Emerson Foulke saw the world with a rare clarity, comprehension, and humor that enriched the experience of others. He lacked sight, physiologically defined, but he did not lack vision.

Writing as three friends, we recount stories and anecdotes about Emerson’s achievements in using alternatives to vision for perceiving the world and accomplishing the tasks of daily living. Writing as three fellow students of perception, we describe some of the central ideas of his research and writings. We wish to call attention to Emerson's ideas about strategies for perceiving, and hope that these ideas and examples may inform a better understanding of perception, lead to research on the guidance of action and comprehension without vision, and inspire others—both sighted and blind—in the better use of their own resources for perceiving the world. His observations, research, and insights benefitted a wide audience. We write now in an effort to expand that audience.

Emerson Foulke was born in 1929 and he died on December 29, 1997. He received his BS in Psychology from the University of Arkansas in 1952, and his PhD in Experimental Psychology from Washington University in St Louis in 1959. A professor of psychology at the University of Louisville from 1962 until he retired in 1992, he founded the Perceptual Alternatives Laboratory at the University. The goal of the Laboratory was to improve and develop alternatives to vision for guiding action and comprehension. Foulke was coeditor with W Schiff of Tactual Perception: A Source Book (1982), editor of Electronic Mobility Aids: New Directions for Research (1986), and author of 75 published articles and book chapters.

Emerson Foulke began his study of experimental psychology when the mainstream of sensory and perceptual research was focused on vision by passive observers in static situations. When his studies ended, the mainstream had shifted and widened, with much greater interest in dynamic stimulation associated with moving objects and moving observers, in exploratory actions, in the perceptual functions of sensory systems, and in nonvisual perception. These changed directions in perceptual research were reflected in the work of the Perceptual Alternatives Laboratory—eg on perception and comprehension of large-scale spaces; on active exploration of space by walking, touching, and wielding a long cane; on reading by touching and listening; and on the design of perceptual interfaces between human perceivers and sources of spatial and symbolic information.

Foulke's ecological conceptions of perception, action, and comprehension

Many of Foulke's ideas about perception, action, and comprehension were ecological. His conceptions were shaped by the problems he researched and by his experiences in perceiving and acting in the world without vision. The following list summarizes what we understand as some of the key ideas developed in Foulke's research and writings.

- Perception is an active process temporally organized by observers interacting with their surroundings. As Gibson (1979) noted, perceiving and acting are a cycle: One perceives in order to act, and acts in order to perceive. Nowhere is the “acting in order to perceive” part of the cycle more clear than in situations where one is exploring the world without vision. Consider wielding a long cane to explore unfamiliar terrain, scanning with the hand to read Braille, and walking to discover the salient features and landmarks of unfamiliar surroundings and learn their spatial layout.
The structure and content of perception are shaped by the structure and content of the environment. For example, sweeping a long cane across a surface results in vibrations that can be felt and/or heard, specifying surface properties like texture, rigidity, and substance. Perception of linguistic material is organized by its meaning and temporal syntax, whether the physical stimulation is presented as speech, print, or Braille.

**Perceivable information is structured across the time and space of actions.** The information acquired during locomotion, listening, and touching is structured in ways that reveal properties of the surrounding objects and events as well as the changing position of the acting observer. The speed and effectiveness of vision for acquiring information in a glance—in localizing and recognizing distant objects, planning locomotion, and anticipating interactions with objects—have allowed perception researchers to overlook the critical importance of temporal structure for visual and nonvisual information. Although the temporal nature of visual information eventually came to be recognized in concepts like ‘optical flow’. Foulke pointed out that the ‘optical’ emphasis is misleading in some respects. What actually is ‘flowing’, he said, is the environment relative to the moving observer, and this ‘environmental flow’ can be specified nonvisually as well as visually.

