

# Six Sigma and the Single Tag

How do you achieve flawless read performance from your RFID system? By making sure it interrogates only one tag at a time.

Jan. 30, 2006—We often read or hear about how one RFID system is better than another because the first can read 500, 600 or even 1,000 tags concurrently. This is a point RFID equipment marketers are constantly making in print and at conferences. The most frequently referenced applications are luggage at airports and the holy grail of reading, an entire shopping carriage as it rolls past a portal. There is a small problem with all of this, though, and it pertains to read reliability.

The inability to read multiple tags reliably is why Wal-Mart and the U.S. Department of Defense have focused on reading only the pallet tag rather than the tags of all cases on a given pallet, and on reading the case tags only when the boxes are on a conveyor. They are subscribing to singulation—making sure only one tag is in an interrogator's read field at a time—and not knowing it.

RFID vendors still drone on about their systems' ability to read hundreds of tags simultaneously. Unfortunately, RFID is being promoted as a confidence game, and we are naively rushing to a sad ending.

Why? Are we inherently stupid? I think not. Is it because we lust for automation and advances in technology? Perhaps, to some degree, but it's not the only reason. Then what is going on?

Most of the world has begun to take bar codes for granted. This is the first part of the problem. When you fail to understand the base solution we live with and how it actually works and doesn't work, you set yourself up to be conned and duped.

Let me take you back for a moment. The bar code actually dates back to antiquity, but the really old part is not pertinent. We will fast-forward to the late 1970s and early 1980s. In that period, companies imagined a new printing market based on item identification. They created symbols such as black and white lines or bars that varied in thickness, width and/or pitch. They standardized them and called them Code 39 and Code 128. They convened U.S. and ISO standards groups, all along making sure they could sell more and more labels with these new bar codes.

Well, they forgot one thing—namely, how the heck do you read a bar code? The early solution was with a camera or line scanner/wand. The first cameras were costly boxes, and the handhelds were boxes with handles. They were ugly and costly, and they were unreliable because cameras had limitations regarding such things as ranges for depth-of-field, depth-of-focus, contrast, dynamic range, etc. The early industrial cameras tended to capture too much or too little information, or the lighting was wrong, or the image was fuzzy, and so forth. Most people rejected bar codes as ever being useful. The wand worked OK, but was very manual and labor intensive.

The big technological breakthrough came with the invention of the galvo-laser reader. This device sent out a single scanning beam that ran across the surface of a bar code, reflecting back any laser light not absorbed. The black absorbed the light, and the white reflected it back to the galvo-mirror optics. Suddenly, you could

reliably scan a single bar code. This laser scanner, which we take for granted today, continued to improve in the usual ways: smaller, lower cost, improved performance, etc. As a result, you can plug one of these modules today into almost any electronic device and reliably read a bar code.

So why don't bar codes work, and why do we passionately want to replace them? Well, bar codes do have some flaws. These flaws are normally either the first or the second slide in most recent PowerPoint presentations at conferences. They include line-of-sight requirements, distorted/soiled or damaged bar codes, lost bar codes and, finally, the inability to write additional data to a bar code. Most of those are described as being solved by RFID within the next two slides at the same conference.

These days, we are so enamored with RFID's potential that we lose sight of one important fact: When we receive a data read, it must have Six Sigma reliability. Manufacturers attain Six Sigma in many of their applications today. They still want to improve but cannot go backward in terms of data reliability.

### **The Problem**

The reasons RFID data can be unreliable are twofold.

First, the interrogator's RF field is not uniform, and is even distorted by the mere object in the field and nearby. The RFID reader sends out a beacon that would look like a flashlight beam if your eyes could see it. The energy in that beacon is absorbed and/or reflected by everything in its path. RFID tags in the field of the beacon absorb the energy and interact with the reader.

Since the field is nonuniform and can vary over time, then even if you were to introduce the same tags over and over again, you would still run the risk of missing one of them at any given time. This is kind of like the camera in the early days of the bar code. You could have a perfect bar code but might not be able to decode it because the image the camera produced was illegible, causing you instead to read a different bar code on the edge of the field of view because its image is clearer. Thus, if multiple tags are in the field and you read them, you cannot be certain you actually read all of the tags.

Second, nonuniformity and uncertainty of the RFID tags' performance occurs due to environmental conditions. Many, many conferences now teach about dielectric packaging materials and the influences of water, metal, soap and other things on RFID performance.

(Note: This article does not discuss poorly manufactured tags or readers, but rather assumes we are speaking purely about reliable, certified and acceptable readers and tags. And while I do make that assumption, in reality, many tags and readers are known to be of poor quality, even noncompliant with FCC requirements. Imagine if you added poor quality readers or tags to the equation above? The first advice I would give anyone new to RFID would be to work only with certified reliable tags and readers. If you receive anything other than that, send it back.)

