



The First Report On Robots In The Aisle:

The Early ROI Suggests They're Here to Stay

By Gordon Wade and David Hasler

Robots have been a growing presence on factory floors for more than 40 years. They have grown because of significant advantages across a number of categories, including finished-item quality, production speed, reliability and cost. These factors translate into a superior ROI that has made robots a competitive necessity. Within the past decade, robots have moved beyond the factory floor to other industries, including retail. Initially appearing in warehouses, robots now have become a familiar mainstay in e-commerce order fulfillment picking practices.

badger
technologies

More recently, we are beginning to see the introduction of robots on the floors of retail establishments. Their tasks range from floor cleaning and slip-and-fall prevention to inventory out-of-stock (OOS) reduction and pricing integrity. Walmart has publicly announced its intention to use robots across the value chain wherever costs can be reduced or the retail experience can be improved. The retail giant's stated intention serves as a fire bell in the night throughout the low-margin, hypercompetitive retail marketplace.

As a recent McKinsey white paper opined:

“Margin pressure has made automation a requirement, not a choice.”

At least four makers of robots are testing their progeny in-store with various functionality and cost levels. Each company is producing a serious, sophisticated piece of machinery that represents a lot more than a toy to amuse--or annoy--shoppers. These companies are Bossa Nova (which has a presence in Walmart), Simbe (currently in Schnucks), Zippedi (a Chilean company with a primary presence in LATAM) and Badger Technologies™ (the leader with approximately 500 robots installed at Ahold Delhaize USA brands GIANT/MARTIN'S and Stop & Shop). The writers of this whitepaper are consultants to Badger Technologies and have been given access to some early data that informs the conclusions discussed herein.

For purposes of this whitepaper, we are going to focus on Badger Technologies' progress as an indication of how robots are gaining momentum in retail. At this early point, Badger Technologies has two functional models (discussed below), both of which are generating positive ROI. This finding alone suggests that everyone in the retail community should begin proof-of-concept testing to decide how robots can best contribute to their unique experience. As we gain more insight from the Badger Technologies' deployments, we will update and sharpen our conclusions. For now, it appears that in-store robots are going to be a permanent fixture of our retail experience.





8% of the 40,000 items in a typical Modern Supermarket are OOS at any given point

A brief background on Badger Technologies

Each of the four established retail robotics companies has a unique story as well as different technical capabilities and business models. In our view, Badger Technologies is the farthest down the developmental path with the broadest retail application.

Badger Technologies began as an experimental skunkworks project at Lexmark International, a printer and copier company in Lexington, Kentucky. Lexmark itself was a spinoff from IBM's printers and copier division. When Lexmark decided to abort robot research, the internal team, led by Tim Rowland, left the company and moved into Tim's basement. Their objective: Build a world-class robot that could improve shelf conditions.

After making remarkable progress, the team began to run low on cash. After exploring alternatives, the operation was indirectly acquired by Jabil, a \$26B electronics manufacturing services (EMS) provider based in St. Petersburg, Florida. Ownership by a large public company is a unique aspect of Badger Technologies, enabling the entity to scale manufacturing operations rapidly, in contrast to competing retail robotics upstarts, which are backed by VC firms and utilize traditional manufacturing models.

Jabil was attracted to Badger Technologies because of the quality of its team, progress it had made with little funding and, most importantly, the perceived value of Badger Technologies' target solution, reducing out of stock (OOS) at retail. Even at this early stage, Badger Technologies had distinguished itself as the low-cost option, having designed a very sophisticated robot with an apparent cost advantage. The ability to pair Badger Technologies with a high-volume manufacturer having decades of experience

producing technology akin to the Badger™ robot offered a distinct advantage. The fact that Jabil's retail division brought more than two decades of experience working within this sector delivered another significant benefit.

The other notable item to mention here is that Badger Technologies' platform is remarkably flexible. From the outset, the architecture was designed to accommodate additional technology as it became available. As you'll see later in this whitepaper, this became a critical advantage that accelerated Badger Technologies' quick rise in retail robotics.

Badger Technologies and Jabil were keenly aware of the cost of OOS in the retail food business. Multiple studies indicated the size and persistence of the problem. One study in particular, sponsored by major trade organizations and underwritten by companies like P&G, confirmed that about 8% of the 40,000 items in a typical modern supermarket are OOS at any given point. This global study was performed by Dr. Thomas Gruen of the University of Colorado at Colorado Springs and European colleagues. Dr. Gruen had been studying OOS for over 20 years. Subsequent studies by the Food Marketing Institute and JDA, the leader in shelf space optimization software, confirmed the size and persistence of the OOS problem. And much to everyone's disappointment, the problem hasn't lessened in the last 20 years. This was the problem Badger Technologies set out to solve.

