

Dallis Ann Hardwick

26 June 1950 – 5 January 2014

Australia

Dallis was born in Sydney to Francis John and June Hardwick on 26 June 1950. She attended Matraville Public School where in 1961 she was awarded the Soldiers' Memorial Prize for Dux of the School. She continued her education at Sydney Girls High School (SGHS). At the school, she was followed two years later by her sister, Glenys May Hardwick. She was awarded the Level 1 Science (Physics) Prize in Fifth Form. On the whole, Dallis taught herself Level 1 Physics in Sixth Form since that course was not taught at SGHS at that time. Dallis immediately started her undergraduate studies in the School of Metallurgy at the University of New South Wales (UNSW), the first woman to do so. She applied her interest in physics to the concentration in Physical Metallurgy. She completed her Bachelor Degree with Honours in April 1972. A Commonwealth Scholarship allowed her to continue directly to the PhD program at UNSW. She earned that degree in July 1977. She was one of the first females to complete the PhD program in the School of Metallurgy. Her dissertation research on the oxidation/corrosion properties of iron-aluminum-carbon alloys set the direction for her technical career.

Canada

Being a lifelong learner, she decided to continue her education through Post-Doctoral studies. She had choices in the United Kingdom but, instead, accepted a Fellowship at McGill University in Montreal, Quebec. This work was in the area of archeo-metallurgy and she dabbled in teaching. This convinced her that she preferred research over instruction. The choice of a research concentration required that another Post-Doctoral position was needed.

While a resident in Canada Dallis continued to play squash, learned to bicycle and became an active Nordic (cross-country) skier.

United States of America

Pennsylvania:

At the Gordon Research Conference on Corrosion/Hydrogen Embrittlement held in New Hampshire in the summer of 1979, she met Professors Melvin Bernstein and Anthony Thompson from Carnegie Mellon University (CMU) in Pittsburgh, Pennsylvania. They offered her a Fellowship to study the interaction of hydrogen in high strength aluminum alloys used in the aerospace industry. She started this work in September 1979 and those studies continued until August 1981. The research led to several journal publications and multiple conference presentations.

In addition to her research in Pittsburgh, she made many friendships that would last for the remainder of her life. She led a group of friends back to Canada to participate in the Canadian Ski Marathon in February 1980. It is an annual three-day ski tour with thousands of participants; it covers up to 160 km from Montreal to Ottawa. Done in stages, with the ability to stop the tour at any check-point, Dallis was very satisfied to complete over 80 km of the course. She also participated in several squash competitions in Cleveland and Dayton, Ohio.

Maryland:

As the two-year Fellowship was coming to an end at CMU, she interviewed several corporate research laboratories and accepted a position at the Martin-Marietta Research Laboratories in September 1981. These laboratories were located in suburban Baltimore, Maryland. She worked on the surface properties of aluminum alloys used in the U.S. Space Shuttle external tank. The adhesive bond between the metal and the external insulation was critical to the successful operation of the system.

Dallis continued to visit her friends in Pittsburg so she became very familiar with the highways that cross Pennsylvania. In August 1982, Dallis married Pat Martin who was just completing his PhD dissertation at CMU.

New Mexico:

In November of 1982, Dallis and Pat moved to Los Alamos, New Mexico. Both became Members of Technical Staff at the Los Alamos National Laboratory (LANL). They were proud of this title as it harkened back to the Manhattan Project where Robert Oppenheimer eschewed gradations among the scientists in his organization. Though not yet a U.S. citizen, Dallis began studies on hydrogen interactions with stainless steels. When she finally became a US citizen and obtained a security clearance in 1985, she was able to appreciate the relevance of her work in understanding how nuclear weapons degrade in storage. She trained herself in the fields of ion beam analysis and surface modification. Dallis also began to volunteer her time in various capacities within The Minerals, Metal and Materials Society (TMS). This is the premier research society in the United States that organizes multiple technical symposia each year and is the principal link to similar societies around the world.

After living in Los Alamos for 3 years, Dallis and Pat designed and built a home on 5 acres just north of Santa Fe, New Mexico. The access to the cultural opportunities made the daily 45 minute commute easy to justify. The museums, opera, chamber music, restaurants and galleries in Santa Fe were enjoyed. Dallis continued to look forward to Nordic skiing but also

revisited alpine skiing. In the summers, she enjoyed backpacking and hiking along the mesas and pre-Spanish Pueblo Indian sites surrounding Los Alamos.

California:

As the Berlin Wall was falling, the main mission of LANL (nuclear weapon design) seemed less significant. At the same time, the Martin-Hardwick team was recruited to join the Rockwell Science Center (RSC) in Thousand Oaks, California. This was the corporate laboratory for the Rockwell International conglomerate that included: North American Aircraft, Rocketdyne, Space Division (i.e. Apollo Program and Space Shuttle), Goss Printing Presses, Allen-Bradley Automation, Collins Avionics, Reliance Electric, several solid state electronics and automotive component divisions. They moved to Thousand Oaks (mid-way between Los Angeles and Santa Barbara) in February 1990. Dallis began working on high temperature, high conductivity and light weight alloys for the aerospace divisions plus a foray into lead-free solder for the electrical products divisions of the company.

