

## **The Global Supply Chain in the Digital Age: Transformative Factors Affecting Industrial Vending**

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### **Abstract**

*For businesses, the unrelenting drive towards efficiency, lower cost, and higher margins, has led to the search for continuous improvements in inventory management. One area driving innovation in inventory management today is industrial vending machines - used to provide workers on the shop floor and in any production process with supplies required in a timely manner. Indeed, vending machines are not just for snacks anymore. It is becoming more ubiquitous in factories, offices, and warehouses and we expect it will continue to become more so. In this paper, we discuss the history of vending machines and the case of one of the leaders in the use of industrial vending – Fastenal Company – to analyze the important factors that have taken place during the last 3 decades which have allowed the transformation of vending from a purely consumer-oriented activity to an important component of the global supply chain. We use Fastenal Company for this study because its development mirrored to a large extent the historical development of industrial vending. The digital revolution, various methods of data handling and transmission, highly developed concepts of LEAN, Just in Time (JIT) Inventory Management, Vendor Managed Inventory (VMI), manufacturing cells, point-of-work (POW) systems, and Six Sigma are just some of the transformative factors we include in our analysis of this industrial transformation. We conclude with a discussion of the business gains in terms of reducing cost, raising efficiency, and increasing profitability that have accompanied the phenomenon of industrial vending.*

**JEL:** M10: M30

**Keywords:** Industrial vending machines, lean processes, supply chain

### **Introduction**

There are times when business ideas are ahead of their times and it requires the confluence of ideas, practices, technology and adaptations to bring an idea to fruition. When management thinking, technological applications and the proper infrastructure come into place, there will often be a change in how we think of things. The industrial vending machine (IVMs) is one such innovation which started out as an idea ahead of its time. We begin with our common idea of vending machines – the convenient dispenser of consumer goods.

### **A Brief History of Vending Machines**

Although the major products that are vended start with the letter “C” and have been called the 4 Cs of vending - cigarettes, coke, coffee, candy – the products delivered via vending machines (VM) have gone through a long history, a history of successes and failures.

It spans centuries with its original conception attributed to the Greek mathematician Hero who found a way to dispense temple cleansing or sacrificial water (some called it “holy water”) by dropping a drachma and receiving the product through a dispenser. After all a vending machine is nothing else but retailing using an automated machine.

But it would not be until the late 1800s that this concept of selling via a machine would take off with the dispensing of products such as postcards and chewing gum. Vending machines took advantage of certain inherent natural inclinations that would make customers buy on impulse a relatively inexpensive product and consume it on the spot. Vending machines were often placed in spots where customers were captive because a service was needed and vending proved to be the most effective way of providing the consumer products in factories, mills, offices, and warehouses. It was also useful in high traffic areas like railroad stations, steamships, washrooms, and bus stations. Today vending locations span the gamut of places like theaters, lobbies, garages, drug stores, depots, hospitals, and schools. Vending machines have even become controversial because they are seen as highly lucrative money makers serving captive audiences that partially cause the USA’s high rate obesity.

Some of the products that have drawn the interest of merchants wanting to engage in automatic selling to revolutionize merchandising include: perfumes to mask odors, lighter fluid, sanitary napkins, dairy products, handkerchiefs, toothbrush, toothpaste, baby needs, videos, ice, popcorn, sandwiches (starting in the 1930s), condoms, aspirin, soup, fruit, juices, pencils, newspapers, magazines, books, and even toilet seat covers.

One attraction of VMs was that it could replace routine sales allowing salesmen to engage in the real task of selling. However, vending machines were not always broadly accepted and in some cases VMs were reviled. For example, the illegal use of slugs and other objects in the coin slots caused machines to malfunction and lose profits. Slugs were blamed for the decline in public morality and even economic problems. The increase in foreign travel also caused problems for VMs as foreign coins came to be illegally used in vending machines.

There were concerns that VMs were destroying jobs because they competed with retail shops, counters and direct sellers. Others resented the floor space occupied by these machines. Public health concerns also accompanied the rise of the VM as worries arose concerning the dispensing of drugs without professional advice, the exposure of children to poison, and mistakes in stocking. VMs were even blamed for deaths in universities when they toppled over disgruntled students who were venting their frustrations on machines that failed to dispense the right product or the correct change. Some also blamed the rise in theft and vandalism on these tempting, seldom-attended machines.

