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# 2022-08-22 preventing loss dot jp2

Programming note: Sorry for the infrequent posts lately, I have been traveling and starting a new job. Probably the next thing I post will be a report on some of that travel, which you will hopefully find interesting.

Previously on Deep Space Nine, we discussed the landscape of common retail EAS systems: electromagnetic, acousto-magnetic, and RFID. I now want to extend on this by discussing some peripheral systems that serve as part of the larger retail loss prevention technology stack. I will follow up on that by saying a bit about why none of these approaches seem to end up working that well.

## Cart control

Shopping carts are fairly expensive, running around $200 to replace. Since shopping carts are attractive for moving stuff, they have a tendency to go for a walk and require frequent replacement. The first type of smart cart technology to make a widespread appearance is cart retention or cart anti-theft. Most Americans have probably encountered these by now, although they remain fairly uncommon in New Mexico.

While there are a number of vendors and systems, most are based around a fairly simple concept. A special wheel or wheel housing contains low-power electronics which observe for an RF tone. When the tone is detected, some type of locking mechanism activates that prevents the wheel from rotating. The wheel usually remains locked until commanded to unlock via an RF or IR device.

To form a cart perimeter, a cable is buried around the perimeter of the parking lot that acts as an antenna. The emitted power is quite low, so carts only lock when passing fairly close to the cable. In some systems, a second cable buried a bit inside of the outer emits a separate tone that commands the wheels to unlock. This makes it possible for a customer to reset a cart by dragging it a short distance back towards the store, potentially saving employee effort.

Most cart retention systems operate at low frequencies, below 9 KHz in the case of the Gatekeeper Systems offering. These low frequencies are fairly efficient with the very long antenna cables used, penetrate materials well, and best of all are below allocated spectrum... so there is no licensing required.

You can probably imagine that the locking cart wheel technology can be applied to a few different problems. A common form of retail loss, and one that tends to involve fairly large dollar amounts, is push-out theft. A push-out thief loads up a cart with

products and simply walks out.  With well-chosen items like powdered laundry detergent it can be difficult to detect this type of theft.

One approach is aggressive traffic management in the store, using one-way gates and barriers to prevent customers exiting without passing through the checkstands.  This kind of highly visible security is becoming more common but its not completely effective...  for one, having a large number of self-checkout machines tends to make it pretty easy to get through the checkstands without paying or being noticed.

A somewhat more sophisticated, and annoying, solution is the installation of a pushout prevention system like Gatekeepers Purchek.  While there can be more complexity to these systems, the basic idea is that each cart is temporarily enabled when a customer completes a purchase, and stays enabled for a time period like 30 minutes.  Outside of that time period, any attempt to leave the store with a cart will cause that cart to lock.  This should prevent anyone leaving with a cart of unpaid items.

You can probably think of a few ways to implement this, and theyve probably all been done by at least one company, even the bad ones.  In the case of Gatekeepers older generation Purchek system, each checkstand seems to contain a unit that transmits a signal which starts the exit timer in the cart wheel.  When the cart is pushed through the exit, a tone transmitted by a floor antenna causes it to check the exit permission timer and lock up if it is not still live.

There are variations with appreciably more complex configurations though, and Gatekeeper Systems holds a patent on a cart-to-cart and cart-to-access-point mesh networking system that can be used to apply particularly complex logic to make lock-on-exit decisions.  Its not clear to me how much of the patented material is actually implemented in their commercial products right now, but certainly some of it is.

Many grocery stores now feature a panel antenna mounted near the exits facing the area approaching the doors.  This panel antenna is used by the Gatekeeper door controller to communicate with the cart wheels, and its hard to suss out the exact logical architecture of the system but it seems that the door controller can query the cart wheels for a recent historical average rotational speed and can use the history of detection of that cart wheel to determine the location history of the cart.  These can be factored into the exit permission decision.

I have heard complaints of Kroger configuring the time window during which exit is enabled after paying to be as short as 60 seconds, short enough that walking slowly toward the exit (e.g. due to a disability) will consistently result in the cart locking at the doors.  There is a substantial accessibility issue with many of these loss prevention technologies and vendors seldom address it in their marketing material.