Dallis began a very successful project to understand how metals burn in high pressure oxygen environments. The Rocketdyne Division was, and still is, the largest liquid rocket engine manufacturer in the United States. The turbopumps that move the fuel and liquid oxygen into the combustion chamber are extremely complex devices. There are only a handful of materials that will not burn when heated in very high pressure oxygen environments inside these turbopumps. Dallis devised an algorithm to define the optimum alloy composition to both maximize the strength and the burn resistance of alloys for use in these pumps. The next generation of liquid rocket engines to be made in the western world (by Rocketdyne) will have one or both of the alloys defined by Dallis. Her long-time collaborator on this project was with a younger engineer, Monica Jacinto. Monica describes her perceptions of Dallis in a separate tribute. The alloys that they jointly developed are named Mondaloy (Mon + Dal) in honor of their close collaboration.

During these years, Dallis made significant contributions to TMS. She became Chair of the Programming Committee which is responsible for the organization of the semi-annual technical gatherings that attract four to five thousand scientists and engineers. Her guidelines for how to organize these technical sessions are still in use by TMS. She also served as Chair of the Publications Committee. Each of these positions made her a member of the TMS Board of Directors.

Washington:

The Boeing Company purchased all of the aerospace operations from Rockwell in 1996. RSC remained a part of the parent company and Boeing committed to funding research within RSC

for several years. As Dallis and Pat had been primarily supporting those divisions purchased by Boeing, it made sense to accept the opportunity to 'transfer' to Boeing during the transition of Rockwell's assets to Boeing. In May 1998, they moved to Seattle, Washington and began working in the Manufacturing Research and Development organization within the Boeing Commercial Airplane Group. Dallis worked in the Machining Group and was responsible for friction stir welding (in its early days) and novel tools for high speed machining of titanium alloys. Dallis was elected to the position of Chair of the Structural Materials Division of TMS, 1997-1999. As such, she was on the TMS Board of Directors for a third time.

Dallis and Pat had planned to make this their last move, but it was not to be. The Boeing Company continued to expand. When it absorbed the McDonnell-Douglas Corporation, the turmoil resulted in morale declines and eventually to an engineers' strike in 2000.

Ohio:

They were again recruited to move during the strike at Boeing. The Air Force Research Laboratories (AFRL), Materials and Manufacturing Directorate at Wright-Patterson Air Force Base was seeking senior engineers with knowledge of both rocket and gas turbine engines. In August 2000, they moved to Dayton, Ohio; the fourth move as 'a team'. Dallis became involved with all of the technologies being developed for advanced rocket propulsion. This placed her back into the Mondalay effort – this time as the government sponsor/program manager instead of engineer.

Dallis was nominated to become President of TMS in 2002. While another female engineer, a close friend of Dallis, was selected to become President of the society Dallis represented TMS on the Board of Governors for *Acta Materialia*; one of the most prestigious peer-reviewed technical journals in the field of Materials Science.

In 2005, Dallis was given the responsibility for coordinating all materials research in the Department of Defense (DoD) aimed at advanced gas turbine engines for aircraft. She reported status and plans in Washington DC at semi-annual reviews for senior administrators at DoD. She included complementary work done by NASA and the Department of Energy to avoid redundancy. In addition, she managed the Propulsion Portfolio (rocket and turbine) for the Materials Directorate of AFRL. For these contributions, she was awarded the Meritorious Civilian Service Medal in 2010. Dallis was appointed as the U.S. Air Force representative on the five country cooperative panel coordinating Materials Technology (USA, Canada, United Kingdom, Australia and New Zealand). This allowed her to travel widely and to add to her international network. She gave invited talks in North America, Europe, India and Australia.

A 'routine' mammogram in the summer of 2009 detected a small growth. It was eventually determined to be Stage 4 metastatic breast cancer. There were no symptoms of the liver and bone involvement at the time of diagnosis. She began a very aggressive clinical trial chemotherapy in September. The infusions were scheduled on Thursday afternoons. She felt fine on Friday and then used the weekend to recover; she never stopped working. The first chemo treatment was successful in that the soft tissue tumors were eliminated and the bone lesions 'lessened' by April 2010. In all, Dallis participated in three clinical trials of experimental chemotherapies.

Dallis decided to retire from Civil Service in April 2012. She retained an office at the laboratory in the Emeritus Program so that she could continue to mentor and guide the younger engineers. She also moved full time into her crafts: sewing, bead jewelry, enameling and weaving. Dallis was chair of the local chapter of the American Sewing Guild for two years. She was also an avid cook with a special interest in French gastronomy and wine following multiple holidays 'barging through' France (1995 and 2005, most notably).

The breast cancer finally crossed to her central nervous system with noticeable weakness and confusion in late November 2013. She died on January 5 2014. She never had any pain. She was smiling and telling her visitors that she 'felt fine' to the last.

She was, and continues to be, inspirational to those who knew her.

Pat Martin