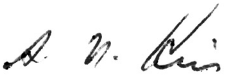

ALFRED A.H. KEIL

1913–2002

Elected in 1966

"For ship structures and explosion research."

BY PAUL E. GRAY

ALFRED A.H. KEIL, contributor to ship design for two navies, and head of the Ocean Engineering Department and later dean of engineering at the Massachusetts Institute of Technology, died at the age of 88 on January 9, 2002. He had suffered for several years with Alzheimer's disease.

In Germany

Alfred was born on May 1, 1913, in Konradswaldau, Silesia, Germany, a country village in a farming area near Breslau. He attended a private school until age 13, when he transferred to the public high school at Freiburg. In 1931 he enrolled in the University of Breslau; his education was interrupted for a year (1935–1936) when a draft of all able-bodied young German men was ordered, and he graduated in 1939 with the degree of Doctor of Natural Sciences (physics). His doctoral thesis, addressing a shift in the spectrographic fine structure of the hydrogen atom, was submitted on August 16, 1939.

Four days later, on August 20, before he could defend his doctoral thesis, he was ordered to report for active duty in the German army. He was assigned to a horse-drawn artillery regiment. On September 1, 1939, his regiment participated, behind the Panzer division, in the invasion of Poland—the beginning of World War II. The Panzers moved into Poland so

swiftly that his horse-drawn regiment did not participate in the fighting. However, a horse stepped on Alfred's foot, which led to an infection and hospitalization—and made it possible for him to complete his doctoral examination. An understanding and sympathetic physician from Breslau University, who had been called up to serve in the army, arranged a pass that enabled Alfred to return briefly to the university. His thesis committee assembled quickly and his doctoral degree was awarded summa cum laude.

In November 1940 Alfred was released from the army and told to report to Keil to join the Chemisch Physikalische Versuchsanstalt (CPVA). The physics department to which he was assigned had two research groups, one for basic explosives and the other for underwater explosions. Their principal concern was the effect of underwater explosions on ship structures. Alfred's work focused on shaped charges for use on the hulls of ships and on the propagation of the shock wave. Experiments were conducted on unused ships to understand the nature of explosion damages on the hull and on the heavy machinery. This work led to his invention of more effective shock mounts for propulsion and other machinery

He had access to a very-high-speed camera that could make a succession of spark-illuminated images of moving bullets, and he adapted it to make schlieren (shadow) photographs of the propagating shock waves in a pressurized chamber used to simulate a range of depths. This work preceded by two years the shock wave research being done by the United Sates Navy.

Alfred was soon promoted to chief scientist for the group working on underwater explosives. Twice the German Admiralty decorated him in recognition of the importance of his work.

By 1944 the Allied air offensive in Europe made research at CPVA more difficult. In early 1945, when Russia moved into Germany, the CPVA moved to a less vulnerable location. Soon after the move the organization was ordered to destroy all research files and documents. Before that was done, Alfred reviewed all the files and took 35-mm photographs of documents he regarded as key. Shortly after the destruction of documents, all the CPVA personnel became captives of the advancing British Army.

After the end of hostilities the American, British, and French forces commenced a search for key German scientists and engineers. The Russian forces were doing the same, and the denial of German expertise to the Russians was a vital concern of the United States. A federal program (called Operation Paperclip) was created in 1946 to import German experts of value to US national interests. Between 1945 and 1952 this program imported 652 specialists, including 111 contracted for by the American Navy. One of those was Alfred Keil.

The laws of the time prohibited issuance of visas to German nationals. Each of these persons of interest was placed under a contract issued by the appropriate federal agency, which took full responsibility for and control of the expert in the United States. Each had an assigned military escort. Upon completion of the contract, each would return to his or her native country.

The US Navy was aware of the general nature of the explosives work done at CPVA. In June 1945 a naval officer interviewed the group led by Alfred. He brought documents recovered from a German navy yard and asked the Keil group if they would, for pay, write a summary of each document, which the group did. Impressed by this effort, the officer asked the group about their work at CPVA. Alfred and two other members of the group began writing, using as their primary source the photos of important documents taken when CPVA was shut down. When this task was completed, the naval officer in charge concluded that Alfred was the key person and placed him on a priority list for Operation Paperclip.

In the United States

In May 1946 Alfred was offered a 10-month contract to come to the United States. His family would be relocated to a camp in Bavaria where they would live and receive all his earnings. He would have quarters in the United States and receive a per diem allowance for his meals and incidentals. In February 1947 he arrived by steamship in New York City for transfer to the Bureau of Ships Headquarters in Washington, DC, to resume life and work in a new setting.

