Mary Baker, A Visionary and Inspirational Leader in Aerospace Engineering
by Wayne Pfeiffer

Mary Baker passed away in her sleep on September 7, 2021 at age 77 in Del Mar, California after a nearly four-year struggle with multiple myeloma. She disclosed her illness only to immediate family, since she did not want others to feel sorry for her or treat her any differently than before. She continued to do the work and biking that she loved until the end of her life.

Mary was born on July 30, 1944 in Madison, Wisconsin to J. Gordon and Betty Baker, a mechanical engineer and a homemaker. She grew up in the nearby small town of Evansville.

Mary idolized her father and cherished the time she spent with him. He would take her with him into the factory of the Baker Manufacturing Company, where he was President, and explain how things worked.

In the summer of 1961 between her junior and senior years of high school, she was selected to attend the National High School Institute for Engineering and Science held at Northwestern University. This was a formative experience for her, especially coming from a small town. She met other students from around the country who were interested in engineering, science, and math. She was one of only eight girls out of 100 students.

Mary enrolled at the University of Wisconsin in Madison in 1962. There she was an oddity, a woman in engineering.

When Mary had to take a class in strength of materials, the instructor told her that he did not want her in his class. He thought it was unlikely that a woman would go on to be an engineer, and he did not want to waste his time teaching her. After she told him that she had to take the class to graduate, he said that he would make it hard on her by having her go to the blackboard to show the answers to homework problems. She developed better study habits to avoid repeated embarrassment and got the top score on the final exam. She was forever grateful for this learning experience. The instructor’s assessment of her changed, and they had cordial relations afterward.

In 1966 Mary was the first graduate of the new Engineering Mechanics Department at UW-Madison. She had an offer to work at Bell Labs in New Jersey, but one of her professors suggested that she apply to Caltech to see whether she could get into graduate school there. She was accepted in applied mechanics and gladly chose to go to Pasadena where she could continue her studies and enjoy outdoor activities in Southern California.

Mary thoroughly enjoyed her time at Caltech. There she met other students who were passionate about what they were doing. However, she was the only woman PhD student in engineering.

She did her thesis research under J. Harold Wayland. His bioengineering group was studying the fluid mechanics of blood in the microcirculation using an optical instrument that measured velocity profiles of blood in living tissue. The group had published several papers regarding the non-Newtonian fluid behavior they had observed and the inferred volume flow rates.

In a letter to a long-time friend, Mary wrote: “I built an apparatus to measure pulsating blood profiles and independently to validate the flow rates. My first task was to repeat the steady flow results published by the group. After much effort, I was unable to repeat their results; I was getting different flow rates.”

When she told her father this, he asked: “Have you tried to prove them wrong?” It was inconceivable to her that a Caltech professor could be wrong, but within a day she found several ways to show that
interpretation of the previous data was wrong due to an artifact of the instrument. Mary wrote: “Once the data were corrected for this artifact, a Newtonian fluid model fit the data even down to the smallest vessel diameters.” Calculation of the volume flow rate was then easy using what came to be called the Baker correction factor.

After graduating with a PhD from Caltech in 1972, Mary briefly worked at the IBM Watson Research Center in Yorktown Heights. She expected to work on a biomedical project but was instead asked to do research on compilers. This was not a good match, so she left for San Diego in 1973 to join her Caltech boyfriend, Wayne Pfeiffer, who had graduated earlier and was working at General Atomics.

On July 4, 1974, Mary and Wayne were married in a small, private ceremony.

In San Diego, Mary first worked for two years at Rohr Industries modeling vehicle dynamics for magnetically levitated trains and doing vibration analysis of surface effect ships. She then worked another two years at Systems Science & Software on computer modeling of earthquakes and detection of underground explosions.

In 1977 a former coworker from Rohr encouraged Mary to join the newly established San Diego office of Structural Dynamics Research Corporation. She gladly took advantage of this opportunity since SDRC was doing pioneering work in mechanical computer-aided design.

SDRC had developed several novel technologies, most notably the use of 3D solids modeling to unambiguously define the components of a design. These technologies revolutionized structural analysis in the automotive and steel industries serviced by engineers in the home office of SDRC in Cincinnati. However, those industries had little presence on the West Coast.

Mary wrote: “What I did was to adapt these SDRC technology developments to the aerospace industry.” These technologies allowed much better structural analysis of space vehicles. “Our solutions were so well received that we quickly became 90% supported by aerospace and worked on every launch vehicle in the country.”

Mary led a multidisciplinary team in the design, analysis, and testing of the space shuttle and its components. The team performed modal tests on many components that revealed damage that had previously been missed upon inspection. This led NASA to use the SDRC-developed tests to inspect the shuttle for damage between flights.

“After the Challenger accident, we had a major role in the shuttle recovery program,” wrote Mary. SDRC developed and implemented novel computer methods for modeling solid rocket boosters with enough detail to reproduce the opening of the O-ring joint that was the cause of the accident. Modeling this failure was not possible with previous methods.

