

A tribute to my father, Karl P. Durre

By Imke Durre

My father, Dr. Karl Paul Durre, devoted his career in mathematics and computer science to the design of algorithms and the development of technological innovations that simplified written communication between braille and print readers. Here I review both his life and his contributions to the fields of mathematics and assistive technology.

The early years

Born on July 20, 1937, as the youngest of three children, my father spent his early childhood years in Reichenbach/Görlitz, Germany, where his parents operated a residential school for children with special needs. After fleeing, together with the school's 100 students, from the approaching front lines during the last months of World War II, his family moved around to various places in Austria and Germany between 1945 and 1948. They finally settled in Delmenhorst in northern Germany, where my father attended secondary school and developed his lifelong interests in classical music, track and field, and mathematics. He took up the piano at age 15, nine years after his first musical instrument, a violin, and any dreams of playing it, had been crushed when one of his sisters plopped herself into the chair where my father had left the instrument after trying it out for the first time. Though not much of an athlete himself, he took to memorizing the track and field performances of both his classmates and the professional athletes of the time. He thus earned himself the honor of being designated "best theoretical athlete" by his peers at their high school graduation in 1957.

After graduation, my father studied mathematics and physics at the universities of Marburg and Hannover, Germany, with the goal of becoming a high school teacher. His knack for harnessing the power of newly emerging computer technology in devising solutions to seemingly intractable problems, however, led him on a very different career path.

Fascination with the four-color problem

Inspired by the work of Prof. Heinrich Heesch at the University of Hannover, my father

became fascinated with "coloring problems," an area of mathematics concerned with the number of colors required for distinguishing adjoining countries on a map. Under Dr. Heesch's tutelage, my father participated in the search for a proof to the Four-Color Theorem. This theorem states that four colors suffice to color an arbitrary map where countries with common borders must be colored differently. Devising innovative techniques for utilizing the limited amount of computer memory, my father designed and implemented an algorithm for performing computations that formed the basis for the later proof of the theorem. It is this work that was the subject of his doctoral dissertation and led to his earning a Ph.D. in mathematics in 1969 from the University of Hannover, Germany.

The availability of more advanced computing resources in the United States brought my father to Brookhaven National Laboratory on Long Island in 1968 and 1969. The invitation to Brookhaven was extended by Dr. Yoshio Shimamoto, who himself was working on the four-color problem and saw great potential in the Durre-Heesch algorithm. While there, my father enjoyed the classical music and opera scenes of New York City and traveled the country extensively by car. These experiences left him with memories and stories that he enjoyed sharing with his family for the rest of his life and in part contributed to his later permanent move to the United States.

After returning to Germany from Brookhaven, he continued to pursue his interest in graph-coloring algorithms and their application to the compression of sparsely populated data bases. As a research scientist, he first conducted this work in the Department of Mathematical Machines and Data Processing at the University of Erlangen and in 1971 transferred to the newly established Department of Computer Science at the University of Karlsruhe. He married in 1971 and had two children with his wife Ingeborg, Imke and Holger.

Pioneering software development

My father's passion for assistive technology was inspired by my blindness and my parents' desire to provide me access to an equal and appropriate education without sending me to a residential school. In Germany during the late 1970s, there was no support system of vision resource teachers, meaning that children with disabilities had to attend a special school. After locating a school principal who was willing to support my parents' attempt to mainstream me in the neighborhood school system, the Department of Education of our home state eventually granted the school special permission to try this educational experiment, under the premise that my parents would provide the support necessary to access educational materials for me. It was understood that they would also take care of the issue with access to my written homework and tests for my classroom teachers. This was possible since my father developed a computer-aided system that would allow for direct written communication between blind students and their sighted teachers, peers,

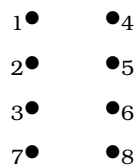
and family members.

Having chosen the recently released VersaBraille from Telesensory, Inc., as the appropriate electronic braille reading and writing device, my father tried to locate software that would allow this device to provide instantaneous braille input and output when connected to a personal computer. Unable to find what he was looking for, he conceived new software and interested one of his students, Thomas Friehoff, in the implementation of his vision. The result was BrailleButler, a screen reader and braille display-friendly editor for the Apple IIe. The first version was completed in September 1983, the night before I entered fifth grade in a regular German secondary school. Before long, the system was also used by several other blind children whose parents desired a mainstream education for them. BrailleButler was eventually distributed and further developed by Baum Elektronik which Thomas Friehoff later joined.