Networked communication with cart wheels can also be used for various convenience use cases, like automatically counting carts in the parking lot to determine when carts need to be rounded up, and allowing a parking lot attendant to unlock all carts in a corral area at once.  Nonetheless, Kroger consistently struggles to have any carts available at the entrances, but that comes down to staffing...  which well get to in a bit.

## BOB

One long-running source of loss prevention frustration is that deck at the bottom of the cart between the wheels, often called the bottom-of-basket or BOB. The way most checkstands are configured, the cashier cannot directly see this area... but its often used for relatively expensive item like 24-packs of beer. It presents a significant opportunity for both accidental failure to ring up an item and intentional theft.

A friend who once worked in a grocery store told me that his chain had a general practice of cashiers making some comment about a fictional coworker or relative named Bob to warn another cashier that a customer had something on the bottom of their cart. For decades, checkstand manufacturers have offered a low-tech BOB solution consisting of a periscope configuration that allowed the cashier to see the foot-level area by looking in a mirror mounted under a hood near the weighscale/barcode scanner. Many stores just placed an adhesive parabolic mirror on the side of the next checkstand over that served the same purpose more simply.

These solutions are simple and effective, so of course there are options which are complex and, well, questionably effective? The Lanehawk from Datalogic is a camera and illuminator which mounts in the space most checkstands have for the lower periscope mirror. It uses machine vision to detect items in the BOB and identify them, giving the cashier a prompt that rings them up in one button press. I have seen LaneHawk installed at several stores and I have never actually seen it work. Its hard to tell if this is because of poor reliability or because of retailers starting deployment and never finishing it due to training or configuration issues, which seems to be oddly common with this type of technology.

## Queue and customer volume management

Customers get irritated if they have to wait too long to check out, but idle cashiers waste money. Stores have to try to strike a balance between short wait times and high utilization rate for open checkstands.

There are two basic ways that technology can, in theory, help: first, counting queues at the checkstand can allow for a fast automatic call for more cashiers when lines start to grow. There are various systems that can do this including Gatekeeper based on counting the number of cart wheels apparently in queue for checkstands.

A second and more interesting approach is *predictive* queue counting. By knowing how many people entered the store and when, its possible to predict the likely number of people who will queue to check out some time in the future. Several grocery chains have invested in Irisyss system, which uses distributed people counting units to track the arrival rate of customers. This data, along with potentially data on customer location in the store based on other vendors systems, drives television screens mounted near the checkstands that display the current number of open checkstands and the number that will be required to maintain a queue depth target in 15 and 30 minutes. For some odd reason these three numbers are labeled Lanes Open, Action Now, and 30 Minutes, the first and third of which are inconsistent but logical and the middle of which is just bizarre. Besides this real-time feedback it also collects historical data to make long-term projections, which can be used for scheduling cashier shifts.

For some reason Irisyss marketing material repeatedly mentions the use of a VGA display.  Its unclear to me if the copy is from the 90s or just the attitude of the person who wrote it.  The use of consumer televisions should reassure us that it is at least WXGA.

The data for these systems can come from many, diverse sources.  Kroger stores in my area are equipped with machine-vision based people counting using multi-lens 360 degree cameras as well as Bluetooth and WiFi-sniffing people counting systems.  Some machine vision is infrared, but some is visual.  Some people-counters use simple multi-spot passive IR methods (somewhat like typical burglar alarm motion detectors) while others use proper imaging.

## Stock management

If data collection on customer volume can be gathered automatically, what about data on stocking levels?  There are products on the market that monitor shelf stocking using machine vision, but I have not personally seen them widely deployed.  The principle is fairly simple, just pointing a camera at a shelf (often using fisheye optics for wide coverage) and using obvious methods to see if items are present where they should be.

Shelf stocking information can also be gathered by robots that travel the store floor observing shelves.  This has been shown at a number of trade shows but Im not sure if its actually being done on any large scale.  I tend to think that it would end up being more expensive overall than fixed cameras, considering the more complex maintenance situation.

## Staff and Equipment

Given the amount of technology apparently being thrown at the problem, why is it that retail loss prevention (at least in my market) mostly seems like a confused nuisance?

