MAURICE E. SHANK

1921–2012

Elected in 1983

"Outstanding contributions and technical direction in advancing the state of the art in aircraft gas turbine technology."

BY EDWARD M. GREITZER AND LEE S. LANGSTON

MAURICE EDWIN SHANK, a major contributor to the development of gas turbine blade metallurgy, particularly directionally solidified and single crystal turbine blades, died February 21, 2012, at his home in York Harbor, Maine, surrounded by his wife, Virginia, and other family. He was 90 years old.

Bud, as he was known, was born April 22, 1921, in New York City. He attended Carnegie Institute of Technology (now Carnegie Mellon University) and, after graduating with a BS in mechanical engineering in 1942, was commissioned as a second lieutenant in the Army Corps of Engineers and served as a platoon commander. He was transferred to the Ordnance Corps, serving 37 months in the Middle East and North Africa in various technical and field positions. At the end of World War II he was discharged with the rank of major.

From 1946 to 1949 Bud was a graduate student at the Massachusetts Institute of Technology, in the Departments of Mechanical Engineering and Metallurgy, and a half-time instructor in metallurgy. He received his DSc in metallurgy in 1949 and joined the MIT faculty as an assistant professor (1949–55) and associate professor (1955–62) in the Department of Mechanical Engineering, where he earned tenure.

His research was on the mechanical properties of materials as related to design requirements. He was also active as a consultant in the fields of design, materials, fabrication of steam turbines and electric power generation equipment, hydropower turbines, aircraft gas turbine engines, and nuclear power generation using liquid metal coolants.

In 1960 he was recruited to direct a laboratory being set up at Pratt & Whitney (P&W), a major gas turbine manufacturer, for research on advanced and innovative technology developments in materials, their processing, and their transition to production. He left the MIT faculty to form the Advanced Materials Research and Development Laboratory (AMRDL) in North Haven and, subsequently, Middletown, Connecticut. Over its 10-year life, AMRDL pioneered single-crystal superalloy technology and was an excellent example of industry using fundamental and applied research to create and bring to market a superior product within a decade. At its peak the staff numbered over 200 scientists, engineers, and technicians doing R&D on all aspects of single-crystal technology, from casting to alloy development, coatings, joining, and repair.

At the start of AMRDL, Bud recruited Frank VerSnyder, who had developed a concept for eliminating transverse grain boundaries and the adverse conditions that can result (for example, void formation and increased chemical activity leading to creep, corrosion, and cracks) in the casting of jet engine turbine blades. Based on this concept a directionally solidified (DS) turbine blade, with columnar grains aligned along the major stress axis, was patented for Pratt & Whitney in 1966. The blade exhibits improved ductility and thermal fatigue life, and, when the material properties were measured and reliable manufacturing techniques created, DS turbine blades and vanes had their first use by P&W in 1969, in the J58, which powered the SR-71.

The DS research led to the development of techniques to manufacture single-crystal turbine airfoils and to overcome casting defects. Single-crystal turbine airfoils were installed in P&W F100 engines for the F-15 and F-16 jet fighters, with the first commercial aviation use in P&W's JT9D-7R4 jet engine, which received flight certification in 1982 for the Boeing 767 and Airbus A310. AMRDL's pioneering work has been improved upon by Pratt & Whitney and other manufacturers over the past 40 years; yields greater than 95 percent are now commonly achieved in the casting of single-crystal turbine airfoils for aviation gas turbines.

Technology history shows that a breakthrough such as single-crystal superalloys usually entails a long-term process, typically 30 years or more. Bud's leadership in using an industrial targeted group approach to bring it about within roughly a decade may be an exemplar worthy of study in itself.

From directing the materials laboratory, Bud progressed through positions of increased responsibility at Pratt & Whitney. In 1971 he became manager of materials engineering and research, with responsibility for all materials research and technology processing and applications. In 1972 his responsibilities were expanded to director of engineering technology and research, where he had a broad remit for advancing gas turbine engine technology. (The authors worked in this organization at the time.)