**Information about the environment can be obtained multi-modally, through nonvisual as well as visual channels.** Consider learning about the texture of one’s walking surface by actively feeling and hearing it through a long cane; learning about the spatial layout of a building, campus, or city, through exploratory touching of a tactual map, or listening to a companion’s verbal description, or walking around on foot; learning the spatial design of architectural, mechanical, or electrical systems by using tactually rendered schematics and diagrams; perceiving and comprehending text by touching Braille or listening to pre-recorded speech; and comprehending the story line of a commercial film through ‘video description’—ie voice-overs that describe the physical situations and events in the film.

**Cognitive representation and inference play critical roles in spatial perception and action.** Foulke emphasized the role of representation and inference in practical wayfinding. From his own experiences he understood that knowledge of the spatial layout of familiar places is amodal and seems to be generically the same, whether it is acquired by soliciting verbal descriptions, exploring by foot, or investigating a tangible map. Spatial knowledge is sometimes inferred and inferences are often made to act on it. Consider situations where one becomes disoriented and then searches for clues about location, generates hypotheses about one’s possible location, and explores to confirm or disconfirm those hypotheses. From Foulke’s perspective, belief that perception is entirely direct and noninferential seemed to be based mainly on the subjective immediacy and scope of spatial vision rather than on analysis of the tasks of perceiving, comprehending, and acting in spatial environments (Foulke 1971c).

**The effectiveness of sensory interfaces with the environment can be significantly improved.** Foulke considered himself a human engineer. He had impressive knowledge and skills in using electronic and computer technology and devoted considerable interest and time to improving the design of long canes for guiding locomotion, to redesigning Braille, to constructing tactile maps, to designing tactile graphics for science and mathematics learning, and to developing practical methods to speed the presentation of prerecorded speech. While advocating the development of new and improved technologies, Foulke stressed the human side, emphasizing the need for research to find out what types of information were the most useful, how the information should be delivered, and how skill at using technologies can be enhanced by education.

**Studies, papers, and anecdotes**

**Long canes as perceptual tools.** Foulke characterized the long cane as a perceptual tool, an implement used to provide information about the surrounding environment and to guide travel. In the hands of skillful users, the angles swept by long canes
provide information about the dimensions of doorways, steps, and objects in the path of travel; the tactile and audible vibrations specify the surface as grass, asphalt, concrete, gravel, or mud. In his home workshop, he tinkered with various materials for cane shafts, searching for those that best transmitted vibrations to hand and ear for identifying the materials of the walking surfaces.

Foulke’s interest and systematic work on cane tips that might supplement the standard cylindrical tip was decades ahead of its time. He worked to discover and devise a cane tip that optimized two functional demands: (a) for perceiving the properties of the walking surface by transmitting vibrations, and (b) for graceful travel by sliding over cracks, crevices, and obstacles in walking surfaces on which the standard cylindrical tip tends to hang up. Some of us laughed at his ‘bent spoon’ cane tip, but indeed his spoon, bent so that the handle was attached to the cane shaft and the bowl slid across the ground, both transmitted important vibrations and also slid over many obstacles or cracks. And Emerson had the last laugh, given that his ‘caster cane’ (Foulke 1969) seems to us to have set the stage for the creation of the collection of cane tips that are commercially available today, including the marshmallow tip, roller tip, ‘J’ or bent tip, fence-trailing tip, and snow tip.

Foulke and his students analyzed the information needed for safe and graceful walking without vision. They noted that it depends on ‘preview’—advance warning about obstacles in one’s path—and conducted experimental tests to find out how much preview was needed, whether and to what degree it depended on the height and speed of the person walking, and how the greater amount of preview afforded by longer and longer long canes might trade off with the clumsiness of wielding longer canes (Foulke 1971c; Shingledecker and Foulke 1978; Barth and Foulke 1979).