Badger's Developmental Path:

Strategy and Serendipity

Badger Technologies wanted its system to be a unique combination of low cost and advanced shelf analytics performance. The first hurdle was identifying a hole or missing item on the shelf. Let us call that "level 1" analytics. Many robots can do this today, but Badger Technologies wanted to go beyond level one to answer two more important questions: "What specific item or stock keeping unit (SKU) was missing? What should the robot tell the store associate to retrieve from inventory"? This is "level 2" analytics. Badger Technologies solved this dilemma by matching the shelf tag with the hole on the shelf. This turns out to be fairly difficult, but Badger Technologies solved the problem and, in the process, discovered another advantage discussed below.

"Level 3" analytics require the robot to ascertain shelf inventory behind items on the front row of the shelf. "Level 4" analytics require planogram compliance, matching the array of items on the shelf (the number of facings per item) to the ideal array mandated by headquarters. Today's robotic shelf visualization and processing capabilities do not permit Level 3 or 4 analytics with any degree of speed or reliability beyond the front facing on the shelf. It should be noted that there are some tests of shelf-level technologies that try to capture all inventory on the shelf, but thus far none have proven scalable or cost effective.

While Badger Technologies' design engineers accelerated development toward Level 1 and 2 analytics, fate intervened. They serendipitously stumbled upon an immediate opportunity to mitigate slip and fall accidents and the corresponding litigation costs. That decision to make the robot's architecture flexible and adaptive had now borne early fruit. The anti-slip and fall detection project turned out to be wise because it led to the rapid deployment of its robots in approximately 500 stores. This, of course, generated much-needed cash flow and credibility for Badger Technologies. It also opened the door to deeper first-hand retail experience, which further enhanced Badger Technologies' retail acumen for the problems they were trying to solve. Last but not least, this also forced the team to develop the support structure and deployment methodologies needed for much bigger projects



badger
technologies



The functionality of Badger Technologies' two robot models

As mentioned above, Badger Technologies currently offers two robot platforms with different functionalities:

- The first platform detects and rapidly reports slip and fall risks, thereby reducing harm to shoppers and employees as well as the associated legal costs of related accidents. In addition, the robot frees store associates from the drudgery of continuous, repeated floor monitoring. Badger Technologies became a quick study in this aspect and now has a proven product delivering significant value for its clients.
- The second model reports OOS (holes and incorrect products) and pricing (regular and sales price) errors. This replaces the task of the collection of data by store employees or third-parties, using the human eye assisted by scanning guns. The data collected by the robot (discussed below) is shared with store personnel and others within the retail ecosystem. Store employees or third parties then take actions upon the data as they would have on information collected manually.

Installing, “training” and servicing the robots

All in-store robots need to be installed and “trained.” The process is quick and non-invasive as Badger Technologies' platform requires no changes to the store's infrastructure. Third-party personnel trained by Badger Technologies walk with the robot to obtain the baseline layout of product placement across the areas to be scanned. This provides a “realogram,” which is a true representation of the product placement in the store, as opposed to relying on headquarters produced planograms, which may not reflect real world in-store conditions. In addition, it validates that the paths chosen to be scanned are appropriate, allowing for permanent obstacles and unique store layouts.



Across the current fleet, uptime has exceeded 99%, and as of this writing, the nearly 500 badger technologies robots have traveled over a quarter of a million miles, running 7 days a week, 12 hours per day, maintaining the customer's specified KPIs 100% of the time.

The process has two advantages.

- First, the “realogram” is typically more accurate than a planogram provided by the store. As a result, remote retail personnel know precisely where categories and items are located and can understand any of the store's unique architectural characteristics that could inhibit merchandising in any way. Surprisingly, many retail home office personnel do not know the precise footprints or item locations at the individual store level. One trip around the store with the Badger robot provides a precise snapshot in time of that store's “retail DNA.”
- The second advantage is the validation of the store paths to be scanned, which are created based on store management feedback, but without a physical visit to the store.

Once installed, the robot maneuvers through the store and achieves its goals without oversight, then docks itself so that it can recharge for the next job. Badger Technologies leverages its cloud-based Fleet management solution to proactively monitor the entire fleet of robots in multiple retail locations. In most cases any issues with the robots are known and corrected remotely by Badger Technologies before the customer even notices.

The Badger robot's durability and reliability have certainly been tested. Across the current fleet, uptime has exceeded 99%, and as of this writing, the nearly 500 Badger Technologies robots have travelled over a quarter of a million miles, running 7 days a week, 12 hours per day, maintaining the customer's specified KPIs 100% of the time.





