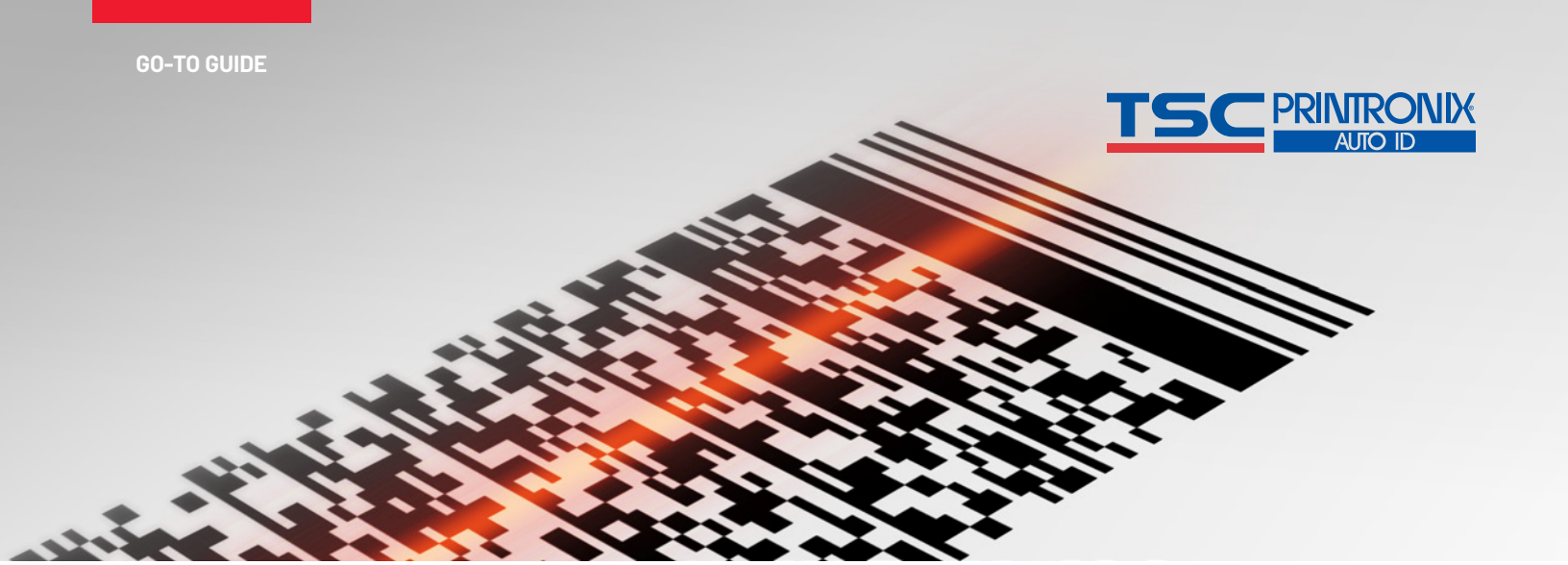

Beginner's Guide to Barcode Inspection

BACKGROUND

The first commercial barcode for retail stores was scanned in 1974. How can a technology that is 47 years old still be relevant in today's fast-paced, high-tech world? Just like phones, cars, TVs, and other devices, barcodes have evolved over time to address a fundamental need that has not gone away: no one likes to wait in line.

Prior to 1974, grocery clerks keyed in the price of every individual item into a cash register. Not only did this provide data entry errors, it was significantly slower, and provided far less information. For example, a customer's receipt might show five different items priced at $1.29. What were they? Was it a duplicate or incorrect entry? There was no way to know. This outdated process could not keep up with price changes on items, specials, or discounts.