Spatial orientation and wayfinding. Emerson Foulke was an accomplished world traveler. He traveled throughout the world on his own, regularly visiting most parts of the United States as well as Europe (Great Britain, Germany, The Netherlands, Norway, Sweden), the Far East (Japan, Korea), South America, and Australia. At scientific meetings, he routinely enlisted the aid of a sighted guide to supplement his use of the long cane as an obstacle detector, but it was usually Emerson who knew the way. More than one of his sighted colleagues tells the story of meeting Emerson at a meeting and serving as Emerson’s ‘sighted guide’ for detecting obstacles while Emerson served as the ‘orientation guide’ for getting from one locale to another on campus or in a city. Marilyn Foulke, Emerson’s wife, tells about Emerson describing the detailed layout of a new house that he had visited just once, and about driving Emerson in Louisville and having him point out that she had taken a wrong turn. During many summers, Marilyn and Emerson toured the English countryside on a tandem bicycle, she steering and braking from the front seat while Emerson pedaled, shifted gears, and navigated from the rear.

None of us knows exactly how to explain Emerson’s skills in orientation, although he evidently devoted more attention, time, and thought than others to the organization of spaces. He was interested in maps, and created a beautiful tactile map of the University of Louisville campus. Emerson spotted errors in the official map produced by the University, and his map was used to correct the official map! He studied maps diligently, mostly by asking sighted persons to describe them to him in detail. When he traveled to new cities, he prepared in advance, typically locating maps of the region and studying them. He often traveled with a sighted partner, quizzing the partner for descriptions of the surroundings. One of the standard methods for organizing space was to place a rubber band around the doorknob of his hotel room as a cue to confirm that he had returned to the correct room. Despite the insights provided by his writing, Emerson’s spatial skills surprised and amazed most who knew him.

Emerson’s writings offer rich descriptions of the nonvisual information available for perceiving spatial environments, task analyses for safe and efficient wayfinding, and descriptions of the perceptual and cognitive strategies for achieving safe and efficient
wayfinding. His analyses of spatial information and its use in travel are developed in his chapters in Graham (1972), Walk and Pick (1978), Potegal (1982), Pick and Acredolo (1983), and Warren and Strelow (1985). He conducted empirical studies to find out more about the perceptual and cognitive skills of blind pedestrians (e.g., Hollyfield and Foulke 1983). The findings reinforced his personal observations that there is a very broad range of individual differences in the cognitive maps of blind individuals. While speculating that some of these differences might originate in biological causes reflected in different etiologies of blindness, his writings develop the importance of educational approaches. For him the key questions were about which cognitive and perceptual strategies can be most efficiently used to acquire spatial information without vision. To learn more about this, he and John Brabyn observed and interviewed five highly skilled blind travelers to find out what things they noticed while exploring new places, what things they selected as landmarks, and what strategies they used to keep track of their changing orientation.

- **Language, comprehension, and articulation.** Emerson's skills in comprehending the organization and meaning of the world were significantly strengthened by his impressive facility with language. He used language as a principal cognitive tool for articulating, organizing, remembering, and also as a creative tool for expressing his insightful and often humorous perspective about people and events. An avid reader, Emerson took advantage of texts available in Braille, audio recordings, print read aloud by computer systems, and reading aloud by his wife Marilyn and secretary Lee Johns. Like many other scientists, Emerson used conversation as a method of understanding things. A skilled listener and witty conversationalist, Emerson was a popular conversational partner. We are uncertain how to document the role of his language skills in his understanding of the world, but it is easy to illustrate his flair for language. He was an enthusiastic author of limericks, many too risqué to be appropriate here. Perhaps the following example will illustrate his facility with phrase.

Some years ago, Emerson and Marilyn shared their house with a good-natured, heavily coated golden retriever named Buster. One day, a potentially serious grease fire erupted in the kitchen. The kitchen was small, just large enough for Marilyn, Emerson, and Buster to occupy at the same time. During the hasty reactions of all three to the fire, some of the burning grease popped from the pan and onto the dog, burning its coat and generally heightening the confusion of efforts toward thoughtful action. In the midst of the chaos, Emerson observed, "Well, there's a pretty little furry with a singe on top!"