Obtaining products from VMs has gone through numerous modifications – from the penny scale for weighing machines to the use of coins and then paper currency. The ability for VMs to give change was a revolutionary event. Prior to this, prices were fixed for all machine contents and change was not calculated nor given. There was a time when each pack of cigarettes in a vending machine was packaged with a coin (e.g. 10 cents) as change when the fixed amount accepted by the VM was greater than the price of a pack. Technological advances particularly in the use of debit cards have rendered the question of giving change moot.

The 1920s and 1930s was an era during which VMs could have increased in popularity along with gaming because of the advent of pinball machines. But because of the Great Depression, consumer spending collapsed taking with it VMs. However, even as consumer spending fell, coin-operated machines continued to develop through such amusements as gambling machines, pinball, and jukeboxes. Eventually VM use increased but there were some products that clearly did not lend themselves to VM even though entrepreneurs tried. Perfume dispensers, dry cleaning, and live bait are just products and services that failed.

VMs eventually gained popularity outside the USA as well but its growth was uneven. VMs started slow in places like London, Paris and Amsterdam. But it showed phenomenal growth in China and Japan - a country where there is 1 vending machine for every 22 people.

The time period from 1960 to 1985 would be a period of stagnation, despite the rise of automation, higher labor costs and increased leisure time. However, the business principles that would dictate success for vended products became much clearer. The 4 basic principles for VM success are:

1. Products must have wide consumer acceptance and already be presold through ads;
2. Profits must be sufficient (at least 30%) for a large enough volume to justify the cost;
3. Products must be consumable immediately;
- and 4. Products must be standardized so that there is no need to test it before buying.

Other product characteristics that are crucial for a product's success include its small weight and size, mass market appeal, high frequency of purchase, and true convenience.

After 1985, sales of consumer products through VMs continued to grow thanks to the widespread use of credit and debit cards. However, VM would remain mired in its position as a niche marketing industry relegated to dispensing a limited range of mainly low-priced snack items. VMs also continued to serve as a means of dispensing a small nucleus of inexpensive products to the public where normal retailing was not feasible. VMs continued to rely on customers who would buy products on impulse and for the most part consume them immediately.

However, there were significant changes occurring that would eventually carry VMs from being a consumer-oriented, niche-market artifact, to becoming a very useful resource in industrial production and in service industries.

### ***An Industry Case Study***

In this study of Fastenal Company, we show that while the initial idea for starting a company may first prove to be unfeasible, a company or entrepreneur may be able to return to the original idea once the conditions are right. In the case of Fastenal Company, whose founder had hoped to use industrial vending machines (IVMs) in the 1960s, we examine the significant changes in management concepts and in technology that had to occur first before IVMs could evolve and succeed. In the process, we show how the millennia-old concept of vending machines dating back to the dispensing of holy water in ancient temples has evolved from primarily consumer applications to industrial uses.

One of the founder's first ideas for starting a business was based on a vending machine – that he would set up rudimentary vending machines for fasteners so that as customers walked into his retail parts store, they only had to put in their money into a machine and down would drop a box of fasteners – in much the same way that people bought cigarettes from a vending machine. In addition to increasing customer convenience, this would also cut down on the use of employee time since there would be less time retrieving many small orders and restocking would only take place once or twice a day.

His vending machine idea for industrial supplies did not take off primarily because of the physical limitations of the machine. Since the vending machines only had fixed-sized slots, only boxes of a certain size would fit and could not accommodate screws longer than say, 6 inches. If the customer wanted a bigger screw, the customer would still have to ask the counter salesman. Likewise, fixed quantities were an issue. The boxes contained set quantities of fasteners, at a set price since at that time machines could not yet give change. If a customer needed fewer fasteners, he would still be stuck with the pre-packaged quantity. If he wanted more, he had to buy additional boxes. Space constraints were also an issue. To meet varied customer demands, the number of stock-keeping units (SKUs) had to be large. But having enough vending machines and space for all the SKUs was cost prohibitive.

While the original idea of selling fasteners using vending machines did not take off, the founders of Fastenal achieved success as an industrial parts supplier. From one store in a small mid-Western town, Fastenal grew to be a leading supplier of industrial parts with 2,637 stores operating in 22 countries, \$3.7 billion in sales, and 18,417 employees. In 2008, when Freddie Mac and Fannie Mae were taken off the S&P 500, Fastenal was one of the companies selected to replace them. (These company figures are taken from its 2014 annual report.)

