Bolder Bar Codes

Squeezing more information into those black-and-white symbols

By ELIZABETH PENNISI

One day we may carry our medical histories on the back of our health insurance cards. And labels on our cars, air conditioners and computers will encode their maintenance records and list serial numbers for replacement parts. All these data will fit into a postage stamp-sized symbol, part of the next—and far more revealing—generation of bar codes and automatic identification technologies.

Bar codes are as familiar as a trip to buy groceries. Now part of almost every package that crosses the supermarket or drugstore checkout counter, bar codes stand poised to move into many other facets of society — from hospital emergency rooms to hazardous waste repositories, perhaps even battlefields. In their quest for ever better device identification, the U.S. Department of Defense and NASA plan to try out coding systems that pack in much more information than current bar codes. Several companies have developed these new technologies, which promise more reliability as well as more comprehensive data. As such, these codes could find their way onto far more products.

"The application in the commercial sector should be even more extensive [than in the military]," says Doug Mohr, mechanical engineer in program development at the Idaho National Engineering Laboratory in Idaho Falls. Developers of these technologies plan extensive promotion of the new scanning and coding devices, citing increased demand from manufacturers for ways to pinpoint where and when parts were produced.

However, if used to keep tabs on or encode data about people, these new codes could threaten an individual's control over personal information. "A technology like this, when it's made commercially available without protection, seems to lead to a further erosion of privacy," says Rob E. Kling, a computer scientist at the University of California, Irvine. An expert in issues of computers and privacy, he worries that people will not be able to read these codes or easily correct mistakes. "In effect, people might not know what they're carrying around," he adds. "The control [of personal records] shifts to the institution and away from the individual."

Today's bar codes work like license plates. They usually represent a number and carry no information per se. Instead, a cashier scans across the code with a laser. The code's colored bars absorb light and its white spaces bounce it back, creating a specific pattern of electrical pulses that a decoder translates into a number. That number calls up specific information in the cash register's computer or in a centralized database about the product, just as a license plate lets police look up information about a particular car and driver.

These new "two-dimensional" bar codes can squeeze in enough information to fit the Gettysburg Address into a two-inch square. But to pack that much data into a small space, they work much differently than those codes on supermarket products. To get more information using the old technology, one has to create longer symbols — and these can require more room than the product's size allows. The new technology adds data along the vertical axis as well as along the horizontal one and relies on sophisticated computer programs and different scanning devices to read and interpret these dense codes.

"It's a technology that will open up a whole range of applications," says Richard Bravman, vice president of marketing for Symbol Technologies, Inc., in Bohemia, N.Y., one firm with a new bar code system.

Miniaturized, some of these new codes can identify electronic components, jewelry or even medical devices. "It represents a giant step in component traceability," says Robert S. Anselmo, president of Veritec, Inc., in Chatsworth, Calif. He boasts that his company's symbols could fit on a grain of rice. Others say they can make their codes invisible to the eye but still readable to a scanner.

This next generation of identification codes needs no centralized database. Instead, the symbol itself can contain all the necessary information, says Bravman. Thus these codes can help companies and the military keep better track of products that "cross organizational boundaries," he adds. When the device, substance or person travels to a new warehouse, store, hospital or location, all its data go along, in compact form, accessible to anyone with a machine that can read the symbol.

"It's a portable data file," says Mohr, who is evaluating these technologies for use by the federal government. "It reduces considerably the amount of paperwork attached to that piece of equipment." For example, a soldier carrying a hand-held scanner could read the code of a piece of equipment to find out its maintenance schedule, specifications, even the serial numbers for replacement parts, he speculates.

No one uses these two-dimensional codes yet, but that will soon change. The U.S. Air Force has begun two projects to evaluate the technology's potential. Also, Anselmo says NASA is considering using Veritec's codes on the space shuttle's heat-resistant tiles. Starting this fall, Mohr will do a study for the Departments of Energy and Defense to determine the best ways to attach labels and how well the new bar
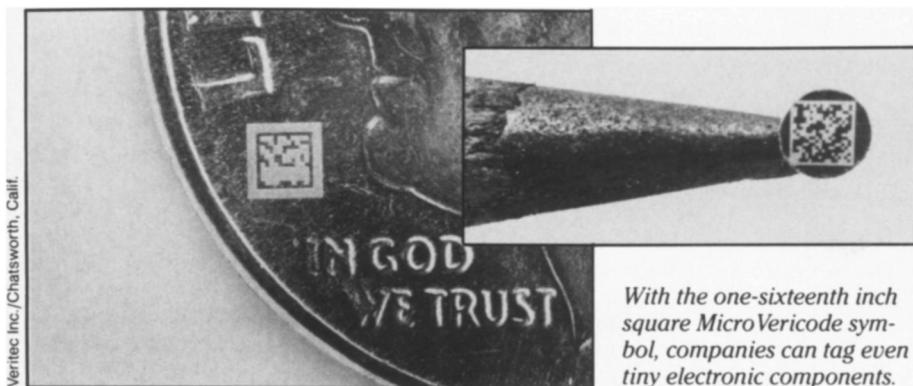
With the one-sixteenth inch square MicroVericode symbol, companies can tag even tiny electronic components.

codes stand up to the harsh environments associated with hazardous materials.

