

For Direct Part Marking, Focus is on the Basics

Mark verification and ease of use are top priorities.

BY GEORGE MILLER

Integrator Greg Hilbert sums up the challenge of reading two-dimensional direct part marks this way: "You have hourly people doing this." Hilbert is president at Electronic Solutions Co. One of his clients is a printed-circuit board manufacturer that makes occupant sensors for automobile airbag systems. The manufacturer uses mostly etched parts (dot peened) and needed a portable way to read the 2D codes on components that had failed during test.

"It's a new technology," says Hilbert, referring to the 2D codes being used by the manufacturer. "It's not like reading with a linear scanner."

Yet the experience of reading an identification code with a linear scanner—efficient after years of 1D barcode refinement—is exactly the starting point for many newcomers to direct part marking. And the ranks of newcomers are swelling as both government and industry are drawn to the greater permanence, security, and data-storage capacity per square inch of 2D direct part marks, and the subsequent benefit they offer in tracking part history.

Newcomers expect to be able to read 2D codes as easily as they read linear bar codes. "For widespread adoption, direct part marking has to be easy to use," says Matt Allen, industrial and vision product manager at Microscan Systems Inc. "You don't want a big training program." And that is integrator Hilbert's point exactly.

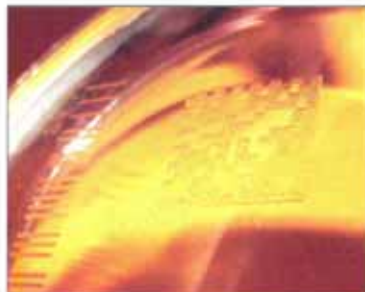
As a result, ease of use in direct part



Dot peen marks rely on changes in depth to create the light and dark elements of a Data Matrix symbol.



Surface irregularities (pits) on cast surfaces can make marks difficult to read. The pits create shadows that can be misinterpreted by the imager as dark elements of the symbol.



Diffused light is recommended for reading marks on reflective surfaces. Images courtesy Microscan.

mark readers and verification of the marks themselves have become paramount to suppliers and users alike. This is the case not just in the traditional bastions of direct part marking—the defense, aerospace, and automotive markets—but also in industries that are more recent adopters of this automatic identification technology: medical device, pharmaceutical, and electronics.

"You have to light the mark correctly to read it. The hard part is getting the illumination correct," says Allen. "Light is critical to make the read."

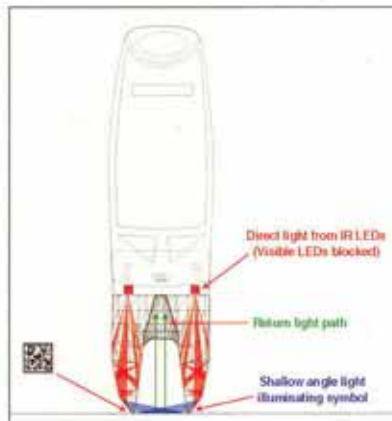
He recalls one case of a laser-etched mark on a brushed titanium surface. "It looked beautiful," he says. "But you couldn't read it because of the light reflection."

Increasing Variety of Samples

In addition, Allen is finding increasing variation in samples to be read—parts that are large, small, and have different surface types. In the case of one integrated circuit, the chip itself is one-tenth-inch square and carries a direct part mark that covers only 60% of its traceability pad area.

So the goal for reader manufacturers, says Allen, is to "improve the percentage of correct decodes with every trigger pull."

Microscan announced in March the LightRay Optics accessory, which attaches to the front of the company's MS-Q Quadrus hand-held imager. The accessory aids in reading direct part marks on reflective surfaces. By directing light at the mark at a very shallow



The LightRay Optics attachment transforms on-axis illumination into diffused illumination. The angles of the plastic contain the light and allow it to propagate until it reaches the optimal distance to illuminate the symbol.

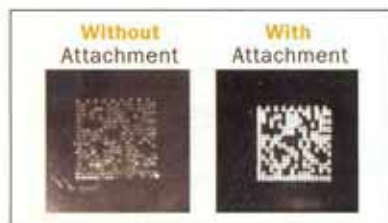
angle, the accessory increases symbol contrast for the reader and improves symbol readability.

The objective of the device is ease of use of the reader. It helps the user position the unit at the proper angle to read the mark, and the optimal focal length is built in. The LightRay can be attached and removed by the user, so the reader can also be used under normal conditions.

