident rates, has substantially improved, particularly in those regions and countries which have stood up their own helicopter safety teams. In North America and the European Union, for instance, accident rates have been reduced by as much as 55%. The IHST continues its important work today toward a vision of zero accidents. (Ref. 109)

For a detailed and highly insightful analysis of the helicopter accident record (11,426 civil accidents from 1964 through 2011), many readers would be enlightened by Franklin D. Harris's accounting, from an engineer's perspective, at "Autogyros, Helicopters and other VTOL Aircraft: Volume II Helicopters." (Ref. 110) Analyzed are various factors, including loss of engine power, loss of control, in flight collision with object, airframe/ component/system failure/malfunction, hard landing, in flight collision with land/water, rollover/noseover, weather, stall/settling with power/rotor contact with person, midair collision and on ground/water collision with object. Today, we would be inclined to include drone incursions as a growing problem, as well.

AHS Transition

The transition within the AHS International in June 2011 from M.E. Rhett Flater to Michael J. Hirschberg as the Society's new leader was relatively seamless. Among Hirschberg's first acts was to restore the frequency of *Vertiflite* to six issues annually (beginning with the January/February 2012 issue) and continue efforts as a strong industry advocate within Congress and the government agencies.

For his service to the Society and industry, M.E. Rhett Flater was honored at the 2011 AHS Awards Banquet as a Society Honorary Fellow; L. Kim Smith received similar recognition as an Honorary Fellow in 2014 for her lifetime achievements as a rotorcraft technology journalist and advocate (she was the second woman to receive this honor; her mentor, Jean Ross Howard, a former AHS Technical Director, received the AHS Honorary Fellow Award in 1957).

Vertiflite's coverage, now increased by two issues, expanded to include more information on international members, such as AgustaWestland and Eurocopter/Airbus, and ongoing research efforts within Russia, China, Korea and India. It also documented major events and pioneers in world rotorcraft history. Finally, AHS *Proceedings* and *Vertiflite* became available online. In 2015, Hirschberg received HAI's prestigious "Excellence in Communications" Award (previously won by Flater in 1997 and Smith in 1984).

CONCLUSION

The original "Articles of Association" filed in the State of Connecticut on June 21, 1943, by The American Helicopter Society, Incorporated proclaimed its purposes. Those have never varied: "to collect, compile, and disseminate

information concerning the helicopter; to hold meetings, lectures, and discussions to present, review and examine matters pertaining to the helicopter; to publish technical papers, journals and records; to create and maintain a library of information pertaining to the helicopter; to conduct and finance a research program pertaining to the helicopter."

Today, AHS fulfills an essential need. The Society allows rotary-wing scientists and engineers the opportunity to exchange ideas on novel research and disseminate scientific and engineering discoveries related to rotorcraft technology. AHS's activities, at the national, regional and local level, help members to remain current in technical disciplines which are undergoing constant change. These undertakings, unique in the industry, permit the Society to provide high quality, low-cost professional development. AHS is, and continues to be to be, a proven vehicle for collaboration, as the Army-NASA Joint Agreement, the Vertical Lift Research Centers of Excellence (VLRCOEs), and the National Rotorcraft Technology Center (NRTC) demonstrate. The contacts and direct employment recruiting facilitated by AHS have become powerful tools for attracting the best and the brightest to industry, government service, and academia. The Society promotes technical innovation and commercialization; it accommodates peer-review of research, provides training opportunities and educational workshops, and facilitates recruiting and helps educate graduate students. No other association or organization within the broad rotorcraft science and engineering community can approach AHS International's achievements in these areas.

The American Helicopter Society International has met many challenges since its founding 72 years ago. It remains a vital force supporting rotorcraft research, development, test and evaluation. Though funding and prioritization issues have frequently threatened DoD, Army and NASA, and Navy and DARPA support for rotary-wing science and technology, the agencies and their trained staffs have always had the enthusiastic support of AHS International and industry. Rotorcraft scientists and engineers have survived and even thrived despite adversity. As recently as November 2015, at NASA's Washington, D.C., headquarters, senior (and former) representatives of all agencies, joined by industry, VLCROE and AHS representatives, celebrated the 50th anniversary of their successful collaboration.

Despite changing times, the Society's focus remains true to its original charter. With vision, dedication, and perseverance, AHS International will continue to meet the challenges of the future.

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