Yvonne C. Brill

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1924–2013

Elected in 1987

"For important and original contributions to spacecraft propulsion."

BY ELAINE ORAN

YVONNE MADELAINE CLAEYS BRILL was a world-reknowned propulsion engineer, inventor, and advocate for space travel. She was also an irrepressible proponent of education, women in science and engineering, and human rights. She died March 27, 2013, at age 88 in Princeton, New Jersey, from a cancer she refused to acknowledge could ever overcome her will to live. She worked until the week of her death, consulting for governments and aerospace companies, planning trips around the world to see friends and colleagues, actively mentoring and promoting her younger colleagues, and, not least, nourishing her children and grandchildren. Among friends, she was affectionately known as "Skywalker."

Yvonne was born December 30, 1924, near Winnipeg, Manitoba, Canada. She originally planned to study engineering at the University of Manitoba, but women were not permitted to enroll in engineering because, at the time, the required summer engineering camp would not make the "special arrangements" needed for women. Instead, she studied mathematics and received a BSc degree in 1945. She received an MS degree in chemistry from the University of Southern California in 1951.

Her career began in the aircraft industry but shifted to the field of rockets and rocket propulsion. Early on, she had major

impacts on the rapidly developing US space program, working first at Douglas Aircraft, then with Douglas on Project RAND and then the RAND Corporation, all in Santa Monica. From there she went on to work at Marquardt Corporation (Van Nuys, CA), United Aircraft (East Hartford, Connecticut), Curtiss Wright, Aero Division (Wood-Ridge, New Jersey), as a consultant with FMC Corporation (in Princeton), the NOVA Propulsion Project at RCA Astro Electronics (Princeton), the Space Transportation System at the National Aeronautics and Space Administration (NASA; Washington), and the International Maritime Satellite Organization (London).

At Marquardt, she was responsible for fuels and ignitors for the ramjet being developed for the Navy's Project Reigel. Reliable ignition at high altitudes and speeds was a very challenging problem. Yvonne devised a new approach for using solid propellants and personally oversaw its integration onto the ramjet. The concept was an essential part of the successful, first US supersonic ramjet flight, from Point Mugu (CA) in 1950.

There were intially no data available to calculate the performance of high-energy propellants of interest for rockets and missiles. At RAND Corporation, Yvonne defined and provided tabulated properties of high-performance propellant combinations at temperatures of interest. For years, these data were the US standard and were essential to developers of rocket and missile hardware until supplemented by the later, very extensive efforts of the National Bureau of Standards (now the National Institute of Standards and Technology) and NASA.

Yvonne joined the staff of RCA Astro Electronics in 1966 as a senior engineer in propulsion systems and later became manager of the NOVA satellite propulsion systems, directing processes from fabrication through qualification and flight for the Teflon Solid Propellant Propulsion System (TSPPS) flown on the RCA/US Navy NOVA spacecraft. The successful flight of the first TSPPS in 1981 brought electric propulsion to an operational status in the United States.

At RCA in 1967 Yvonne invented a new rocket engine, the hydrazine resistojet, perhaps her most important technical

invention. This spacecraft propulsion concept (patented by RCA in 1974) allowed both stationkeeping and orbit insertion using the same fuel. The resistojet was a game-changing concept that was remarkable for its simplicity in using a single propellant; and because it reduced weight requirements, payloads could be increased and mission life extended. The resistojet system was developed and first applied on an RCA spacecraft in 1983. The concept became a standard in the satellite industry—since 2000, resistojets have been used for stationkeeping and orbit insertion on more than 110 geosynchronous (GEO) and low-Earth-orbit spacecraft.

Yvonne also defined, advocated, and conducted a program to evaluate capillary propellant management for three-axis stabilized spacecraft. Her efforts directly resulted in the first use of such management on a GEO spacecraft, the RCA Satcom, in 1975. Capillary propellant management is now routinely used on a significant fraction of US space systems.

Her extraordinary impacts in enabling the innovation, development, and application of resistojets and capillary propellant feed systems enabled major improvements, over several decades, in the capabilities and competitiveness of very large numbers of US spacecraft.