Hilbert of Electronic Solutions tried out the LightRay with his airbag-system-maker client. "LightRay took care of the angle and users picked up on it quickly. Without LightRay, it takes three to four seconds to do a read. Now it's less than a second."

Verify Mark Readability

No amount of illumination, how-



When light is directed at a dot peen symbol at a very shallow angle, it creates contrast by bouncing off the indentations of the mark. Image courtesy Microscan.

ever, will help a user read a 2D code that was rendered badly. Vision systems company Cognex advocates in its white paper, "Implementing Direct Part Mark Identification: 10 Important Considerations," that users install a code verification system at the marking station. Such a system detects marking problems and provides feedback on the marking process (for example, wear of the tip on a dot peen machine).

The company describes a code verifier as a system that includes lighting, optics, camera, and software, and that captures and analyzes an image of the code and rates it according to quality assessment metrics. "By understanding the root cause of poorly formed codes, manufacturers can troubleshoot marking equipment, better maintain the equipment, and prevent bad codes from entering the manufacturing process and supply chain," says Justin Testa, senior vice president for ID products at Cognex.

Part of the Process

Although bar code verification technologies have been in place for years, the use of verification systems for evaluating and optimizing the quality of 2D direct part marks have just begun to emerge. In fact, a growing number of companies are just beginning to incorporate direct part mark verification systems into their processes.

For some companies, the goal is process control. For others, the goal is contractual compliance. In either case, verification can help manufacturers improve the marking process, increase read rates, lower costs associated with rejected parts, and help ensure that parts maintain their lifetime identity.

Cognex unveiled in January its In-Sight 5410 and high-resolution 5411 readers for parts traceability and process control. The 5410 reads at rates to 7,200 parts per minute. The 5411 provides 1024-by-768-pixel resolution for

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Stationary imagers can be permanently installed at the appropriate focal distance and angle for optimal lighting to read low contrast direct part marks.

a larger field of view to handle variation in the position and orientation of codes on parts and packages.

The readers provide omnidirectional reading of 1D and 2D bar codes and support an expanding list of codes including Code 128, Code 39, UPC,

EAN, 12 of 5, and QR code. Cognex is also beta testing a verification system that it plans to release next month.

When it comes to verification, there's a big difference between 1D and 2D codes. The 1D bar codes are usually printed on labels, product packaging, and sometimes the products themselves. Bar width and other characteristics are well defined. But with direct part marking applications, there are other issues. Current standards don't take into account the variability in dot peening, laser printing, and etching, for example.

And although Data Matrix codes offer built-in error correction, which can compensate for some mark damage, users can achieve consistently high read rates only when a mark of sufficient initial quality is made and that level of quality is maintained throughout the manufacturing process. To accomplish this, a mark verifier—as opposed to a reader—is needed to show that a mark can be

read and to measure its quality, according to Robotic Vision Systems, Inc. (RVSI) Acuity CiMatrix division, a maker of Data-Matrix-based traceability systems. RVSI is also developed the Data Matrix code, the 2D symbology commonly used in direct part marking.

[Ed. Note: Information attributed to RVSI came from the company websites, www.rvsi.com and www.rvsi.com/acuitycimatrix/. RVSI last November filed a voluntary petition under Chapter 11 of the U.S. Bankruptcy Code. The company could not be reached for comment.]

Traceability Elements

RVSI has identified four elements of any direct part mark traceability implementation that need to be considered during design and deployment. These four key elements are marking, verification, reading and communication, which comprise the company's MVRC methodology, developed to simplify the

The Data Matrix Symbol

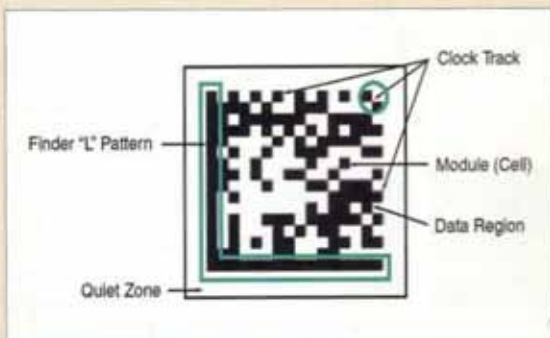
The Data Matrix symbol, developed by RVSI, is approved by national and international standards bodies for small part marking and is used in the automotive, electronics, pharmaceutical, and aerospace markets. Data Matrix supplements the first- and second-generation bar codes used to track packages by expanding automated data collection into the manufacturing, operations, repair, and overhaul environments.

