The Path to Retail 4.0

COMPUTER VISION PLATFORMS

Seeing the Future of Retail

As the DNA of traditional retail becomes digitized and mixed with accelerating and converging technologies, the massive FMCG industry is undergoing profound change. Retail 4.0: The Age of Metamorphosis promises to be a near-total transformation in how people shop, how retailers operate, how products are distributed, and how brands manufacture and market. The development of Retail 4.0 will not be evolutionary; instead, the digital transformation of retail will be breathtaking in its scale, scope, and speed. But to realize the opportunity companies need to prepare their organizations for convulsive change, embracing new practices, processes, and business models.

The Path to Retail 4.0 is a series of papers intended to help industry participants understand and prepare for this new world.

INTRODUCTION

Retailers for decades have successfully employed a 'fast-follower' strategy, letting someone else bear the cost of trialing a new technology or business process. But in a world of fast-expanding AI powered capabilities, following begets growing risk.

A case in point: Computer vision platforms. Computer vision is one of the truly transformative - and disruptive - technologies as the massive fast moving consumer goods retail industry undergoes the digital metamorphosis that is Retail 4.0. As the physical store becomes digitized it promises a near quantum leap in store performance.

Early adopters are poised to open up a growing performance gap versus their slower moving brethren as they move out and up the exponential growth curve of computer vision technology. Those performance increases - cost savings, revenue growth, new insights & analytics, and more - set in motion a flywheel of growing financial performance. And early adopters can increasingly invest some of that gain back into additional innovation, strategic pricing, and services, adding to the flywheel's momentum.

TECHNOLOGY AND RETAIL STRATEGY

The sensors and AI that power up computer vision systems - the tech behind 'just walk out' shopping experiences - is moving fast.

Huang's Law, the AI equivalent of Moore's Law, "describes how the silicon chips that power artificial intelligence more than double in performance every two years" according to a Wall Street Journal article.

"Between November 2012 and this May (2020), performance of Nvidia's chips increased 317 times for an important class of AI calculations… On average, in other words, the performance of these chips more than doubled every year, a rate of progress that makes Moore's Law pale in comparison."[1]

Noted Professor Thomas Davenport co-authored a Harvard Business Review article, "Why Companies That Wait to Adopt AI May Never Catch Up"[2] that speaks to the power of AI systems and first-mover advantage. His call-out: **AI fueled capabilities are so powerful that slower moving companies may not be able to catch up to the leaders. Technology innovation is transforming and disrupting traditional business strategy at a blistering pace.**

And we are already seeing this play out in supermarket retail. Tesco opened its first checkout-free store in October (2021) in London using technology provided by Trigo, an Israeli company that's received over $100m in funding based on its technology and retailer relationships. Just weeks later

[1] Wall Street Journal; Huang's Law is the New Moore's Law. (Sept. 19, 2020)

[2] https://hbr.org/2018/12/why-companies-that-wait-to-adopt-ai-may-never-catch-up

Sainsbury announced a partnership with Amazon to use its Go technology to power up a store… just blocks from the Tesco location.

THE COMPUTER VISION CHALLENGE

Computer vision presents a multi-faceted challenge for technologists as they confront digitizing the three dimensional store with its vast product assortment, constant flow of shoppers, and the element of time.

Take, for example, several shoppers in front of the yogurt display, and what must happen to accurately capture the specific product selected by one of those shoppers. First, cameras must be positioned to capture all that activity as shoppers jostle back and forth as they seek their selected products. Those cameras may have different views of the same shopper selecting his product that occur over the span of some minutes or seconds. The computer vision systems must stitch together these different views, and understand the milliseconds between those different views, to accurately capture and record the shopper selecting Dannon strawberry yogurt.

When confronted by this challenge, computer vision solution providers typically employ one of two approaches to ensure accurate identification of people and products in the retail environment. These two approaches highlight the importance of Huang's Law and risks of Davenport's slow-adopter thesis.