For Fastenal, the industrial vending machine idea lay dormant until it was revived in 2008 but in a completely different incarnation. Now named Fastenal Vending Solutions, these vending machines are outwardly similar to the older vending machines the snack-consuming public is used to. But today they have much more sophisticated internal mechanisms and support infrastructure. The configuration of space is more flexible allowing for parts of various sizes. Access need not be by cash but by secure ID or swipe cards. Information regarding stock availability and usage are now gathered and transmitted electronically eliminating the need for visual inspection for restocking and allowing for easy reporting. And rather than have customers traveling to a store to get parts, today's vending machines are placed on the factory floor close to where the end-users are.

A company like Fastenal, which owns the vending machines, is responsible for restocking making the IVMs a form of vendor managed inventory. In the rest of this paper, we discuss the factors that have evolved during that hiatus of 40 years which has made this reincarnation possible.

### ***Management Concepts and the Transformation of Vending***

While many of the concepts and technologies we will discuss were being developed even before the 1980s, it took time for their widespread adoption to take place. But once there was widespread buy in of the concepts and broad adoption of the various technologies, the path was open for management's adoption of IVMs.

Perhaps the most important managerial concept that helped the development of industrial vending was "lean manufacturing" and the various management practices that sprung from it. In 1990, James Womack published "The Machine that Changed the World." Based on an extensive study of the automobile industry, the book made the terms "lean production" and "lean manufacturing" popular and more importantly, spurred the aggressive search for practices in the work place that would increase efficiency and lower cost. As a management practice, the emergence of adaptable "manufacturing cells" was a natural outgrowth of lean production. Because such manufacturing cells were easily identifiable "points of work" (POW), the placement of IVMs close to the end-user became possible. In turn, by bringing supplies closer to the POW, IVMs became cost reducing enhancements on the shop floor. Rather than spending time to go to a central tool and parts crib and spending time with an employee manning the tool crib to get the supplies, for example, workers took far fewer steps and less time to get needed supplies from an IVM.

Total Quality Management (TQM) was another management concept that gained broad acceptance and use during the past 30 years. As a management philosophy, TQM seeks to continuously improve both products and processes with the goal of increasing customer satisfaction. It is management's preoccupation with improving process quality that has led suppliers to keep seeking ways to shorten delivery time, to reduce the direct and indirect costs of supplying production workers, and to gather data pertinent for management decisions. The placement of readily accessible inventory of selected supplies close to the POW, while maintaining employee accountability, has become increasingly accepted as a process improvement.

In addition, Japanese (i.e. Toyota) production processes also received greater acceptance as part of modern management. For the development of IVM, the concept and practice of Just in Time (JIT) inventory management was crucial. Based on the notion of minimizing inventory cost, JIT required balancing the minimization of supply stock with the need for having enough stock all the time to avoid any interruption in work flow. Vendor Managed Inventory (VMI) was one response to the requirements of JIT. As the responsibility for supplies fell on the vendors, it became incumbent on the suppliers to assure timely restocking of supplies without burdening manufacturers with too much inventory. Later on, vending machines would become one instrument of VMI allowing workers at the POW to have access to needed supplies at any time. And because today's IVMs are connected via the internet to a supplier's office, real-time information on stock levels can be monitored continuously to keep inventory within pre-set min-max levels.

In 1982, Keith Oliver introduced the term "supply chain management" to the lexicon of business. It encompassed the notion of understanding the totality of the process for efficiently and reliably fulfilling customer needs. This forced suppliers to find ways to integrate their information and logistics processes with the needs of their customers. But it was not enough to align supplier processes with the demands of customers. It also required that each supplier take into account their linkages with their own downstream suppliers as well as their logistics providers. As such the "chain" could only be strong and reliable if all components were integrated. This has even led some suppliers to build up their own expanded logistics capabilities in order to have greater control over the management of the supply chain. With sophisticated supply chain management systems in place, it became possible and even advantageous to develop and install IVMs as one more step to bring the supply chain closer to the end user at the POW or the point of use.

While cost-minimization and profit-maximization are concepts that have been around for a long time, it has been in the last 40 years that there has been a concentration on identifying value – value that a seller or partner brings to a business. Hence, we have greater management use of the terms "value-added" and "value proposition". Value-added has long been used in the National Income Accounts but it has been appropriated widely in management as a way to rate the attractiveness of sellers and providers. Greater consciousness of value-added has forced sellers to explain and enumerate the benefits they bring. This is usually encapsulated in the so-called "value proposition."

