Weber, Johanna Salome

(1910–2014)

- John Green

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Weber, Johanna Salome (1910–2014), mathematician and aerodynamicist, was born on 8 August 1910 in Düsseldorf to a poor farming family that had moved from the Walloon region of Malmedy. She had a younger sister, born in 1912. Their father died in November 1914, an early casualty of the First World War. Johanna did well at school (first a primary school in Düsseldorf, then a convent school) and began a degree in mathematics, chemistry, and physics in 1929 in Cologne, switching in 1930 to Göttingen University, which at that time (prior to the Nazi purge of 1933) was world-renowned for mathematics and science. She graduated Dr rer. nat. with first-class honours in 1935 and then successfully undertook a two-year teacher training course. Refused a teaching post because she was not a member of the Nazi Party, she took a job at Krupp in Essen. Although, in her own words, she 'really knew nothing' of aerodynamics (Warren, oral history interview), she applied successfully in response to an advertisement for mathematicians at the Aerodynamische Versuchsanstalt (AVA, or Aerodynamics Research Institute) in Göttingen and on 1 February 1939 took up a post there. On her first day at the AVA she met Dietrich Küchemann, who was organizing a social that evening where she met Dietrich's wife, Helga. It was the beginning of a friendship with the family and a professional relationship with Dietrich that became close and lasted throughout their lives.

The AVA, under the leadership of Ludwig Prandtl, had led the world in the development of aerodynamics in the early decades of the twentieth century and it was in the mathematics of this field that Johanna Weber found her feet. Six months into the job she began working with Küchemann on the aerodynamics of engine cowlings and jet engine intakes, she doing the mathematics and also diversifying into wind tunnel testing and liaison with the workshops while he, in consultation with the manufacturers, developed the research ideas and shaped the direction of their work. Weber and Küchemann continued to work together throughout the Second World War.

At the end of the war Göttingen fell into the zone occupied by the British, who after a few months encouraged (and paid) some of the researchers, including Küchemann and Weber, to return to AVA and write monographs of the work they had undertaken during the war. These were subsequently translated into English. Copies of the originals and translations are held in the National Archives. The substantial output from Küchemann and Weber formed the basis for their textbook *Aerodynamics of Propulsion*, published in 1953 by McGraw-Hill, which became a standard text on the subject.

In the early post-war years Küchemann and Weber were among the German scientists who moved to Britain. In October 1946 Küchemann came to work in the aerodynamics department at the Royal Aircraft Establishment (RAE) at Farnborough and persuaded Weber to join him in 1947. Their first work together was on the crescent-shaped wing of the Handley Page Victor, a very advanced design submitted in May 1947 in response to an Air Ministry specification for a jet bomber capable of carrying a nuclear weapon. The crescent-shaped wing was inspired by a concept first proposed and patented in Göttingen in 1939 but the war ended before the concept could be flight-tested. The aerodynamics of such a wing at high flight speeds was well outside British design
experience. Küchemann enlisted Weber to help with the calculations and in September 1947 they issued a joint paper assessing the aerodynamics of the proposed crescent wing and suggesting modifications that resulted in an aircraft with outstanding high-speed performance. Its maximum Mach number in horizontal flight was 0.98 and in a shallow dive it became the largest aircraft to break the sound barrier. It served in the RAF, in various roles, from 1957 to 1993.

Weber's analysis of the Victor wing used simple, linearized aerodynamic models and hand calculations—there were no computers at that time. Even so, following on from the Victor, Küchemann and Weber set about improving theoretical methods across the whole aerodynamics spectrum. It was Weber who, in the mid-1950s, at the time when aerodynamic design of the Vickers VC10 was beginning, finally produced a method that enabled all the key features of a wing—thickness, camber, twist, and sweepback—to be treated simultaneously. The Vickers aerodynamicists worked with Weber to develop her method into a powerful design tool. Applying the concepts that Küchemann and Weber had used to optimize the Victor
wing, Vickers produced a wing for the VC10 that was aerodynamically more advanced than on any previous civil aircraft. The Weber method used in the design of the VC10 wing was a major step forward and was adopted by both de Havilland and Vickers in their future designs.

In parallel with her work on swept wings Weber became involved in supersonic transport aircraft, beginning in 1955 in studies with Eric Maskell at RAE demonstrating that a slender delta wing at high angles of attack generated strong vortices from its leading edges, greatly increasing its lift. Küchemann recognized that this made a slender delta a realistic possibility for a Mach 2 airliner and it was partly his advocacy that led to the launch of the Anglo-French project. Weber's subsequent research on wave drag and wing warping provided a spring board for the design studies in industry from which Concorde emerged.

With the peak of research in support of Concorde past, Weber reverted to the task of improving and extending design methods as part of an effort, led by Küchemann, who was by then head of the aerodynamics department at RAE, to advance national wing design capability. Her most important contribution in this period was the use of her latest methods, by Hawker-

Siddeley at Hatfield, to design the wing of the first Airbus, the three-nation A300B. This aircraft entered service in 1974, the year before Weber retired. It consumed 30 per cent less fuel per passenger mile than its American competitors, the Lockheed Tristar and the McDonnell Douglas DC10, and eventually outsold them by a comfortable margin. The final A300B, the 561st, was delivered in 2007, thirty-two years after Weber's retirement. By then four new Airbus types were in service, all with wings designed and manufactured in Britain. The civil aircraft market was divided between two giants, Boeing and Airbus, and Airbus was delivering more aircraft per year than its American competitor.

Weber retired in 1975 and Küchemann died unexpectedly in 1976. She had made an important contribution to, but declined to be a joint author of, his seminal book, *The Aerodynamic Design of Aircraft*, published posthumously in 1978. She was a very modest person and would have dismissed any suggestion that she had played an important part in laying the foundations for the great enterprise that Airbus became. However, without the drive of Küchemann and the mathematics of Weber, the UK would probably not have designed a wing for the A300B that gave it the aerodynamic edge to break into the American, and hence the world, market. And if the A300B had not proved a considerably better aircraft than its competitors, Airbus might never have established parity with Boeing.

Johanna Weber never married. She never drove a car. She lived happily in an RAE hostel from 1947 until 1953, when she and the Küchemann's became British citizens. Thereafter, she lived in her own quarters in the Küchemann family home until 1961 when she bought the bungalow next door. After the death of Helga Küchemann in 1987 she became a kind of elder, 'Tante Jo', to the rest of the family. Her last four years were spent in Hill House nursing home, Beacon Hill, Farnham, Surrey, where she died of natural causes on 24 October 2014.

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