Results to date

The robot with slip-and-fall functionality known as Badger™ Retail inSpect

This robot circumnavigates the store continuously and “looks” at nearly 100% of the retail selling space in the stores. The individual trips throughout the store are referred to as “plays.” The system is designed to notice spills and objects on the floor that have been deemed as a “hazard” by the customer. The robot records the hazard’s location and conveys that information to the appropriate in-store associate for remedy. If the hazard is not addressed quickly enough, the robot is capable of “escalating” with friendly PA announcement reminders.

This functionality was beta tested in several stores and then expanded to roughly 500 locations. The most common iteration is a robot named “Marty” with big googly eyes, wandering the aisles of Ahold Delhaize USA Brands GIANT/MARTIN’S and Stop & Shop stores. Simply stated, the robot pays for itself in a matter of months by reducing falls and the losses from expensive lawsuits, settlements and lost associate productivity. Opinions vary regarding the precise role the robot is playing in reducing lawsuits claiming injury. Some believe the mere presence of the robot and its robust technology is causing the legal community to shy away from filing obviously bogus claims. The results aren’t in dispute. Ahold is realizing significant savings that validated the decision to deploy 500 robots.

Whatever the reason for the decline in claims, the results are simple to calculate because the introduction of the robot is the ONLY change in the in-store experience. The costs of settlements are easy to calculate especially across a vast store universe with over 300 million shopper trips per year. The savings make the introduction of the Badger robots a “no brainer.”

Results may vary for retailers in areas with different legal standards regarding the relevance of the “evidence” brought by the robot. However, the frequency and breadth of “slip and fall” occasions and claims is such that a single case may justify “hiring” the robot for every store. This does not just apply to the United States; Badger Technologies is gearing up for pilots on two other continents as we write this article.

The robot with inventory monitoring functionality know as Badger™ Retail inSight

The robot offering an OOS and price monitoring solution traverses the specified aisles at a frequency and time determined by retail management, just like the “plays” of the floor inspection platform. However, the Badger robot is equipped from head to toe with special cameras and on-board processing, and diligently makes its way down selected aisles. In theory, the robot could scan the center aisles of a 45,000-square-foot store continuously making about eight complete trips daily, but experience suggests that two trips per day is adequate to capture OOS and pricing anomalies. This frequency is adequate given the realistic responsiveness of the supply chain and demands on the time of store associates to physically restock shelves.

At this stage in its development, the Badger robot does not retrieve stock from the backroom or restock shelves. We are not aware of any practical robotic application offering these capabilities that will be available any time in the foreseeable future. Today's robots merely report findings to anyone authorized within the retailer's vast supply chain. Therefore, the robot's reports must be integrated into the store's routine of physically restocking shelves and correcting erroneous shelf price tags. Without the flawless assistance of the humans in the supply chain for which the robot's information is a key driver, shelf conditions will continue to be as sub-optimal as they are today.



Results of the initial testing

The robot is more accurate than humans

The robot's superior accuracy is what justifies its adoption by the retail grocery industry. The accuracy is determined by two components; the hardware, firmware, and AI the robot can carry and deploy as well as the accuracy of the back-end analytics that interpret what the robot "finds." To prove the accuracy of the robot, Badger Technologies conducted rigorous side-by-side comparison tests in which the robot and human personnel using the current industry-standard digital auditing devices were asked to report OOS conditions on identical aisles. The test aisles reflected both Direct Store Delivery (DSD) and Warehouse-delivered products. The aisles were chosen to reflect real-world conditions throughout a typical shopping day.

The robot repeatedly outperformed the human auditors, with the robot being nearly 5X more accurate. Even with this overwhelming advantage, the robot was NOT perfect. Product placement, tag and shelf conditions, blockages, and similar sources of error contributed to an error rate of a little over 10% out of > 3000 real issues across the test aisles. Most of the system errors were "false positives," where the robot reported an item as missing or wrong, when in actuality for the reasons stated above the system did not recognize the issue correctly. The rare "false negatives," where the robot misses an item that was actually OOS or mispriced, will in all likelihood be captured on the next run through the store.

Two factors seem to explain the robot's advantages. Humans apparently find it difficult to concentrate for long periods while doing such exacting, meticulous work. The robot does not suffer from concentration lapses. Additionally, store associates may get distracted by interactions with shoppers or by any number of other factors. In some cases, the associates actually create errors by filling an OOS hole on the shelf with a nearby (but incorrect) SKU from the same brand as the OOS item. The robot never touches items on the shelf, nor does it get distracted. As mentioned above, even if the normal path is blocked, the robot is programmed to double back and capture every accessible inch of the area of the store to be scanned.