In 1980 he became director of engine design and structures engineering, with oversight of engine mechanical design and technology and design analysis in structures, and in 1981 he was named director, engineering–technical, for P&W's Connecticut (commercial) activities. In this position he was responsible for analytical and component development activities in support of commercial engineering programs as well as the research and technology activities needed to provide technology for current and future applications. The work included a range of technical areas: aerodynamic components (fan, compressor, turbine, nacelle aerodynamics), acoustics, reduction of emissions, secondary flow and cooling systems, structures and dynamics, mechanical components, fuel systems, engine controls (both hydromechanical and the then new area of electronic controls), materials, preliminary engine design, advanced engine performance analysis, and vehicle applications.

In 1985 Bud became director of engineering technology assessment, with responsibility for identifying and providing leadership in the development of technology and technical expertise in the company's Engineering Division. This included technologies for both commercial and military applications, with the mandate to enhance P&W's position in the aerospace industry.

In 1986 he became vice president of Pratt & Whitney of China, responsible for technology exchange with the People's Republic of China, establishing working relationships with the country's technically oriented business, government, professional, and academic communities. He also coordinated activities relating to China from other P&W units (such as the Government Products Division, Engineering, and Manufacturing Division), as well as the units of United Technologies Corporation (the parent company of P&W) that formed the Power Group: Elliott Company and Fuel Cell Operations.

As part of his work, with emphasis on educating future leaders in China, Bud established graduate engineering scholarship programs at US universities. Invited in 1985 by the Chinese Ministry of Aviation to visit and report on aeroengine design, manufacturing, and test facilities, he toured a number of facilities not previously seen by foreigners.

Bud's early work in the fracture of iron and steel gained him widespread recognition while he was a professor at MIT. His subsequent impact, at P&W, was seen more broadly in gas turbine engineering. He demonstrated leadership in organizing and effectively operating a range of research that resulted in substantive advances in gas turbine technology and components, blending scientific and engineering approaches to solve problems in the development of complex engineering products.

His recognition of, and philosophy for promoting, the applicability of fundamental science from other fields to practical problems resulted in the formation of an organization with a number of pathbreaking achievements. In addition to the DS and single-crystal turbine airfoils mentioned above—the latter of which are now the industry standard—these include the following: full authority digital electronic controls for aircraft engines, lower cost of engine ownership through fuel burn reduction, increased reliability, and decreased maintenance; controlled diffusion airfoils for shock-free transonic flow and prevention of boundary layer separation, allowing lower fuel burn and greater resistance to erosion from foreign object damage; and ceramic outer air seals for advanced gas path sealing in the high-pressure turbine, with benefits from lower fuel burn and better performance retention.

Bud was an advisor to many universities, professional societies, and government boards and committees. These included MIT, where he was on the visiting committee for the Departments of Materials Science and Engineering and of Aeronautics and Astronautics, and the Materials Processing Center, as well as visiting committees for Carnegie Mellon University and the University of Pennsylvania and advisory boards for the Society of Automotive Engineers, American Petroleum Institute, National Science Foundation, NASA, and National Research Council. He presented testimony on aeronautical matters to House and Senate committees of Congress, and was an invited lecturer at universities, professional societies, and government meetings in the United States, United Kingdom, and China.

Elected to the NAE in 1983, Bud served on the Charles Stark Draper Prize Committee, the Aeronautics and Space Engineering Board, and a number of other committees. He was a fellow of the American Institute for Aeronautics and Astronautics, American Society for Metals, American Institute of Mining, Metallurgical and Petroleum Engineers, and American Society of Mechanical Engineers, and served as a conference organizer and on technical and/or executive committees.

On a more personal note, many of those who worked with Bud at Pratt & Whitney remember him writing and reading at a custom-made, stand-up desk, which he used to alleviate back strain. He maintained close ties to academia, which served him well in recruiting new talent for the company. Colleagues also remember him for the career advice he provided, explaining that one's career trajectory is rarely straight up, and can have flat periods and downturns. He counseled patience and (especially) perseverance; one had the impression he was talking from personal experience, which lent substantial credibility to his insightful advice.

Bud was survived by his wife of 63 years, Virginia (she died February 18, 2017); daughters Diana Shank and Hilary Shank-Kuhl; sons-in-law Glenn Allen and Andrzej Kuhl; and grandson Nicholas Kuhl.