HUMAN-SUPPLEMENTED SYSTEMS

The first approach is used by many of the computer vision systems in market today and relies on a human being in the background to verify any product 'purchase' that fails to meet a specified confidence level when processed by the AI system. Often, these solutions use a limited number of more expensive, high definition cameras to provide product recognition. The problem is that a more limited number of cameras increase the probability of the system not having a good line-of-sight to the product being selected.

This lack of accuracy can encompass the shopper, especially when multiple people are shopping together on one account (for example, a couple or family), or can encompass a lack of confidence related to what and how many products are picked up by the shopper. In these cases, the system kicks the low-confidence transaction over to a human being to make the final decision.

The problem with this approach is that human involvement slows down the process, delaying the generation of the receipt to the shopper, sometimes by hours. Needless to say, this can create a negative shopping experience and lead to shoppers not trusting and accepting the technology. And the use of a human to verify product selection (purchase) creates serious barriers to scaling the technology.

FULLY AUTONOMOUS, MACHINE LEARNING SYSTEMS

Much more conducive to scaling computer vision tech is the second approach that uses a plurality of low-cost, commodity cameras along with a limited number of shelf sensors to fully automate the process and remove any dependency on human involvement.

Camera density provides overlapping video coverage, ensuring that at least one of the cameras is able to see and identify the product being selected. This multiplicity of images requires massive computational processing power provided by the cloud.

Shelf sensors are commonly used on more challenging products, things like small candies or smaller packages difficult for the vision systems to consistently identify with a high confidence level. In these cases, the sensors provide a sort of backup verification to supplement the computer vision camera and directly feed the machine learning system, creating a true self-learning automated system.

JUST WALK OUT IS JUST THE BEGINNING

The ability to remove cashiers and traditional checkout from the shopping experience provides retailers significant benefit - especially in a time of labor shortages. But labor savings is only the first of myriad benefits that, together, transform brick & mortar store performance.

Consider these additional benefits that flow from a computer vision platform:

Improved shopping experience: Long checkout waits are eliminated as shoppers can just walkout the door when finished shopping. And think about extending frictionless shopping to the fuel pumps increasingly found in retailers parking lots.

Scheduling effectiveness: Being able to feed scheduling applications with true customer traffic in realtime for the store and for each service department results in growing labor efficiency and increased service levels.

Shrink reduction: The typical supermarket experiences an estimated 1% (often more) shrink from shoplifting, breakage, and employee theft. A computer vision platform monitors all shoppers and the products they pick up (well intentioned or not) and can automatically monitor and track the opening and closing of delivery doors and other non-public store exits.

Out-of-Stocks: 24x7x365 monitoring of out-of-stocks across the brick & mortar store gives retailers the opportunity to reclaim lost sales and improve the shopping experience. Connecting realtime OOS data to the eCommerce system enables temporarily withdrawing an out-of-stock product until its replenished, and then reinstating it in the digital store when it

reappears on the physical shelf. Downstream benefits include improved picking efficiency and improved shopper satisfaction through elimination of out-of-stock driven substitutions.

Aisle hazard detection: Computer vision is able to automatically monitor hazards across the store, notifying a store employee of a spill in aisle 2 before a shopper slips and falls.

Shelf management / planogram compliance: Computer vision provides the ability to constantly monitor product placement and planogram compliance, automatically alerting category managers when a store is having an issue.

Promotion compliance: Promotion compliance remains a significant challenge for retailers and CPG brand manufacturers alike. Computer vision platforms can be trained to monitor signage and display activity around the store, providing valuable measurements and automating notification of failure to comply with merchandising programs.

In-store location marketing: The ability to target shoppers based on realtime in-store location is well established. But this capability becomes even more powerful when combined with AI personalization and shopper traffic, giving retailers the ability to influence and maximize in-store shopper traffic in realtime.

Computer Vision: Seeing the Benefits

So what do all these application opportunities add up to? Big numbers that transform physical store economics.