How much money is the robot saving the retailer?

The value of the robot and its ROI depend upon two factors that are relatively easy to identify.

- The amount of human labor costs saved by the robot
- The incremental profit saved by preventing a lost sale due to an OOS

Although easy to identify, these two sources are more difficult to quantify because of the variables discussed below.

What's the value of labor time saved?

Best available estimates suggest that store associates expend about 10 hours cumulatively every day just gathering data on OOS items and pricing, excluding items in service departments such as the deli, bakery and fresh meat. So, associates are checking >30,000 items by looking for OOS and pricing errors and recording them using handheld digital readers. It is painstakingly meticulous work and the accuracy undoubtedly varies from chain to chain, store to store, department to department and associate to associate.

The next factor is the hourly value of the saved associate time. Is it \$ 10/hour fully loaded with tax and benefit costs or is it \$16/hour or something even higher? As you may imagine, that depends on the area of the country, the prevailing wage, union contracts and the specific employees assigned to the tasks. For our calculations, we have chosen a \$13/hour fully loaded rate, based on US Labor Department data for 2019 or \$11.19/hour rate before adding the incremental cost of benefits and taxes payable by the employer.

The two factors above create a labor savings potential of about \$50,000 annually per store assuming two complete audits are performed daily. This estimate does not include time required to retrieve inventory and restock shelves. We have not attributed any incremental value to other potentially profitable tasks the freed-up associate time could be dedicated to, such as helping shoppers find specific items.

What's the value of reducing OOS?

For years retailers, manufacturers and various third parties have tried to estimate the cost of OOS or, said differently, the lost sales attributable to the shoppers' inability to find desired items on a shelf.

Multiple studies have strived to pin down a reliable estimate. The most prestigious study was funded in 2003 under the auspices of several trade groups. The study was conducted under the leadership of Dr. Thomas Gruen of the University of Colorado, who studied out-of-stocks globally for decades. The Gruen study and several other less ambitious ones have consistently found that 8% of items regularly stocked in a large supermarket were OOS on any given day. Since those supermarkets generally carry about 40,000 SKUs, the math concludes that over 3,000 items are OOS on any given day across all departments of a store.

Now the question is: "How do shoppers behave when they encounter an OOS on an item they intended to purchase?" The Gruen study mentioned above and others have tried to ascertain shopper behavior when desired items are missing. The shopper response data from the Gruen study revealed that 31% of shoppers leave the store without purchasing a substitute item. These shoppers claim to buy the desired item at another store. Another 15% claim they postponed purchasing. That is to say, they do not buy the intended item on that trip but leave the store without buying a substitute item.



8% of items regularly stocked in a large supermarket were OOS on any given day

Most alarmingly, the Gruen study projects that this behavior costs typical supermarkets 4% in lost sales annually. This translates to yearly losses of almost \$1 million for the average supermarket. The Badger robots are trying to recapture at least a portion of this enormous loss.

Separately, a study of household panel data by the writers revealed that approximately 40% of any given brand's volume is accounted for by shoppers who are exclusive purchasers of the brand and type. If one assumes that virtually all these shoppers would not switch to an available item, one gets an estimated lost sales number in the same neighborhood as the number revealed by the Gruen study cited above.

In our calculations of incremental volume and profit saved by the robot, we have been deliberately conservative because we are just beginning to understand all the in the savings equation. We will definitely get more confident in our conclusions as we acquire more data. For now, here are the key inputs in the equation:

The number of OOS found when the robot traversed all 24 center aisles in the test stores. Only the perimeter of the store, fresh and the frozen areas were excluded. Please note that the data is an average of three runs per day for five days in three stores with 30,000+ SKU's in aisles audited. For purposes of our calculation, we have included savings from OOS found on only two runs per day because we believe human associates perform two runs per day in most stores. The robot found an estimated 1,300 OOS totally on these two runs.

The retail price of the missing items. Please note we are using what we believe to be a conservative number, \$2.75 per missing item. In the future, we will work to capture a more exact number.

The retail margin of the missing OOS items. We have estimated a retail margin of 26%. Please note that margins vary widely by a store's geographic location, chain, category and by item. We have chosen 26% as a conservative average. In the future, we will work to capture a more exact number.

The lost sales when shoppers discover an OOS on their desired item. This is a critical number, which we have estimated based on several inputs. Specifically, the Gruen study discussed above says that 46% of shoppers leave the store without purchasing any substitute item when the item they intended to buy is OOS. The study says that 31% of shoppers buy the item at another store and another 15% postpone buying any comparable item in the store on that day.