Data Matrix symbols can be applied directly to part surfaces using permanent marking processes to deter part counterfeiting and can be hidden from view where product aesthetics is a consideration or where required for security reasons. The symbol design also overcomes shortcomings of linear and stacked bar codes.

Data Matrix symbols:

- Can be read omni-directionally.
- Can be damaged but still return accurate data.
- Can be scaled up or down to fit available space.
- Can contain more than 100 times as much data in the space used to apply a typical bar code.
- Can be produced using square or round data cells
- Can be square or rectangle in shape.
- Can be read when surface contrast levels are as low as 20%.

Source: RVSI



Data Matrix symbol features. Each individual element is referred to as a module, or cell. Image courtesy Cognex.

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interrelated activities and requirements of 2D code marking and reading.

Verification, the second element, is fundamentally different than reading because it tells the user not just that the mark can be read but also how close to the edge of readability the mark is. A verification process can detect marking process changes and degradation before unreadable marks are produced and aid in the necessary corrections. Both the semiconductor and aerospace industries have created mark-verification standards to determine direct part mark quality for laser-marked silicon wafers and dot-peened aerospace parts, respectively. RVSI developed a set of direct-mark quality measurements that are more applicable to the requirements of a variety of direct part marking processes and applications. The verification technology is available on the company's reader/verifiers.

The U.S. Department of Defense is also wrestling with the verification issue. Military standard 130L outlines the standard practice for identification marking of U.S. military property. The DoD last December issued a change to the standard, updating the version published in October 2003. The change document added a reference to the International Organization for Standards/International Electrotechnical Commission (ISO/IEC) 15415 standard, a bar code print quality test specification for 2D symbols. Other changes to MIL-STD-130L also involved specifications for 2D code feature characteristics and quality.

Unique Identification Program

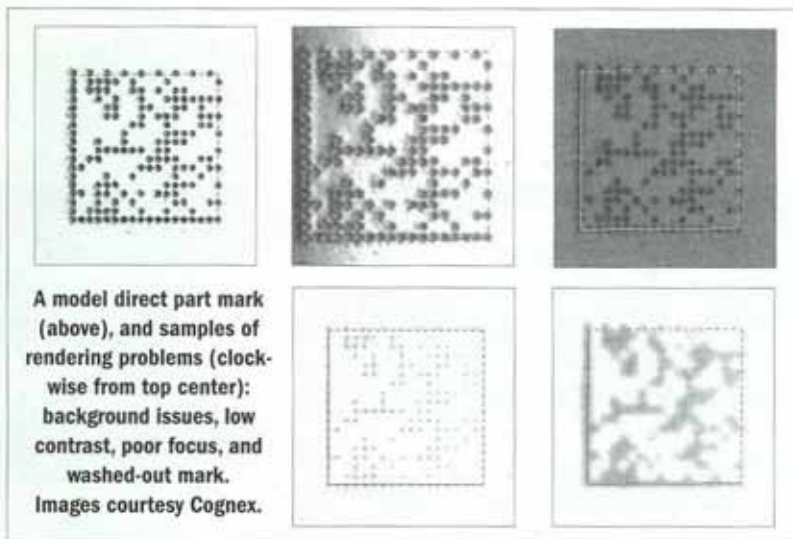
The standard is one facet of the DoD's Unique Identification Program, being conducted at the Office of the Under Secretary of Defense for Acquisition Technology and Logistics. The UID program office and defense prime contractors are currently redefining ver-

ification metrics, according to Robert Liebrandt, deputy program manager for unique identification. "There are machine vision problems," he says, "but

it's all possible."

The DoD has committed to the Data Matrix symbology as the technical baseline for item identification.

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Under MIL-STD-130L, items that meet criteria associated with cost, serial management, or status as mission-critical, are required to be permanently marked with a unique identifier using, at a minimum, a Data Matrix 2D machine-readable code. The rule applies to all qualified solicitations issued after January 1, 2004.

The Ground Rules

The DoD Guide to Uniquely Identifying Items, v1.4, requires the application of Data Matrix symbols to parts in the following categories:

- Costs more than \$5000.
- Serially managed.
- Mission essential.
- Controlled inventory.