Imagine what an ROI would look like for a store doing $500,000 in weekly sales ($26m annually)…

Savings:
- Shrink reduction (cutting shrink in half, from 1% to 0.5%) = $130,000
- Labor savings (front end labor at 2% of sales) = $520,000

Revenue gain:
- Out of stock reduction (from 8% to 6%) = $520,000
- Improved shopping experience (1% increase in sales) = $260,000
- Improved merchandising impact (2% increase in sales) = $520,000

So over $1.3m in revenue increase in addition to $650,000 in cost savings combine to power a nearly $2m annual financial gain. And that's probably being conservative. Easy to understand why the early adopters of this technology are keeping the results of their pilots quiet.

DIGITIZING THE STORE
[A NEW WORLD OF PERFORMANCE METRICS]

Nearly fifty years ago the first UPC barcode scanning system was deployed, creating a new stream of SKU level data that helped transform the industry. New metrics gave rise to category management practices, inventory optimization, and far more. Look no further than Walmart's use of item level data to transform its supply chain in support of its everyday low price philosophy.

Around thirty years ago the first retail loyalty programs opened the door to shopper identified transaction data, enabling practitioners to measure and understand shopper behavior over time. Retailers like Kroger leveraged this new data into new insights & analytics, transforming their marketing and operations into a string of 52 consecutive quarters of same-store sales growth, an unparalleled feat. A handful of other retailers, many of them smaller and more nimble, used new measures like customer retention over time and customer lifetime value to guide decision-making across their organizations.

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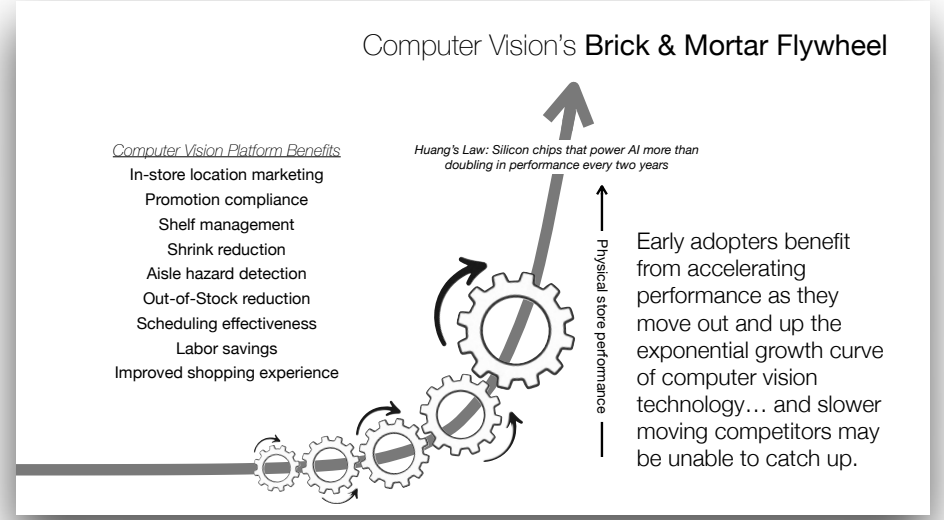
Imagine creating store level scorecards that measure shopper behavior across the store. New measures of department and category performance grow from the ability to measure conversion rates; of all the shoppers entering the store, how many visit each department? Each aisle? Each category? Of the shoppers passing a category or section, how many of them stopped to consider a purchase (dwell time) and what is the purchase conversion rate?

But we're just getting started. Those new shopper behavior scorecards can be linked to in-store merchandising activity to understand the impact of signage, special displays, and promotion activity… just like measuring clicks on a website. Imagine being able to understand the impact of a weekly ad promotion on aisle and category traffic, dwell time, purchase conversion, and adjacent product sales.

This is not idle speculation. An early retail pioneer in using computer vision - who was also a pioneer in the understanding and use of early shopper data - conducted multiple studies related to understanding the power of

merchandising on in-store shopper behavior. In one particular study the retailer found that three specific brands of cereal, when promoted on the front page of the weekly ad, resulted in significant gains to aisle traffic and double-digit sales increases for adjacent products. Imagine designing the weekly ad with a view to the impact on store traffic, not just promoted product sales.