At the Wilford Hall U.S. Air Force Medical Center in San Antonio, Texas, hospital administrators expect that within a year patients there will carry ID cards with medical histories and personal data encoded on the back. The hospital had evaluated other types of codes, including current bar codes, but discovered with the two-dimensional format that "we didn't need to tie up our database memory," says Lt. Col. Frank J. Criddle, an emergency room physician at Wilford Hall. Also, other systems, such as smart cards with a microchip built into a wallet-size card, cost too much money per person to issue or update cards, he adds.

Instead, once the hospital has installed the new bar code system, it will print out labels for any incoming patient and then simply scan that label if and when the person returns. Criddle and others think these two-dimensional codes will help make Wilford Hall's emergency room — which treats about 56,000 cases a year — run more efficiently. "The quicker you can check in a patient, the quicker the patient can be seen," Criddle says.
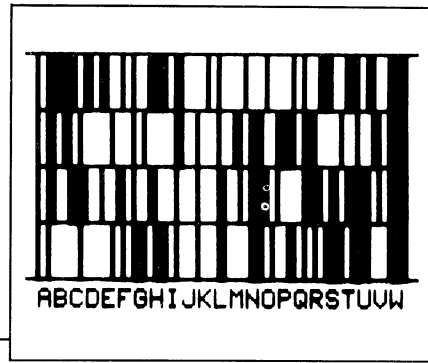
In another application, the Air Force plans to put the codes on hazardous materials containers during the next year. By federal law, safety data and handling instructions must accompany these materials, and by having that information encoded right on the package, manufacturers can ensure the data will not get lost during distribution.

As soon as the material reaches a central warehouse, a scanner can read the label and load all the information into a computer, where anyone tied into the computer's network can readily obtain it, says Col. Phillip Brown, an industrial hygienist at Wright-Patterson Air Force Base in Ohio. Otherwise, copies of the information must be passed along with the material to specific users. "I think it will save a lot of trouble and time," Brown adds.
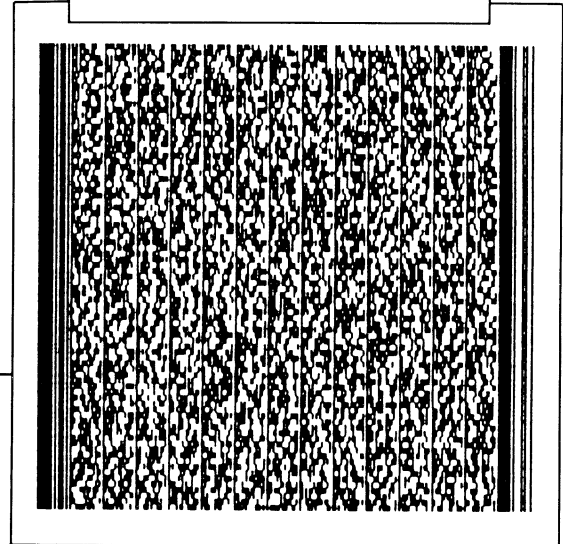
S everal different two-dimensional coding technologies vie for these applications. Anselmo's system, called Vericode, relies on a matrix of data cells set up like a checkerboard. Each cell represents a binary bit, so the symbols wind up looking like a maze, rather than a checkerboard, with the numbers and words encoded in the pattern.

Other two-dimensional codes consist of tiers of squat bar codes. For example, one type called Code 49, developed by Intermec Corp. in Lynnwood, Wash., stacks rows of 17 spaces and 18 bars on top of each other, with stop and start codes at each end. Another stacked bar code, PDF417 by Symbol Technologies, uses thin dark-and-light spaces grouped into more than 900 "code words," each of which can represent about two characters. That adds up to 1,750 characters per coded symbol. Both companies can increase the information by adding additional symbols.

Both the matrix and stacked bar codes seem more reliable than current bar codes, Mohr says. Existing bar codes read in just one direction — horizontally — like the words in this sentence. The widths of the lines and spaces encode numbers, while the height adds redundancy and makes the pattern easier to read. But these codes become indecipherable if a smudge or scratch disrupts the scanner's ability to read these widths. In contrast, the new bar codes fit in enough data that important information is repeated and therefore the scanner can retrieve it even if part of the symbol is destroyed. Also, their software often can "reason" what the missing data should be and fill in what's missing, he adds.

T wo-dimensional codes have yet to stand the test of time in real applications, however. And companies with competing technologies can identify potential weak points in their competitors' approaches. Anselmo argues that stacked bar codes may work well on paper, but not when etched into glass, plastic or metals because these materials make it difficult for scanners to accurately read very thin lines. Also, as the density of information increases, the lines get thinner and the signal weakens, increasing the chances of error.

Those companies with stacked bar codes quickly point out that their technology blends in better with existing bar code readers. The addition of new software allows conventional bar code scanners to read the tiered bar codes but not matrix ones. "The matrix approach potentially gives you the highest reading density, but it needs an imaging system," says Bravman.

Whatever their strengths — or weaknesses — these new bar codes will likely start showing up along assembly lines, on containers and possibly in places where one least expects them. "You can increase your efficiency and capability with these two-dimensional codes," says Mohr. "I think they will catch on very fast." □

Intermec Corp./Lynnwood, Wash.

Symbol Technologies, Inc./Bohemia, N.Y.

Veritec Inc./Chatsworth, Calif.

With tiered bar codes like Code 49 (top) and matrix codes like Vericode (square inset at bottom), more data fit into smaller spaces. Thus, a single PDF417 symbol encodes the Gettysburg Address (middle). In contrast, the traditional bar code (bottom strip) needs a much longer space to carry words.