A consumable item or material where permanent identification is necessary.

But it's not quite as simple as it appears, says Liebrandt. "[The requirement for direct part marking] is still not getting into contracts like it should. It was supposed to start in January 2004 for all new items—a small percentage of the total. But in many cases, it requires consultation on which parts should be marked. Some of it is [an issue of] contractual language."

A recent UID program workshop—the first of its kind—focused on aerospace applications. Attendees were program managers, contractors and their counterparts. "We got good feedback about the program," says Liebrandt. Common concerns involved understanding what the marking requirement entails.

Attendees also wanted to know if current 2D marking and reading approaches will work. "Typically, yes," says Liebrandt. "The beauty of 2D matrix is that all forms will work." And for those who already have 2D implementations, the UID program simply "means adding data to your plate."

Program managers and contractors were also concerned about downstream suppliers' ability to work with 2D codes. "They have to become knowledgeable," says Liebrandt. Among these suppliers are a range of small to large companies, some of which may not want to invest in a direct part marking capability in-house. "Outsource,"



In-Sight test stand and reader from Cognex. The readers provide omnidirectional reading of 1D and 2D codes.

says Liebrandt. "It has now become reliable; there are many sources available. A lot of people don't realize that option exists."

Prime Effort

A prime contractor invested in direct part marking is General Dynamics. Its C4 Systems business unit currently assigns about 20 people—including representatives from contracts, quality, operations, and IT—to its core UID/Rfid team, according to Gary Binder, vice president and director for manufacturing, environmental, health, and safety operations.

Their current focus is developing awareness of the technologies and contract requirements; ensuring that implementation is achieved when required by contract; and applying UID/Rfid benefits to internal processes where applicable.

Binder says that General Dynamics first became aware of UID requirements about two years ago through its property management function. "Since then we have formed a UID/Radio Frequency Identification (RFID) project team that includes all



BINDER: Formed UID/Rfid project team of members from contracts (customer interface) to operations (product build and delivery).

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the cross-functional disciplines ranging from contracts (customer interface) to operations (product build and delivery)."

The UID/RFID team keeps up with industry changes, reviews implementation alternatives, and determine database hosting needs. "For our business unit, our primary customers are government agencies so we use more of a case-by-case approach than may be typical of commercial enterprises," says Binder.

Not-So-Strange Bedfellows

The company combined its UID and RFID efforts for several reasons. "RFID is one medium of transport for UID. We wanted to review all options. Also, we were looking for synergy opportunities in the database creation, access, and data retrieval process. We believe that similar data format and information could be combined on one database."

Another reason is that General Dynamics's customers have different levels of need. Binder wanted to be fully knowledgeable of the options. A final reason, he says is that defense acquisitions have embedded both UID and RFID requirement options as potential contract stipulations.

Binder finds that the UID program poses several challenges for defense prime contractors with varying customer requirements. These include technical, financial and programmatic.

"Not all customers want or need UID or RFID information right now," he says. "Our customer base is developing at different stages of transactional understanding and use of UID/RFID technologies, so for us one end user format and information database is not appropriate at this time."

In addition, the financial business case for return on investment needs to include the varying customer requirements and formats. "As such, the cost of implementation, data storage, and retrieval for all permutations overrides the benefits," he says. Although it may provide internal benefit to have a single process, the many exceptions and exclusions outweigh the benefits right now."

Allen of Microscan also finds that even within UID alone, some users are in transition, using both linear and 2D codes. But they don't want to have to use two readers. "They haven't made full commitment to direct part marking yet, but they want to be able to do both." In some cases, users design in the company's MS-Q product today for 1D code reading, and then "a year from now, when they want to read 2D codes, they add a LightRay, which gives them forward and backward compatibility."

One reason some users are slow in their transition to 2D codes, he says, is sticker shock from the inevitable comparisons with traditional bar coding: "It's a big capital cost up front [compared to reading 1D codes]," he says. "But you don't have the costs of consumables. It may cost a few hundred dollars to read a bar code, but a few thousand for 2D. It requires a more powerful vision system." **FS**

Extra! Extra!

For further reading on this and related topics, see these articles, available at

www.frontlinetoday.com/102003links:

"Parts Marking Makes a Dent in Manufacturing"
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