A new, more effective process was needed – a way to uniquely identify an item like Green Giant®canned green beans for example. A code could be used to look up the price from a central database, so it was accurate and up to date. Not only could the item and price be recorded on the receipt for better customer service, but it provided a better way to manage store inventory. For example, the store may find it is selling an average of 32 cans of Green Giant® canned green beans per day, with Friday being its highest volume day with an average of 40 cans sold. Furthermore, the grocery store would be able to cross link items purchased by a customer. For example, 63% of customers purchased milk in their order and 80% of those also purchased butter at the same time.

Printing lines in a predefined pattern could be recognized by a laser scanner. Printing the lines proved easy and added no cost to the label. Laser scanners were easily cost-justified by productivity savings, higher throughput through the registers, better job satisfaction from the cashiers, and valuable information for the store manager.

Barcode technology took hold. Rapidly. Soon barcodes were being placed on everything.

CRACKS IN THE SYSTEM

Barcodes soon stressed the limits of the technology. Early barcodes could hold up to 13 characters of information. But with more items needing barcodes, this wasn't enough to avoid duplicates or hold all the information required in a transaction.

New symbologies were invented with more capacity and the ability to have fields in the barcode. For example, a barcode could have a field for the manufacturer, the item serial number, the item's manufacturing date, and so forth. Barcodes started to grow.

Since barcodes were linear at the time, there was a finite amount of information that could be coded before the barcode grew longer than the label it was on. The laser scanners also needed to scan the barcode in a single orientation. Aligning the barcode with the scanner orientation started to slow down productivity. As the relentless demand for more data continued, it was clear that a new solution was needed.

Linear barcodes can only grow in one dimension, and therefore are called 1D barcodes. In 1989, optical readers were invented that could read in two dimensions, hence 2D barcodes. Adding an additional dimension to the barcode enabled more data to be placed into a smaller space. New symbologies were added to leverage these new optical readers.

Today, Quick Response (QR) codes, one symbology in the 2D barcode family, can store up to 7,000

characters in a single barcode. Considering most written pages have about 2,000 characters on them, this is a three-page article in a barcode.

The power of a barcode to hold and rapidly transmit data has made it ubiquitous. Automation systems are built with scanners to take action based on the barcode content. Supply chain productivity is based on barcodes. But what happens if a barcode can't be read?

WHAT COULD GO WRONG?

Thermal printer technology is proven, durable and simple. A printhead element heats to either create a dot on coated papers, or melt wax in a ribbon to create a durable dot on a variety of substrates. Companies have been doing this for more than 20 years. The paper path is short and straight. How difficult is creating a barcode?

Barcode Sizing

The "bars" in barcodes are created with one or more sets of dots that create a straight line. Since dots are round and lines are straight, it's easy to see that the smaller the dot, the more the collection of dots will approximate a straight line. Also, if you can put down multiple rows of dots very close together, there will be a higher chance that the resulting line will look better. In general, a double row of dots is generally considered the minimum to create a quality barcode line.

These dots are measured in thousandths of an inch. A 203 dots per inch (dpi) printhead, for example, will put down 203 dots in an inch, so each dot is 5 thousandths of an inch. A 300 dpi printhead has a dot size of 3.3 thousandths of an inch. "Thousandths of an inch" is a mouthful and hard to type, so the industry has settled on "mils" for "thousandths of an inch". Therefore, a 203 dpi dot is 5 mil, a 300 dpi dot is 3.3 mil, and so forth.

At 203 dpi, each dot is 5 mil in size. So, the thinnest possible barcode bar with one set of dots would be 5 mil wide. If, however, you follow the general guidance that bars should be 2 dots wide, then a 10 mil barcode would be the smallest recommended barcode size on a 203 dpi printer, a 6.7 mil on a 300 dpi printer, and a 3.4 mil on a 600 dpi printer. Barcodes are typically measured in mils. If you use any label software like BarTender, Nice Label, TEKLYNX, and others, the barcode properties will always specify the mil size of the barcode.