Im not an industry insider or anything, so I can only speculate.  But it seems clear that insufficient staffing is the single greatest issue at the moment, and I think thats been the case since prior to COVID. Basically al of these systems are dependent on having enough staff to attend to them, and grocery stores frequently fail on this front.  Kroger spent a good chunk of money installing guard podiums at the entrance of all their stores with monitors showing surveillance video, but I still havent actually seen one staffed, presumably since it would prevent the single guard actually walking the property.

The issue has become more acute as retailers have made increasing use of two particularly labor-intensive approaches:  separate, dedicated cashier stands for high-theft areas, and locking displays.

In the former system, the liquor and cosmetics sections are isolated (perhaps by awkwardly installed screen walls) and have a dedicated cashier.  This cashier is presumably more able to monitor for shoplifting since they have a small assigned area, and it prevents unpurchased items from those sections circulating to parts of the store where they would be much easier to conceal.

Kroger rolled out this system over the last two years in my area and has had

significant practical problems. The thing that has most stood out to me is that they have consistently laid out these areas with the expectation that the cashier stand with their back to the products. This obviously limits how vigilant the cashier can be, and moreover poses a safety concern to the staff since it reduces their situational awareness and provides an easy covert approach to potential thieves. There is news reporting that, in some areas, these checkstands have been modified in response to union complaints related to employee safety.

There are other issues yet. The checkstand obviously needs to be staffed for this system to be effective. Early on Kroger tended to leave it unstaffed most of the time, but the switch to self-checkout stands seems to have enabled more consistently posting a cashier. Second, it creates a situation in which *purchased* merchandise circulates around the store. This is significant, since it means that it is now fairly normal for a customer to check out and only pay for *some* of the items they are taking with them. This makes theft by omission, already common at the self-checkout stands, difficult to impossible to detect. The use of paid stickers and stapling bags shut mitigates the issue somewhat but not entirely, since the realities of a busy retail store make it very hard to consistently adhere to and enforce these mechanisms.

In a particularly interesting gaffe (or perhaps partially implemented change in policy), Kroger stores in my region have not installed an EAS tag deactivator at the cosmetics checkstand. Cosmetics items are relatively commonly tagged, and Kroger tags many items post-manufacturing with an anti-tamper tape overlay. Due to the lack of a deactivator, though, these items now set off the EAS portal every single time they are purchased. The guard now responds to all EAS alarms by resetting them with no further investigation. Brilliant.

Nonetheless, there is obvious potential to reduce theft. I tried to find some sort of data on the efficacy of this measure but either theres little to be found or, perhaps more likely, I dont know the right terms to search for.

The other common staffing approach seen today is locking up certain items in their displays, and then requiring customers to find a staff member to have them unlocked. The staff member might walk the item to a checkstand instead of trusting the customer with it, once unlocked [1]. This method has been around for decades and is becoming increasingly common, from Walgreens (just about everything) to The Home Depot (cordless tools, certain consumables like diamond blades). The theft advantages are obvious, but the big problem is that there have to be enough employees around for a customer to reasonably be able to find someone. I am always very curious about how much sales drop when this system is introduced; I have basically stopped buying cosmetics at Walgreens because of the difficulty of getting an employee to show up.

## Futures

Where does this whole thing leave us? Despite a lot of development retail loss prevention is still an unsolved problem in many ways. The greatest problem remains the trade-off between loss prevention and staffing costs: loss prevention technologies have to be cost effective, and that usually rules out the most effective designs (ubiquitous use of RFID).

Amazon Go has demonstrated the strong potential of machine vision and other machine learning technologies. This kind of ubiquitous tracking requires extensive infrastructure support, though, and major retail chains often seem to struggle with

much more basic equipment installations.  No doubt the management model of these companies, including franchising in some cases, is part of the difficulty, but its also what has allowed these chains to grow to such large scale.

To some extent the increase in online shopping has obviated loss prevention technology, and there are no signs of this trend stopping.  Future stores will probably lean more and more into showroom-type design, but in many cases their loss prevention efforts will lead to higher and higher friction to actually making a purchase.  This seems unwise as a strategy to compete with Amazon but, well, does anyone have a good plan to compete with Amazon?

[1] An interesting factoid is that Walgreens uses expensive Medeco cylinders on the plexiglass display cases that you can force open by hand.  I assume this is just to allow same-keying with other more secure enclosures, but one wonders at how much extra money these expensive cylinders have cost across the enterprise.