His initial status in the United States was as a foreign national supervised by an assigned personal military escort.

He was expected to be returned to Germany at the end of his 10-month contract.

In March 1947 he was assigned to the Design Division Ship Protection Branch, Code 423—the Bureau of Ships Underwater Explosions Research Division (UERD) at the Norfolk (Virginia) Naval Shipyard. He quickly learned that there was very little research and no science done there. The staff of 14 was skilled in instrumentation and data recording, but there was no analysis of test results—the recorded data were sent elsewhere for study. He reorganized the work in UERD, creating test plans and analyzing test results onsite before passing the data up the assigned channels. Also, he had built a hyperbaric research tank modeled after the tank he used in Germany to study the pulsations and migrations of the shock waves caused by underwater explosions. His high-speed photos showed that the shock wave damaged the hull and left an expanding gas bubble, void of water, outside the hull. This void was quickly filled by a battering ram of water, which did more structural damage to the hull. This was the first research undertaken on behalf of the US Navy.

His colleagues and supervisor soon recognized that he had "more experience and knowledge in the field of underwater explosion damage than anyone in the business." In August 1947 he (still an alien) was appointed acting chief scientist in the division. Two months later he was joined by his wife, Ursula, and their two sons, Michael and Juergen.

In May of 1949 arrangements were made to get a visa for Alfred. Through the joint efforts of the US Military and the US State Department, the "enemy alien scientist" was taken to the US consulate on the Canadian side of Niagara Falls, where he was issued an entry visa. He immediately crossed the bridge to the United States. A year later Alfred and his family decided to apply for citizenship, and on November 11, 1954, the Keil family became US citizens. In the same year, the quality of his work was recognized by the Navy with the first of several Meritorious Civilian Service Awards.

His work on hull designs more resistant to underwater explosions continued. His group continued testing scale models of ships and submarines (including the Nautilus),

and in 1959 he went to Eniwetok Atoll to study the effects of nuclear weapons on ships, with particular reference to the consequences of shock wave reflections from the sea bottom. By 1959 Alfred was the highest-ranking civil service employee in all of the Navy's shipyards.

A Change of Venue

In July 1959 Alfred was chosen to be the technical director of the Structural Mechanics Laboratory of the David Taylor Model Basin (DTMB) in Carderock, Maryland. The laboratory had four sections: hydromechanics, aeromechanics, applied mathematics, and structural materials. As soon as he arrived at the lab, he visited with each of the section heads. The existing work arrangements required that test reports be independently reviewed four times, with changes made after each review. Reports were usually delivered late.

Alfred substantially changed the report process. The supervisor who drafted the test report presented it orally to all the supervisors in the approval hierarchy. All comments and questions were resolved at that time and were reflected in the final version and publication of the report, usually in weeks, no longer in months. Only persons who had personally participated in the effort signed reports. Soon Alfred further revised the test reporting process: Before the test, the supervisor prepared the test report with the results blank. With the test data in hand the report was filled in, the commentary written, and the review process occurred within a few days.

An important test involved a fully manned and operating diesel-electric submarine of a new design, the USS *Trout*. The explosive charges were suspended from a moored buoy and the explosions were fired when the submarine at periscope depth was abeam of the buoy. After each explosion the distance from the buoy was reduced. Six explosions were planned, but the test ended with the fifth. One week after the completion of the tests, Alfred and the DTMB researchers briefed the Secretary of the Navy and delivered a preliminary report.

Alfred's most important unclassified publication was for the Society of Naval Architects and Marine Engineers in November 1961, entitled *The Response of Ships to Underwater Explosions.*

The results of many of the tests done at DTMB showed that the shock isolation of heavy machinery in the holds of ships was very deficient. As a result of his attention to this concern much better mountings were devised and employed.

Another Promotion

In March 1963 Alfred was appointed the first technical director of the DTMB, reporting to the codirector, a senior naval officer.

He brought to DTMB greater coordination among the several research activities, operating as a single functional entity, producing test reports that would benefit the entire laboratory. In Alfred's three years as technical director, DTMB nearly doubled its staff and increased its budget by a factor of four, driven in part by the addition of a fifth laboratory concerned with acoustics and vibrations. In late 1963 he prepared a report forecasting the Navy's deep ocean strategic objectives for the next quarter century.