If you now imagine that the goal is to read variably performing tags, in a nonuniform and varying field, then you have the recipe for disaster. This is where most people find themselves today.

### **The Answer**

The first practical action is to understand how to read one tag reliably. What are the limits—in terms of speed, distance, attenuation, orientation, interference, and so on—of your ability to read a single tag?

Once you have answered that question, you have the raw material for a successful implementation of a Six Sigma RFID system and can look forward to automation with assurance and confidence of high reliability.

"Hold on," you say. "Not so fast. That sounds too naive and simple."

I assure you, the solution really is just that simple. Once you know how to read a single tag, you can then step back and take a look at the bigger picture. This is usually referred to as a site survey and business-case analysis. The problem is, until you understand how an appropriate individual tag and reader perform in this environment, you should not do any kind of site survey and business-case analysis. As you approach the site survey, ask yourself this: What opportunity do I have for singulation? If you find, by some good fortune, that the entire application lends itself to singulation, then you already have the formula for Six Sigma RFID reliability.

Most of you will have more complicated requirements, but maybe you don't. Try to force singulation into your requirements, even as a new or reengineered process. If you can, then you have a solution for Six Sigma RFID and will be the envy of your industry.

For those who need to read further, let me provide a few examples of how this practice can be applied to current manufacturing and supply chain processes. Let's assume you have an over-the-belt application and need to read a large variety of designs of RFID labels on boxes, and that the belt runs at 600 feet per minute. I am sure you are laughing at me right now, and that your current answer is to add more and more readers in all sorts of bombastic orientations to compensate for the infinite number of orientations you imagine likely. Most likely, you are adding triggers and sensors and gauges. Rube Goldberg would be proud of you.

Yes, you will eventually catch the mouse, but if you have ignored singulation, I cannot warrant that you will ever have reliability, much less Six Sigma reliability.

At this point, I want to show why RFID is better than bar coding, as I am afraid I may have turned you off by now. If you apply the same singulation principle to bar codes, you will still have the same problem—that the laser must find the bar code, and the bar code optics are limiting. The performance level of modern cameras is unbelievably high, but even if you move to a camera, you will still have endless problems, including maintenance of the optics.

If you are still unconvinced that singulation-based RFID deployment will yield Six Sigma results, here are three case studies:

**Case Study 1: A number of items (with tags) are on a shelf, and you want to do an inventory.**

If you merely want to scan the goods as a bulk audit, then you can sweep the reader in the area of the products and record the tags. This method is good only for a general information record. You have no certainty that you have read all tags and should not assume you have. To read the items reliably, you must assure that the RF field includes only the number of items you know to be in the field (be careful, though—if you cannot see a field and merely aim it at a tag does not preclude reading its neighbor). In this case, you may sweep the tags at full power so the interrogator can get a general idea, and then at a lower power, operating closer to the items of tags, so that the interrogator can read them individually.

So why is this better than bar codes? Time-and-motion studies will show it to be significantly faster because you do not actually need to find the tag and observe it visually.

**Case Study 2: You have an over-the-belt situation and need to read a variety of shapes reliably at blazing speed, and also do sortation.**

Sounds hard—even impossible, right? Well, you have two choices. You can either add varieties of readers and bells and whistles and still fail, or you can apply singulation. The latter is actually easier than you might think

because you, the person concerned with this requirement, are already an expert in all the other necessary skills. Moreover, you already know everything about belts and motors, rollers and sorters, chutes and sensors. What a perfect candidate to apply singulation to RFID. The reward for using singulation is that RFID, coupled with the other normal triggers and sensors on the line, will provide Six Sigma results and increased opportunities for automation beyond what a bar code ever could. In the end, you may still have multiple RFID readers, but each will have Six Sigma reliability.

**Case Study 3: You have a mailbag or carton filled with tagged items, and you need to know its contents.**

In this application, you can be certain of 100 percent of the contents only when the container is being filled or emptied (singulation). You can always scan the closed bag or container—and even rotate it in the field to maximize the reading—but you will never be positive of the contents until they are singulated. If bulk scanning is adequate, then the only issue is that you should not base transactions on that reading.

"Those were crummy examples," you may be thinking. If so, then you are probably the type who insists on having your cake and eating it, too. You maintain that the penny tag will allow you to find the stick of chewing gum in the department store at will, via the Internet or even from your cell phone. If this describes you, then I apologize for wasting your time, but I do feel your delusions have (or will) cost you far more than the time spent reading this article.

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