A major contribution of Mary’s was to lead a NASA-funded project during the early stages of the space station design. This project used the solids modeling capability to define and communicate the current design configuration to the participating NASA centers and contractors working in various disciplines. The resulting software, called IDEAS®, ensured that consistent models were used through each design iteration and was used for seven years to do design tradeoffs during space station development. It also helped SDRC expand beyond structural dynamics analysis and testing into adjacent disciplines such as thermal, aerodynamics, controls, and acoustics.

While still at SDRC, Mary began a long-term relationship with Pratt & Whitney on liquid rocket engines. She was the SDRC principal investigator supporting Pratt & Whitney’s development of the RL10B-2 engine, which powers the upper stage of the Delta IV launch vehicle. She wrote: “My initial role was to determine dynamic loads for the deployable nozzle that allowed the RL10 engine to greatly increase its
performance but still fit within the payload fairing of the first-stage booster. There were many new methods developed as part of this project, which were captured in SDRC software products for dynamic analysis.”

Meanwhile the upper management of SDRC changed and decided to shut down or sell the services divisions and focus on the more profitable software business. The aerospace division, however, could not be shut down because of long-term contracts, and a buyer could not be found. Mary, who was Vice President of that division, was thus able to negotiate a friendly spinoff.

In April 2000 she and 27 other SDRC employees formed a new company called ATA Engineering with her as Chairman and, later, President as well. They agreed to take on all contractual obligations of the SDRC aerospace division in return for the intellectual property, equipment, software, and facilities. This allowed the new company to start with no debt or outside funding. ATA was immediately profitable and has since grown to nearly 200 employees.

Mary promoted and practiced a visionary leadership philosophy that was refreshingly different from the prevailing one in industry. She insisted that ATA be 100% employee owned from the outset. She was familiar with the benefits of that ownership model because of the employee profit sharing and stock-purchase plan pioneered in 1899 by her grandfather, John S. Baker, at the Baker Manufacturing Company. She saw that it eliminated conflicts between employees and owners, since they were the same.

Mary also wanted ATA to focus on continually developing and applying novel engineering methods to challenging problems rather than maximizing revenue and profit. She wrote that “ATA was created for the simple purpose of enabling us to do the work we loved to do.” She personally interviewed most employee candidates and looked for ones who shared her vision.

Mary recognized that ATA’s competitive edge was having an outstanding technical staff who could develop new methods. Rather than keep the methods proprietary, she thought it was better to openly share methods with customers because that was in their best interest. Doing so also provided pressure for further developments internally, and customers almost always came back seeking those improvements.

Mary saw great benefit in having strong ties to leading engineering universities. She served on industry advisory boards for UW-Madison, UCSD, and Caltech. Moreover, ATA staff were encouraged to write joint proposals with university faculty to obtain external funding to transfer methods developed in academia to industry.

Mary championed the co-op program initiated at SDRC and expanded it at ATA to include a broader set of universities. She wrote: “We have a very active co-op and intern program in which engineering students alternate between school and ATA as undergraduates and sometimes continue through to their Ph.D. These students make up approximately 10 percent of our project engineering staff, keep ATA cost competitive, and provide a steady stream of trained new recruits.”

Mary structured ATA to allow senior management to be heavily involved in technical work. As ATA’s senior technical director, she oversaw ATA’s involvement in the testing, analysis, and design of two generations of Mars rovers developed by NASA’s Jet Propulsion Laboratory. ATA’s efforts helped ensure the successful Mars landings of the Curiosity rover in 2012 and the Perseverance rover in 2021. Mary was also the technical director for rocket engines and worked on ones from all major suppliers in the US.

Mary received many awards but always said that they were only possible because of the talented staff that she recruited. She was elected to the National Academy of Engineering and received Distinguished Alumni Awards from Caltech and from the UW-Madison College of Engineering.
When receiving the award from Caltech, Mary said: “Many engineers believe that you have to make a choice between an academic career or a big company. I believe that we have discovered a wonderful place in between, where you can still do research and find solutions to real-world problems that make a difference.”

Although Mary primarily focused on her work, she also loved to exercise for fitness and to travel for adventure. She swam enough in the Caltech pool to join the 100-mile club, she ran two marathons after coming to San Diego, and she went on many multi-day bicycle tours. The first of those tours was a 25th anniversary celebration with Wayne and their two children, Betsy and Gordon, in Wyoming and Idaho. When Mary was 74, she was thrilled to have all three of them join her again on biking and trekking tours in Chile and Argentina. On the day before she died, she and Wayne biked 20 miles and swam 400 meters.

Mary was an early adopter of new technologies and a strong proponent of electric cars and bicycle commuting. Even in her 70s, she continued to commute to work more than 20 miles a day by bike, often leaving or returning home in the dark.

Mary was not only a visionary leader, but also an inspirational and personable one. She strived to bring out the best in people and help them reach their highest potential, often by sharing stories of lessons she learned through her long career. Many of her former colleagues credit much of their professional success to the guidance they received from her. And all who knew her well appreciated her contagious smile and the kindness and generosity that she showed to others.