But how many shoppers is that? If the missing item is in a fast-moving category, one OOS may cause two or three lost sales. Moreover, the Gruen study confirms that OOS occur most frequently in the 20% of categories with the highest sales velocity. For purposes of estimation, we conservatively assumed that only one sale is lost per OOS occasion. Please note that this assumption would understate sales losses when a high velocity item generating multiple sales per hour is out of stock. This factor probably explains why our conservative lost sales estimates are lower than those of the Gruen study.

The estimates of the various factors above mean the equation for estimating lost volume goes something like this:

1,300 items OOS on two runs X \$2.75 /item X a 26% margin X 46 % of item buyers leaving the store without purchasing X 365 days = an annual loss of > \$150,000.

Please note that we have not attributed any increased volume to the associate's time freed from OOS duties nor have we included any savings from the perimeter of the store or the fresh / frozen aisles that are not being scanned today by robots. We have also not included the impact of mispriced items or items not in the location indicated by a shelf tag. We have only included those items where the robot saw a "hole" and no inventory at all is behind the shelf tag for the item.

Total savings vs. the cost of the robot

The estimates above suggest the robot saves the store almost \$200K per year (\$50K from labor savings + \$150 K from the saving of lost sales). We do not have robot cost and store savings data from all the current companies offering in-store robot solutions. In Badger Technologies' case, the saving of \$200K annually per store would represent an ROI of more than 400% per year on average, assuming a typical, fully loaded three-year purchase contract that includes various service and maintenance fees.

Future capabilities of the robot on the developmental runway

A third Badger Technologies model combining slip/fall and OOS/pricing functionalities is close to commercialization. This model brings a valuable incremental benefit. It allows confirmation of promotional end-aisle display compliance. Manufacturers invest millions of dollars to purchase promotional displays on the end of aisles (end caps) because these displays are passed by most of the in-store shopper traffic, thereby generating awareness and often impulse purchases. Manufacturers understandably want assurance that retailers are giving them the space they have paid for and assigned the correct promotional prices on the featured items. Badger Technologies' "two in one" robot provides that compliance assurance.

Next-generation Badger Technologies systems will have a sophisticated analytics package tailored to the unique needs of all relevant stakeholders in the supply and demand chains (i.e., aisle associates, store managers, HQ category managers, vendors and third-party service providers). For example, the robot will provide aisle associates with a list of missing items in their order of placement in the aisle. This will save associates time by facilitating servicing of shelves in an orderly manner.

The foreseeable end-state functionality for in-store robots

Based on existing or developing technology, in-store robots will be able to:

- Capture and report planogram compliance

- Identify issues with produce freshness

- Provide real-time reports to logistical partners in the supply chain

- Identify the location of OOS items across the entire supply chain

- Pinpoint problem items, suppliers and categories for remediation

- Optimize space and assortment at the store level in almost real time

Experience to date indicates all this can be done with limited negative effect on the shopping experience or strains on retail personnel. In fact, early indications are that store associates seem to appreciate being relieved of the tiresome, meticulous tasks of visually locating OOS and pricing issues.

As we mentioned in the beginning of this paper, we will continue to monitor developments in this space and report back. Things are moving at a rapid pace, and we anticipate another update may be warranted before the back-half of 2020.





About the Authors

Gordan Wade

Gordon Wade is a recognized thought leader in the CPG space. He is one of the primary creators of the discipline of Category Management used by every major CPG retailer and manufacturer globally. He has authored numerous white papers and consulted for scores of companies around the world. He is currently focusing on AI ,robotics and anti-counterfeiting technologies as they relate to CPG. Gordon is an alumnus of P&G's marketing department and a Harvard graduate.

David Hasler

David Hasler is the Vice President of Strategy at G4S Retail Solutions and the Founder and President of Breakthrough Solutions Consulting, LLC (BSC). David has worked at various CPG and retail organizations like Procter & Gamble, Limited Brands and Walmart. David holds a bachelor's degree in Finance from the University of Kentucky in Lexington, Kentucky, and a Master in Business Administration from Xavier University in Cincinnati, Ohio.

About Badger Technologies

Badger Technologies provides actionable data and analytics for retail operations through automation solutions that include a fully autonomous robot to address out-of-stock, planogram compliance, price integrity and other operational inefficiencies. Actionable data and business analytics translates into improved store execution, lower operational costs and higher profits. Badger Technologies offers complete end-to-end solutions, from robot and software to store integration, maintenance and analytics. Badger Technologies is a product division of Jabil, a \$26 billion global company with over 50 years of experience delivering technology, manufacturing and supply chain solutions to the world's leading brands.