COMPUTER VISION IN AN AGE OF PRIVACY

Some retailers may have concern around deploying a computer vision platform with dozens of cameras throughout the store at a time when growing numbers of consumers are focused on privacy and data security. And these concerns are not without cause.

Some retailers have tested cameras at checkout, clearly aimed at the shopper's face, tied to AI powered age verification systems, loyalty initiatives, and other applications. But computer vision platforms as discussed here can, and should, work differently.

Some tech providers, again we will use Trigo as an example, purposefully do not capture 'faces' or use any kind of facial recognition. Instead, the system creates a shopper identifier derived from myriad data points that is used to monitor the shopper as they shop, recording purchases. This process is designed to insure complete shopper anonymity while providing the frictionless shopping experience.

If they choose to, retailers can link the shopper identifier to a transaction at checkout. For retailers having a loyalty program, this would remove the anonymity of the shopper but would give the retailer knowledge of how different shoppers (gold level shopper vs tin level shopper) behave in the store. This de-anonymization happens completely on the retailer side, the solution provider, like Trigo, only 'sees' anonymous shoppers and does not use any kind of facial recognition.

> ***In two years there will be hundreds of (computer vision enabled) stores. Next year you will find autonomous stores in any major city around the world.***
> *- Michael Gabay*
> *Co-Founder and CEO | Trigo*

This is an important consideration to understand when talking to different solution providers of computer vision platforms.

COMPUTER VISION
[MOVING FAST]

As described earlier, computer vision is a classic exponential growth technology powered by the sensors and AI tech governed by Huang's Law. This technology has hit the inflection point on the growth curve and is accelerating. Look no further than Amazon to see just how fast this is developing…

- The first Amazon Go store opened in January 2018: ~1,800 square feet.
- Amazon Go Grocery opened February 2020: ~10,000 square foot store.
- Amazon Fresh opened 2021: ~25,000 square feet.
- Amazon Whole Foods scheduled to open 2022: ~37,000 square foot store.

That represents an over 2,000% increase in store size in four years. Think about that.

Amazon has announced its intentions to deploy computer vision across a fast-growing number of its stores, including the Whole Foods chain. And like it has done with other tech-based capabilities, Amazon is packaging the technology up to sell to other merchants. Beyond Sainsbury, airport retailers Hudson and Cibo Express have both opened stores using the technology with plans to expand deployments.

Michael Gabay, Co-Founder and CEO of Trigo, projects "In two years there will be hundreds of (computer vision enabled) stores. Next year you will find autonomous stores in any major city around the world."[3]

So what are retailers to do?

START NOW

Retail executives are aware of computer vision technology and yet for many it is not a priority for their organizations. The common thought seems to be that it is still some ways off in the future and there's no need to expend precious resources now, especially given the myriad other challenges and tech related projects retailers have on their plate.

But this is shortsighted thinking. In the world of Retail 4.0, retailers must think exponentially and understand not where a given technology is today, but where it is going to be at some point in the future. For example, in a recent meeting with a respected regional retailer, the discussion focused not on current computer vision deployments - stores around 2,500 square feet - but where the technology will be in two years when the retailer will be opening a new format of around 30,000 square feet and able to engineer computer vision into the store design.

Beyond Amazon, there are a small number of solution providers seeking to bring this technology to market for the benefit of retailers. Grabango, Standard Cognition, Zippin, and AiFi, are all bringing computer vision systems to market, nearly all of them in pilot at small footprint retail like cafes,

[3] https://thespoon.tech/aifi-and-trigo-ceos-weigh-in-on-when-cashierless-checkout-will-go-mainstream/

convenience stores, or pop-up stores. And visiting some of these stores it is readily apparent that their respective technologies are in different stages of maturity.