Grading Barcodes

Barcodes are graded using ISO standards to reflect readability. The grades are based on 4.0 scale which relate to letter grades A through F. An A grade means that the label should read on the first try. An F grade means a scanner will struggle to read it. Many distribution or manufacturing sites will require a C or better as a minimum grade specification.

How do you grade a barcode? You measure a dozen attributes and aggregate each of the results into an overall grade. These attributes include:

- **Contrast:** Is there a distinct difference between the background and the line? For example, imagine an absurd situation where you place a black dot on a black label. Obviously, the contrast in this case is zero. The less the contrast, the lower the contrast score. Conversely, a light dot will yield a lower contrast score. If the heat setting is too low, the dot quality could be impacted.
- **Alignment:** Is the line perfectly vertical, or slightly at an angle? If there is any skew or imprecision in the drive, the line will not be absolutely vertical.
- **Gap width:** Is the line perfectly straight? Are the gaps between the lines exactly the same size across the entire length of the line? If there are any issues with the label feeding mechanism, there will be variability in the line. Or if the printhead temperature is too high, or the control of the temperature is not consistent across the printhead, some of the dots could be too big, creating an uneven line.

- **Voids:** If you look at the line under a microscope, are there holes or voids where the dots don't overlap well and there are gaps where the background shows through. If the dot size is not consistent, gaps could appear.
- **White space:** Is there a clear zone around the barcode? Is there text that overlaps or touches the barcode? This is most typically a customer design issue.
- **Decodability:** Is the barcode constructed properly according to the rules of the symbology? If there is a problem, it is usually an issue with the software.

Paper path control and print head temperature control are fundamental to generating barcodes that will grade well. In addition to potential issues with settings or printer quality, other issues can impact print quality as well. For example, dust can collect under the printhead creating voids. Or a printhead element can go bad creating a continuous void. Other issues include ribbon wrinkles, or a potential quality issue with either the ribbon or label stock.

Even with a mature technology and tested media, flawless barcode creation is not a given.

Inspection Specifications

ODV will grade 1D and 2D barcodes, 10 mil or larger.

How Frequently Do Barcodes Fail?

Printer brands vary based on the engineering devoted to paper path management and temperature control. One recommendation is to have a customer print 25 identical barcodes on a single label and print 10 labels. This will generate 250 identical barcodes. How tightly are these barcodes graded? Are they consistent? Are the grades all excellent?

In normal operation, it is not uncommon to see one label in 1,000 grade below specifications. One way to look at this is 99.9% of labels are printing just fine. How big an issue can this be?

FINANCIAL IMPACT OF A FAILURE

Let's assume your customer prints 5,000 labels per day with one label in 1,000 failing. That is 5 labels per day failing. If there are 20 production days per month, that is 100 failing labels per month. That is 100 opportunities to disappoint their customer, or potentially incur an audit or possible chargebacks. In the U.S., chargebacks in retail customers is often around $20 or more per label. If there are 100 labels that are at risk of a $20 chargeback penalty, that is a financial exposure of $2,000 per month.

Other Impacts: A failed barcode can result in a returned shipment, a misrouted shipment, a lost link with the end user, or impact automated handling equipment. Label quality can impact satisfaction with the supplier, brand reputation, and internal productivity in the warehouse or shipping lines. These are harder to quantify the impact, but can negatively impact productivity, relationships, and profitability.

It's not uncommon to see one label in 1000 grade below specifications. How big an issue can this be?

SUMMARY

Barcodes are invaluable tools to increase the speed of product selection, checkout, and shipping. Although barcodes look simple, they are created using an intricate and precise process to align dots to render the boxes and bars that make up the barcode. Because barcodes are so critical for productivity, some companies require barcode labels on shipments they receive meet a minimum quality or grade based on worldwide ISO standards.

Many retail or automotive suppliers prefer to inspect their labels before shipping to avoid issues with their customer. Label inspection can be done in the printer, or on the shipping line. For a deeper exploration on the topic of barcode inspection, please contact TSC Printronix Auto ID.