In July 1963 the Navy honored Alfred again:

> Through his unique combination of administrative and technical ability, Dr. Keil organized and directed the professional activities of the Structural Mechanics Laboratory of the David W. Taylor Model Basin in a manner which has achieved world wide recognition in the field of structural mechanics research. His personal contributions in the area of air blast resistant ship structures, the Navy's shock-hardening program, deep-diving submarines, nuclear weapons effects, and noise reduction of submarines have been of paramount significance to the Navy and to the defense of the Nation. For achievements of such a high order Dr. Keil is eminently deserving of the Navy's Distinguished Civilian Service Award.

During his entire career of 19 years with the Navy he received performance reports from the naval officers to whom he reported in three categories: Quality of Work; Quantity of Work; and Adaptability. For every period and every officer he was rated "Outstanding." The four Navy officers to whom he had reported nominated him for the Gold Medal of the Society of Naval Engineers, the highest professional award in its field,

which he received in 1964. Throughout the last half of the 20th century, Alfred Keil's research leadership and technical achievements were responsible for all major improvements in damage resistance, shock protection, and the survivability of US Navy ships and submarines.

Massachusetts Institute of Technology

During his years with the Navy, Alfred met Gordon S. Brown, the dean of the MIT School of Engineering. A new head for the Department of Naval Architecture and Marine Engineering (NAME) was needed, and Alfred was Brown's desired nominee. Alfred had, since his time in Germany, ambitions to work in a university, and this opportunity came at the right time. On April 5, 1966, he was appointed head of the MIT department effective July 1, 1966, and on April 22, 1966, he resigned his position at DTMB.

Alfred began his work as head of the department in characteristic fashion; he talked with faculty and staff in NAME and with his counterparts in the other engineering departments. His first official act was to write the department's contribution to the President's Report for the 1965–1966 academic year. Although he was not at MIT during that year, he took on the task to study and understand the departmental and Institute budgets and administrative processes. It enabled him to ask probing questions about past happenings.

His first priority was to strengthen the research base of the department beyond ships and shipping to include all aspects of ocean resource utilization. His second priority included upgrading the technical range and expertise of the faculty, expanding and strengthening the graduate program, and addressing engineering problems using a systems approach. His third priority was to revitalize the undergraduate curriculum. New subjects were introduced; one of the first was Hydrospace Vehicles and Their Use. Computer applications received new emphasis, and in 1967 Alfred introduced a new graduate program in ocean engineering (OE).

Also in 1967, a year after his election to the National Academy of Engineering, the National Academy of Sciences

presented Alfred with the Gibbs Medal for his outstanding contributions to naval architecture and marine engineering (the Gibbs Medal had been awarded only once before.) His honors and awards also include the Coast Guard's Meritorious Public Service Award, the Gold Medal Award of the American Society of Naval Engineers, the Lockheed Award for Marine Science and Engineering, and the Officers Cross of the Order of Merit of the Federal Republic of Germany. He was an active member of the National Academy of Engineering, serving on its Committee on Ocean Engineering and the Panel on Ocean Transportation, as well as several professional organizations.

In 1967 the National Sea Grant Program was established at the National Science Foundation. Alfred saw this new program as an opportunity to broaden research support. The MIT Sea Grant Program began in 1968 with a grant issued to Alfred Keil as principal investigator. The program has grown in size and scope and is now a permanent component of the Institute.

In 1970, following a year of conversations between Alfred and all imaginable stakeholders, the department changed its name to Ocean Engineering, within which was the Program in Naval Architecture and Marine Engineering. The name change reflected more accurately the scope of the department and appealed to a broader range of student interests.

Late in 1971, Alfred was asked (by this writer) to serve as dean of the Engineering School, and he accepted with two entirely reasonable conditions. He wanted a full month off duty, and he wished to appoint an associate dean.

Dean of Engineering

After careful assessment of possible candidates, Keil appointed Professor James D. Bruce, then executive officer of the Department of Electrical Engineering. This team proved to be a fine asset for the Institute. At his first meeting with his associate dean and the department heads of the School of Engineering, Alfred announced that their mode of operation with the Council of Deans would change. While each department head had responsibility for the administration of his department, as a group in the Council they would be expected to collaborate and function as a "board of directors" for the school. Their first

responsibility would be to work for the good of the school as a whole. His leadership in this respect was essentially the same as his practice in each of his three leadership positions during his 19 years working with the US Navy.

