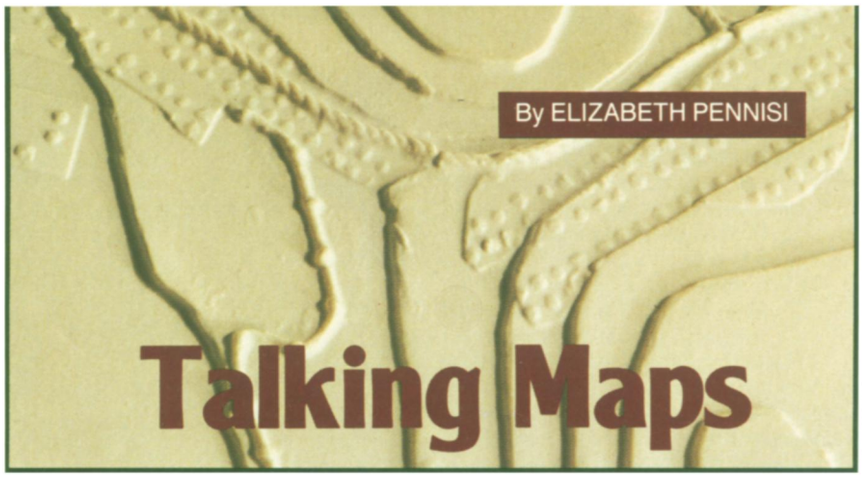

By ELIZABETH PENNISI

Talking Maps

Christer Palm

Technologies to give the visually impaired a sense of space

Imagine never being able to gaze at a globe's vast blue oceans, never seeing that Italy looks like a boot or that Long Island, N.Y., resembles a long fish.

Maps put states and countries into perspective (SN: 10/3/92, p.222). They show quite clearly that Texas dwarfs Rhode Island, that many, many miles separate California from New York, and that Interstate Highway 70 connects Philadelphia, St. Louis, and Denver.

Increasingly, these visual representations of space—and graphics of all kinds—help people navigate through ever more complex environments and information. Charts and graphs make sense of reams of otherwise confusing data. With a map in hand, a person can move with greater confidence across unfamiliar territory, be it a shopping mall, a city, or a foreign country. Atlases inspire armchair explorers to wonder about what exists beyond their immediate worlds.

But some people have few chances to share in this wonder. Blind since birth, Karen Luxton vividly recalls each one. A baseball fan, she finally understood what the game was all about when her dad fashioned a crude diamond from cardboard and ran her fingers from first base to second to third and back to home plate. Then in sixth grade, a teacher and a classmate made Luxton a solar system using blocks of wood. In high school, she learned about Europe and Africa from a few Braille maps. That was it.

Soon Luxton and others like her may have many more opportunities to use tactile graphics. The Americans with Disabilities Act, passed earlier this year, could force companies and institutions to provide disabled people with equal access to what our society has to offer, including the ability to travel independently. At the University of Maryland in College Park, cartographer Joseph W. Wiedel now gets several calls a day from people who want to make their organizations more accessible.

"I think [every] institution is going to be looking for anything practical in the way of helping people," says Reginald G. Golledge, a geographer at the University of California, Santa Barbara.

Also, researchers seeking to develop maps for the blind are beginning to see their efforts bear fruit. Golledge, for example, has devised a way to make small guide maps that can be updated easily on office copiers using a special paper. Luxton, now director of a computer center for the blind at Baruch College in New York City, has spearheaded efforts to produce tactile subway maps. The American Foundation for the Blind, Inc., also in New York City, has just published *Tactile Graphics,* a how-to guide for creating three-dimensional graphics based on decades of research by its author, graphic artist Polly K. Edman.

This January, a nonprofit organization will begin manufacturing a computer-based technology that allows tactile maps to talk. And Wiedel hopes to harness compact-disc technology to make talking maps that cost less and are easier to carry around than computer-driven ones.

In his work, Wiedel has developed tactile maps of the Washington, D.C., metro system, Asia, the former Soviet Union, and the Middle East. He became interested in creating tactile maps almost 30 years ago, when he realized that "you couldn't take a map and simply raise the lines," he says. He's still exploring better ways to present information.

"There's a question of what's readable but also the question, Is a triangle, for example, the best way to represent a staircase?" says Elliot Schreier, a computer scientist at American Foundation for the Blind, Inc.

Tactile-map cartographers must choose their symbols carefully. A sighted person can instantly distinguish a square from a diamond or whether stripes slant left or right, but a blind person—who may feel a map from any direction — may not read those symbols as different.

Sighted map readers take in the whole map at a glance. That overview helps them see details in context. But when fingers do the looking, they tend to take in the contents of the map one press of the fingertip at a time. "Everything will be coarsened up, and the information is going to be sensed grid square by grid square," says cartographer Andrew Tatham, Keeper of the Royal Geographical Society in London.

"The problem with [tactile] maps is that you don't get the resolution that you do with printed maps," adds David Andrews of the National Federation of the Blind in Baltimore, Md. Fingertips just don't "see" as well as eyes do. For example, most people can see features a hair's width apart, whereas the finger can only distinguish those about 2.5 millimeters apart, says Tatham. Consequently, a 0.5 mm dot denoting a city on a typical topographic map must be five times that diameter on a tactile map. Contour lines must have at least 6 mm of space between them, and no line can be less than 13 mm long, Tatham reported in August at the International Geographical Congress, held in Washington, D.C.

"That's a fairly severe barrier to the sorts of maps that we're used to drawing," he adds.

Then, too, while all cartographers grapple with the problem of avoiding clutter on their maps, the use of Braille makes that task much more difficult. Braille comes in just one type size. Each character contains up to six dots placed in a space 4 mm wide and 6 mm high. These letters dwarf those used in most maps, so fitting names in can prove difficult.