- **Tools and object design.** Foulke was skilled at designing and building objects from wood and metal. His creations include a 20-foot diameter, 14-foot high dome in the woods that served as a place to sleep. The design of the dome originated with a photograph in a magazine that Marilyn described to Emerson, who then proceeded to work out the design, partly by building scale models from cardboard. Other projects included a geodesic dome house for his dogs, tables, desks, and waste baskets. Working alone to build them, he used hand tools as well as power tools, nails, screws, glue, and so forth. His woodworking projects are notable to us for the precision of their joints. For example, he built a waste basket, precisely sized to enclose a standard paper grocery sack, and consisting of half-inch-square pine boards, each mitered so that the 30 vertical pieces fit cleanly with the 80 horizontal pieces. We do not know how he designed them, but suppose he relied on spatial imagery and models that he built, since his wife Marilyn reports that he did not purchase plans or make drawings.

- **Reading by listening to prerecorded speech.** Foulke focused on two practical reading problems. One was the lack of independence involved needing assistance from sighted persons to read text, a problem that gave rise to his interest in computer systems that could read printed text aloud. The other was that the 120–200 words-per-minute rate of much reading aloud is slow compared to reading and skimming printed text by sight. These practical problems gave rise to Foulke's systematic research on the intelligibility
of accelerated speech and compressed speech delivered via tape recordings and speech synthesizers (Foulke and Sticht 1969, 1974). His research generally assessed comprehension as the dependent variable in the context of experimental manipulations of word rate (Foulke 1966, 1970; Holding et al 1973), signal rise time and decay time (Warm and Foulke 1970; Warm et al 1966), harmonic compression of the stimulus (Foulke 1971a), the reader’s voice and vocal style (Foulke 1967), the structure of the text (Foulke and Sticht 1966), and practice listening to speeded speech (Lass et al 1974). Foulke’s systematic research provided an important basis for the time-scale modification of recorded speech today, in which recorded speech is played at faster or slower rates while original properties like pitch, speaker identity, and intelligibility are preserved. The applications are widespread, and include speeded reading-by-listening by persons who are blind, foreign language instruction, and the speeding up of dance music. We believe that Foulke may be most remembered by future generations of blind people as the person who opened the door for them to read by listening at speeds greater than 200 words per minute.

- Reading by touch. Foulke’s earliest research on reading with the skin was focused on electro cutaneous stimulation, where he investigated the effects of stimulus dimensionality on rate of information transmission (Foulke et al 1966), transmission of the Katakana syllabary (Foulke and Sticht 1966), threshold factors (Sheridan et al 1966), and reaction time as a function of rise and decay time (Sticht and Foulke 1966). This approach soon gave way to work on ‘reading by touch’ with Braille. His experimental studies emphasized identification by hand of objects or raised line drawings or Braille cells (Foulke 1971b), as a function of variables including stimulus orientation, hand orientation (Warm et al 1970), the tactual field of view (Lappin and Foulke 1973), and the type and complexity of the Braille code (Foulke 1979). This work culminated in psychophysical studies of the decreases in tactile sensitivity associated with aging (Stevens et al 1996) and on public policy issues associated with implementing alternative forms of the Braille code (Foulke 1996). He emphasized especially the need to simplify the code and to increase its power for representing concepts in mathematics and science.

According to Tim Cranmer, Chair of the International Braille Research Center in Baltimore (which Emerson helped establish in 1985), Foulke “is probably the most widely published and widely quoted person in the field of Braille research and tactile communications. ... We do not have a successor to Dr. Foulke” (from the Louisville Courier-Journal December 31, 1997). Indeed, we close by noting that Professor Emerson Foulke was one of the most influential researchers of the nonvisual guidance of human perception, action, and comprehension. The field of human perception and performance does not have a replacement for Professor Foulke.

Acknowledgements. We are grateful for extensive conversations about Emerson’s hobbies and works with his wife, Marilyn Foulke, and his long-time secretary, Mrs Lee Johns. In addition we thank John Brabyn, Tim Cranmer, David A Guth, Philip Hatlen, and Herbert L Pick Jr for insights, anecdotes, and comments on the manuscript.

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