Direct written communication through 8-dot computer braille

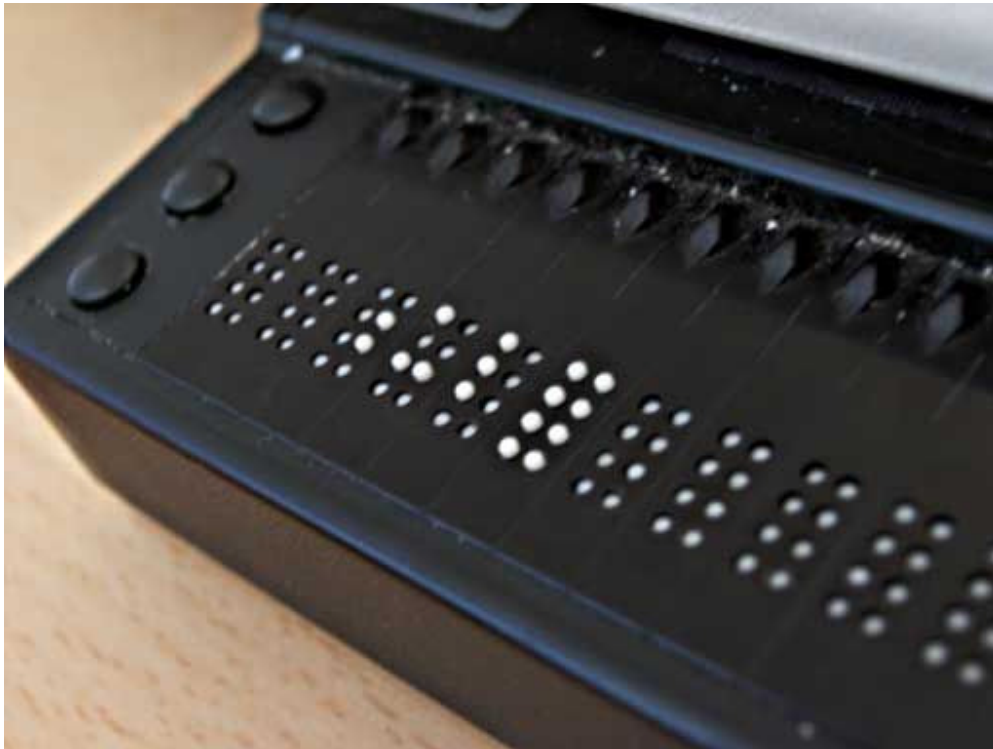
One particularly useful aspect of the BrailleButler was its reliance on an uncontracted braille code that made full use of all eight dots available in computer braille characters, thus allowing for a one-to-one correspondence between print and braille characters. At that time, the number of dots in braille displays was limited to 6 dots per cell. To increase the number of unique dot combinations, my father conceived a method for simulating the addition of dot 7 only, dot 8 only, and dots 7 and 8 together by way of different speeds of vibration of the 6-dot characters. Six-dot characters to which only a dot 7 was added, e.g., the capital A, vibrated the fastest, characters containing both dots 7 and 8 vibrated the slowest, and characters to which only dot 8 was added vibrated at an intermediate speed. Since the VersaBraille model on the market at the time did not have this vibrational capability, my father arranged with Baum, Telesensory's distributor in Germany at the time, to have a VersaBraille specially adapted for me. Soon, the expanded functionality became a standard feature for all new VersaBraille units. Around 1990, with the advent of braille displays with 8-dot cells, the true 8-dot characters replaced the different modes of vibration.

Picture 1: The 8-dot braille cell.



Whether dots 7 and 8 were virtual or real, their use made it possible to expand the number of symbols that could be represented with one braille character to four times the number available in the traditional 6-dot system. Thanks to this expansion, blind students now had a sufficient number of symbols to write all assignments, including those in math and foreign languages, on the computer in a form that both they and their sighted teachers could read. Conversely, any person without knowledge of braille was able to make texts accessible to the blind student by entering them into a regular word processor on a conventional QWERTY keyboard. Furthermore, the simultaneous appearance of text in print on the monitor and in braille on the refreshable braille display facilitated direct written communication between blind and sighted individuals in school and in employment settings, thus greatly simplifying the integration of blind individuals into the regular classroom and working world.

Picture 2: A refreshable braille display with 8-dot braille cells.