These limitations mean that maps for the visually impaired must pare down their information and be simple.

When Golledge suddenly became blind seven years ago, his longtime colleague and fellow geographer Donald N. Parkes realized that these limitations would make it almost impossible for Golledge to keep up in his field. "So I decided to put tactile maps

American Printing House for the Blind, Inc.

NOMAD's computer technology makes tactile graphics and maps talk.

into an electronic environment," recalls Parkes, of the University of Newcastle in Australia. He recognized that if he could pair audio information with tactile data, he could make tactile maps as detailed as regular maps – perhaps even more so.

Having little experience with electronics, Parkes was stymied by the prospect of building a prototype. Then he discovered musical Christmas cards. "I bought every [singing] card in the store," Parkes recalls. Once home, he tore out the microprocessors that generated the tunes and soldered them into an array. Then he pasted on a map of Australia.

When he touched Canberra, the map sang, "We wish you a merry Christmas"; when he touched other parts of the map, he elicited other carols. "In that way I was able to demonstrate what I wanted to do," says Parkes. Within a year, Quantum Technology, Ltd., a company based in Sydney, Australia, had produced the first talking touch-pad maps. Parkes named the device NOMAD, after the guide dog belonging to a blind university student who helped Parkes develop the machine.

NOMAD requires some clever software but little other innovative technology, says Parkes. It consists of an 18-inch by 15-inch touch-sensitive screen fitted with a speech synthesizer. The screen is connected to a computer containing programs that run NOMAD.

"It's unique and it's very user-programmable," comments Schreier. A user lays a map or any graphic with raised lines or textures on the screen and then lets the computer know what that graphic is. When the user touches a particular spot, the raised lines provide one kind of information, such as a city name. Press slightly harder, and the computer sings out more details specific to that spot.

"You can store information in audio form that is related to information that exists in a tactile form on the map," says Tatham. For example, many maps indicate a city's size by enlarging or filling the dot that marks its location. NOMAD's maps can keep the dots the same size; it lets its voice reveal the population.

Repeated touches on the same spot elicit ever more detailed geographic messages, says Tatham. Also, just as one can jot notes on a paper map, a NOMAD user can type in comments that NOMAD recites back when prompted by a touch at that particular spot.

Thus, this electronic map sidesteps the limitations of Braille lettering and may even exceed regular maps in the amount of information squeezed into a unit of space, Parkes says. NOMAD makes possible "virtual" travel, in which people can "take" a journey of any length and hear about the landscape they pass through – be it a building or a continent.

"Instead of colors, you can actually paint sounds in any area," says Tatham. Thus a map of the United States might produce different tones for adjacent states. A blind person could trace the state borders by listening for changes in the sounds.

"These end up being far more efficient maps than maps for sighted people," Tatham says.

In fact, NOMAD's sounds can reinforce what the sighted child sees and touches because NOMAD can make any graphic talk. So text from a nursery rhyme or even a scientific journal can be scanned into the computer's memory and coupled with the appropriate picture or figure laid down on the touch screen. By adding sound cards to the computer, one could match a graphic – such as the outline of a lion – with the proper noise – in this case, a roar. "What many teachers have said is that it has applications to other learning difficulties," Parkes says.

By March 1993, American Printing House for the Blind, Inc., in Louisville, Ky., plans to have produced 500 NOMADs. In addition, the nonprofit organization makes maps and graphics to go with NOMAD and may even use puff ink – the three-dimensional paint that decorates T-shirts – to make raised graphics cheaply and easily, says David A. Bice from the American Printing House.

Taking a slightly different approach, Wiedel wants to pair compact-disc (CD) players with touch screens for a less interactive, but also less expensive, talking tactile map. About 88 hours of speech can fit on one CD, and the quality of the speech surpasses that synthesized by computers, he says. Thus this device would prove most useful in instances where answers do not require frequent updating. This past summer, he and a colleague finished building a prototype, Wiedel says. They hope to improve their design and to incorporate the new 2.5-inch erasable-rewritable discs as they become available.

Wiedel even envisions a pocket-size version, with a CD player the size of a beeper and a screen fitted with index-card strip maps. Users would flip to the next map as they progress from point to point. "I think the technology is there," he says. "It's in the realm of reality."

Rather than wait for electronic components to shrink enough that NOMAD or touch pad-CD maps become truly portable, Luxton simply uses computers to help her make tactile maps. With the help of programmer Mitchell Balsam, now with Digital Media Systems, Inc., in New York City, her group incorporated commercially available graphics software into a system that runs an engraving machine.

Thus they can copy any map and simplify its features so it contains just essential information. They direct an engraving machine to etch those features into a foot-square piece of plastic and then pour resin into the plastic and remove the hardened sheet that forms. They make multiple copies by vacuum-forming plastic sheets on this template.

Graphic (left) shows limits of fingers. Each square can contain just one piece of information from the map (right). so its highway (purple), railroads (black), cities (pink), and parks (green) are sketchy, with no streets or contours.

Luxton and her mapmakers design maps no bigger than two hands can cover. Thus, just as a sighted map reader can get a sense of a whole map at one glance, a blind person can feel the whole map with one touch, she says.

For the New York City subway system, they designed three kinds of maps that parcel out information in ever finer detail. Earlier this year, 31 blind people tried out the first maps and took five trips each using a map that described the Lexington Avenue subway, which runs up the east side of Manhattan. When Luxton surveyed their reactions to the maps, she found the participants were eager to use them again.

Her findings echo Parkes' experiences. "In the seven years that I've been working with blind people, the thing that impresses me most is their hunger about the world they can't see," he says. "To most sighted people, maps and plans are boring. But for a blind person, these things are terribly important.

"Any information that is spatially related has the value of gold to them." □