He soon put forth a broader challenge for engineering education, based on his conviction that the school should take into account the growing problems of a society that has become more dependent on technology and too frequently suffers from its abuse. Engineers should be prepared to analyze the needs for and the likely impacts of new technology. His view was that the scope of the engineering profession must evolve and broaden to encompass four types of engineers: innovative technologists, practicing designers, engineering scientists, and systems engineers.

In his first year as dean, Alfred revolutionized the way faculty salaries were administered in the school. Previously, department heads distributed salary increases to the faculty so that each individual received the same percentage increase. Alfred insisted that each department head generate lists, separately for assistant, associate, and full professors, based on their contributions, broadly construed, in teaching, research, and public service. The sizes of the increases were expected to correspond to the lists, with individuals at or near the top of the rankings receiving the largest percentage increase while those at the bottom may not receive any increases. In spite of considerable grumbling by the department heads, this merit-based allocation was enforced. In a year or two it was widely recognized as an improvement, and it became the standard pattern in the Engineering School and eventually spread to other schools at MIT. Managing this change of practice was seen as one of Alfred's most significant contributions to the Institute.

In 1974, Alfred hosted representatives of the Doherty Foundation for briefings on the Sea Grant Program's use of the funds provided in 1970. The visitors were impressed and hinted that a new proposal would be looked upon favorably. He suggested a grant that would support research for two or three years on any marine-related topic by promising untenured faculty. This idea was approved by the foundation

in 1974 and since then two or three junior faculty have held Doherty research grants each year. Alfred seldom missed the chance to raise research funds.

During his time as dean he, at Jim Bruce's suggestion, created a summer program for underrepresented minority students at MIT. The program was named MITE—Minority Introduction to Engineering. The program, now known as MITES, continues at the Institute. Other lasting educational programs include the Center for Technology, Policy and Industrial Development and a Program in Technology and Policy.

In 1973 the Center for Transportation Studies, drawing on faculty from several engineering departments and headed by Professor Paul Roberts, was inaugurated. In 1973, the Technology and Policy Program, led by Professor Richard de Neufville, was created, drawing on faculty from other schools and from the School of Engineering. These continuing new foci for research and education reflect Alfred's lifelong desire to shake up the status quo.

By the mid-1970s several new issues affected the Institute, including relatively high inflation and flattening federal research support. Alfred recognized that there would necessarily be constraints on appointments of new faculty. He and Jim Bruce developed an early retirement program that was adopted Institute-wide, and effectively employed by the School of Engineering. In his belief that an alternative to the present primary structure of eight departments in the school would provide greater opportunities for faculty collaboration and better alternatives for teaching and research, Alfred put together a proposal for a structure built on four organizational units: electrical, information and computer sciences; materials and chemical sciences; mechanical and thermal sciences; and engineering sciences related to civil systems and their engineering applications. In spite of many discussions and Alfred's efforts to address all questions, faculty support in 1975 was insufficient to depart from the historical departmental structure.

The pace at which Alfred operated, and the continuing constraints on resources, took a severe toll, and he asked in

December 1976 to be relieved of his position by June 1977. On August 31, 1977, he was relieved as dean and appointed Ford Professor of Engineering, a position he held until his retirement in July 1978.

In his capacity as Ford Professor of Engineering, Dr. Keil became increasingly concerned about what he called the "wiser use" of science and technology and the importance of considering their interrelationship and resulting impacts on broad societal issues such as quality of life, economic development, preservation of resources, and national security. Reflective of his deep commitment to MIT and education, he prepared a November 1984 document for MIT titled "Wiser Use of Science and Technology: The Theme for Providing Coherence, Unity and a Shared Purpose for MIT." He remained an active participant with MIT throughout the 1980s when health issues caused direct interactions with MIT to cease.

Alfred Keil, in his service to two navies and to MIT, brought to every enterprise he touched exceptional energy, a deep interest in and commitment to his colleagues, unusually effective administrative skills, and a mind always searching for new and better ways to address every question or problem.

Karl Taylor Compton, president of MIT from 1930 to 1949, had this motto: *Leave every campground better than you found it.* Alfred may never have heard that expression, but his entire career reflects Compton's saying.

Author's Note

I am deeply grateful to Dean A. Horn, retired Captain in the US Navy, alumnus of MIT, and director of the MIT Sea Grant Program. Together with Byron Laursen, he authored *Alfred Keil, Multiple Genius*, published by the MIT Sea Grant Program in 2001. I relied on this book for factual information about Alfred's life before his arrival at MIT.