Rather than focusing on smaller footprint applications, Trigo appears to hunting bigger game, positioning itself to be the Amazon Go alternative for grocery retailers. Their work with forward-looking retailers like Tesco (U.K.), Rewe (Germany), Aldi (Netherlands), Shufersal (Israel), Wakefern (U.S.) and others soon to be announced, provides insight to the company's focus on scaling computer vision.

There is a learning curve to this technology as Davenport calls out in his article. The need to train machine learning models, integrate computer vision with operations, make decisions around the shopper experience, and far more, take time. But this is all the more reason for retailers to start understanding and deploying this technology now.

We've all lived our lives in a local-linear world where we expect today to be much like yesterday and tomorrow to be much like today. But that's no longer true.

Welcome to Retail 4.0: The Age of Metamorphosis.

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What to look for in computer vision platforms.

- ***Is there a human behind the curtain?*** Many solution providers' vision technology is still maturing so they employ humans in the background to monitor and verify certain questionable transactions. Ask if the solution provider you're talking with makes use of people which can slow down transaction processing and negatively impact customer experience.

- ***Just cameras or shelf sensors too?*** Many solutions use shelf sensors in addition to cameras to validate the purchase of small products (like small candies). In some cases, the sensor will trigger a review of the transaction by a human, in other cases, the sensor is used to help train and validate the computer vision.

- Ask solution providers for a roadmap of how they assist a retailer in scaling the technology from small locations to ever-larger store formats. This should include a playbook of other applications (scheduling, merchandising, etc.) that can be added to the platform over time.

- Ensure that the solution provider can provide you a clear list of retailer requirements including both hardware and software integrations. Alongside the requirements have them identify who is responsible for doing the work and ensuring completion.

- There are many key decisions a retailer needs to make when deploying a computer vision platform, many around the shopper experience. Will all shoppers be required to use the frictionless shopping system (like Amazon Go stores) or can shoppers opt for a traditional checkout experience? The solution provider should help you walk through all these decision points.

- Able to share best practices around marketing and positioning of technology for shoppers to alleviate any privacy concerns.

- Integration to POS for applying complex promotions, digital coupons, personalized promotions (including personalized pricing), etc.

- Integration to operations and merchandising. What are best practices around using computer vision for fresh prepared foods (pizza, sandwiches, salads, etc.), drinks (fountain soda, coffee, etc), and other things.

- Have a discussion around how the computer vision platform is architected. Is processing done in the store (store-level server) or in the cloud? Or a hybrid approach? What are network bandwidth requirements?

Retail 4.0: The Age of Metamorphosis

5 years. 60 months. 260 weeks. 1,825 days.

That's how long this retail industry metamorphosis is going to take. The digital transformation of retail has already started. And as Davenport so clearly calls out, time is of the essence.

The clock has started.

Retail 4.0 is the radical reinvention of retail, driven by the digitalization of nearly everything across the organization and across the supply chain. The automation of physical work and business processes over the next several years will drive dramatic change. The development of digital networks encompassing digitally engaged customers opens the door — for the first time — to exponential value creation for traditional retailers.

Retailers have no time to lose. The time is now to re-envision the future. Begin the process of assessing where you are today and understanding where you are going. Put in place a process to understand, discover, and deploy new innovation. And embrace the possibility of an exciting future.

There's no time to waste.

Gary Hawkins has lived his career ahead of the curve, putting him in the right place at the right time to help guide the fast moving consumer goods retail industry into the future in a time of exponential technology growth using never-before-available capabilities to innovate the future of shopping. Hawkins is the Founder and CEO of CART **(Center for Advancing Retail & Technology).**

Drawing on his work advising leading companies around the world, Hawkins is a regular guest lecturer at Georgetown University's McDonough School of Business in addition to keynoting retail conferences in the US and abroad. Hawkins is the author of three books including the latest, Retail in the Age of 'i', that explores the future of retail propelled by the exponential growth of technology. **Retail Mindsteps** (retailmindsteps.com) serves as Hawkins' personal blog and repository of the myriad articles and papers written for industry publications where he distills the complexity of tech-fueled retail innovation into digestible and actionable insights.