In a 1991 conference paper, my father, in collaboration with Dean Tuttle and my mother, presented an Americanized version of the 8-dot code in which print symbols were matched with braille dot combinations familiar to the American braille reader. The authors argued that this system represented “a user friendly universal braille code that permits the combination of literary English texts with foreign language and/or

mathematical texts.” They regarded an 8-dot code as an appropriate answer to the revived search for a universal English braille code, rather than the 6-dot code others proposed. Their paper is frequently cited in discussions about a universal braille code for the English language and has been brought to the attention of the Braille Authority of North America (BANA), the official entity regulating the usage of braille in the U.S. and Canada. However, even though computers are now widely used in all areas of life, a variety of concerns have prevented many in the United States, among them BANA, from accepting an 8-dot code as a viable option for a universal braille code. In Europe, on the other hand, the 8-dot code became widely used in the 1980s and its popularity continues to this day.

Other contributions

Together with another of his students, my father also designed GeoTac, an Apple IIe software that allowed blind students to complete typical geometry assignments using a computer, joystick, and Telesensory's Optacon. Connected to the computer, the Optacon's display showed a small excerpt of the virtual page presented on the screen. Using a joystick, the user could explore the contents of the entire screen. Through the system's menus, commands could be issued that were equivalent to the functionality of a compass, protractor, and ruler. For example, one could set a marker at a particular point on the virtual page, use the joystick to navigate to another spot, and choose the option of drawing a circle that was centered on the marked point and went through the current cursor position. Other menu commands allowed for the labeling of segments, points, and coordinate axes. The teacher or parent could observe on the monitor's screen every step of the drawing process, and the work could be sent to a print printer to be turned in to the teacher. Aside from assisting me and several other students throughout their secondary education, GeoTac's underlying concepts laid the foundation for the Graphics Window Professional recently developed and marketed by Handy Tech.

Recognizing that developments such as the BrailleButler and GeoTac make it possible for persons who are blind to be fully integrated into society on both a personal and professional level, my father proceeded to conceive a Support Center for blind and visually impaired computer science and industrial engineering students at the University of Karlsruhe in Germany. With the support of federal and state funding, the center was established as a demonstration project in 1987 – too late to prevent my parents from executing their decision to move to the United States, based on an offer from Southern Methodist University (SMU) in Dallas, Texas, to my father for a position in the computer science department. Under the leadership of his former colleagues, the center became a fully funded, permanent program of the University of Karlsruhe in 1993 and continues as such to this day.

Once in the United States, my father continued his work in the assistive technology field, initially as a professor of computer science at SMU, from where in 1988 he transferred to the computer science department at Colorado State University in Fort Collins. While adjusting to the English language and American academic system, he engaged in conversations with developers and manufacturers of blindness products, among them Telesensory and Blazie Engineering, and thus influenced the development of devices such as the Braille 'N Speak, Navigator, and BrailleMate. In the early 1990s, he also published papers in which he presented ideas for making graphical user interfaces accessible to computer users who are blind. Some of the concepts he introduced were used in the design of Baum's Windows screen reader Virgo, which was distributed in the United States under the name ScreenPower.

Retirement

During the early 1990s, my father's career became increasingly impacted by health issues, and in 1994, the effects of hydrocephalus forced him into early retirement. He then moved to Phoenix, AZ, where my mother had taken a job in view of his health problems. Taking great pride in the professional success of his children and wife, his life then centered around supporting all of us in our careers. For as long as his health allowed, he took over the cooking and grocery shopping at home and was willing to be dispatched at a moment's notice to provide moral and practical support to my brother and me in various parts of the country. He was always ready to dispense advice, oftentimes indirectly by serving as a sounding board, at other times by issuing the solicited or unsolicited, firm directives of a concerned father.

All movement including walking and getting up from a chair became increasingly difficult for my father, which led to the additional diagnosis of Parkinson's disease in early 2004. With a heightened sense of urgency, he pursued his lifelong interest in traveling, in the company of my mother, and not seldom myself. He still took a great interest in politics and followed daily events by reading the local newspaper and several online English and German newspapers, although his mental abilities noticeably had started to wane. He also enjoyed following sports events, especially in track and field and professional tennis and shared articles with his family by forwarding them by email. My father's death came unexpectedly on March 5, 2008, while he was enjoying a steam bath in a local fitness room, for which he had just discovered a great love, as he experienced an elevated sense of lightness while in the steam bath.

Picture 3: My father on March 1, 2008.



Personally, I will remember my father as a warm-hearted man who did everything in his power to allow my brother and me to obtain the best and most appropriate education possible. I will particularly cherish my memories of the daily phone calls of the past five years during which he and I rode our respective stationary bikes and shared thoughts about the day's events in our lives and in the news. Professionally, he will be remembered for his contributions to the solution of the Four Color Problem as well as for his pioneering work to improve the communication between blind and sighted persons.