As manager of NOVA propulsion, Yvonne personally directed and performed the design, fabrication, integration, and test of pulsed plasma thrusters (PPTs), which were very successfully used on Navy navigation spacecraft launched in the early to mid-1980s and not decommissioned until the mid-1990s. This accomplishment was especially noteworthy as the PPTs enabled a previously unattainable degree of real-time navigational accuracy for defense systems and represented the first operational use of electric propulsion on any Western spacecraft.

Her work both enabled unprecedented navigational capability and opened the way for the now routine use of electric propulsion on commercial Western space systems. In addition, current PPTs—direct descendants of her design—are being developed for propulsion functions on small government spacecraft for many applications.

At NASA headquarters Yvonne managed the Space Shuttle Solid Rocket Program during a critical period of its implementation. With her usual foresight, she identified shortfalls in the national infrastructure available to support solid rocket production and supply. She then defined, spearheaded, and directed the programs necessary to redress the situation. This effort led to the development of increased propellant production capabilities, specialized rail cars for essential transportation needs, and processes for the production and supply of engine motor segments, all of which were critical to enabling the Space Shuttle orbiter to maintain its flight frequency.

In 1994–2001 Yvonne served on the NASA Aerospace Safety Advisory Panel (ASAP), an independent group created by Congress that reported directly to Congress and the NASA administrator. During her service ASAP defined and recommended many technical and programmatic changes to enhance orbiter safety that were subsequently implemented by NASA, such as a modified space shuttle main engine design that enabled lower turbine inlet temperatures with greater safety margins.

In recognition of her substantial contributions, Yvonne was elected to the National Academy of Engineering (1987) and received the National Medal of Technology and Innovation from President Obama (2011). She was a fellow (1986) and honorary fellow (2008) of the American Institute of Aeronautics and Astronautics (AIAA) and a fellow of the Society of Women Engineers (SWE) (1985). She was inducted into the Women in Technology International Hall of Fame (1999), National Inventors Hall of Fame (2010), and New Jersey Inventors Hall of Fame (2009). Among her other honors are the AIAA Wyld Award (2002) in rocket propulsion, the IEEE Judith A. Resnik Award (2002), and the NASA Distinguished Public Service Medal (2001). She also received the SWE Resnik Challenger Medal (1993) and Achievement Award (1986), SWE's highest honor.

She served on many National Research Council committees—including the committees on Strategic Assessment of

Earth-to-Orbit Propulsion Options (1991–92) and on the Role and Scope of Mission-Enabling Activities in NASA's Space and Earth Science Missions (2008–10), and the Space Studies Board (2008–13)—as well as the NAE Aerospace Engineering Peer Committee (1992–97, including as vice chair and chair).

Any account of Yvonne's life must include mention of one of her strongest passions: educating and advancing the younger generations in almost any field of engineering, science, or medicine. Most of her community was in awe of her extraordinary efforts for women in science and engineering, but, in fact, she advocated for, and advanced the careers of, both men and women, boys and girls. As she grew older and was able to see routes for changing the system, she became even more determined to find ways around the prejudice, dishonesty, and discrimination she saw.

In 2003 a small group of friends and colleagues gathered around her during the NAE annual meeting and honored her with a beautiful crystal plaque; it bore an amusing inscription but ended on a true note: "For all you have done to help others succeed, we thank you."

The Yvonne C. Brill Lectureship is a lasting tribute to her. Established in 2013 jointly by the AIAA and the NAE Aerospace Engineering Section, it recognizes an individual who has made significant contributions in aerospace research or engineering.

Finally, no tribute to Yvonne is complete without mentioning her husband of nearly 60 years, William Brill, PhD, a research chemist. Besides his research, he was an avid scuba diver, fisherman, and gardener. Life lost a great deal of its meaning for Yvonne after his death in 2010. Both of their ashes were scattered in the ocean off the coast of New Jersey, where Bill loved to dive old shipwrecks. They are survived by three children—Joe, Matt, and Naomi—and four grandchildren—Harry, Lauren, Michael, and Nathan.