Management sensitivity to value-added and value propositions opened the door to providers of IVMs who are often able to demonstrate and quantify the gains from installing IVMs at the point of work – less waste as hoarding is discouraged, less time spent by employees going to and from the tool crib, reduced chances of stock outs and therefore reduced down time cost, and reduced employee resources used in managing the tool crib and restocking. In other words, its value proposition has allowed vending machines to move from the 3 Ss of the consumer market (snacks, sodas, and smokes) to industrial vending.

### ***Technology and the Transformation of Vending***

While the management concepts and practices were leading to changes in thinking, there had to be complementary technological advances that could be incorporated into vending machines making them economically viable on the shop floor. Advances in digital technology and other types of technology made the use of IVMs attractive and profitable by allowing for: restricted and identifiable access; variable dispensing; inexpensive and timely data gathering and transmission.

Before vending machines could be brought to the shop floor, access without cash had to be developed along with a mechanism for limiting and tracking supply use. The development of bar codes and magnetic card technology allowed employers to issue unique identifiers to each employee. With the rapid improvement in different card reader technologies—barcodes, infrared, and proximity readers—employers could limit who could access IVMs, which specific items could be accessed, and in what specific quantities. Furthermore, the controlled access digital technology enabled employers to track usage by employee and or department thus improving accountability and reducing supply waste and loss. And just as importantly, workers did not have to carry coins around to get needed industrial supplies.

As the cigarette-style vending machine (lever-pull) gave way to the helix machine, dispensing became more versatile. But even helix technology had severe limitations for the shop floor. The helix vending machines could not always be readily configured for different sizes, shapes, and weights of products. But with the adaptation of radio frequency identification (RFID) technology, weight scale sensing, and other sensing technologies, IVMs could be reconfigured to accommodate any shape or size of product. IVMs became versatile dispensing machines (VDMs) allowing for greater flexibility in what could be brought to the POW. This also allowed for maximum use of space as the interior of a vending machine could be rearranged to accommodate the items of greatest need in the POW.

Finally, advances in card reader technology and tracking allowed the vending machine door to be opened completely with less chance for waste and loss. Prior to the accountability and security provided by card reader access, end-users were not allowed to open the vending machine itself. One of the few exceptions to this is the newspaper vending machine. The door of a newspaper vending machine is designed to be opened after the customer inserts the required coins because vendors know that the marginal utility of the second copy of a newspaper is zero leaving the end-user with no incentive to take more than one newspaper. That is not the case with vending machines for snacks or for industrial supplies where access to more than product at a time is not allowed. But with access and usage tracked by various types of card readers and other digital devices, it has become less of a concern for management to let employees open the door of the IVM allowing for the storage of various shapes and sizes. In one version of the IVM, even large power tools can be stored and “checked out” from the vending machine with full employee accountability. These “locker-type” IVMs would not be possible without traceable access provided by digital technology.

The development of the internet also contributed to the greater acceptability of IVMs. With internet technology it became possible to remotely gather and store information on who was using supplies and in what quantity. Suppliers could monitor stock levels remotely and instantaneously. These all helped accomplish important management objectives such as JIT, lean manufacturing, and cost reduction. That software and data could be remotely hosted also meant that today’s IVMs need not be complex computers requiring on-site support staff. While the software and data are remotely hosted, the internet also made it possible to quickly transmit data back to the management of companies for the purpose of tracking, determining usage, effectiveness, etc. This in turn bolstered data-driven continuous improvement, another management practice that has gained significant popularity. For example, the real-time data collected through IVMs can now be used for process improvements associated with Six-Sigma and with Lean Processes.

## **Conclusion**

In the interim since its founder shelved his idea for IVMs, Fastenal, like other leading industrial suppliers, has developed capacity that would eventually lead to the support of IVMs. These industrial suppliers developed strong capabilities in sourcing, logistics, and the whole gamut of supply chain management – capabilities that are necessary to support successful IVM operations. In Fastenal's case, it developed a network of stores, distribution centers and employees in more than 2,600 locations that brought it closer to industrial users. If one were to view IVMs as logical extensions of vendor managed inventory, then such a network that can respond to restocking needs becomes necessary. In addition, for IVMs to be truly responsive to producer needs at the POW, the logistics capability of the supplier must already be in place. In an era of global supply chain management, this is what industrial suppliers have indeed created – a complete logistics system from product acquisition to warehousing to shipping all within acceptable time limits. With these in place at Fastenal, it is no longer a surprise that the company founder's first rudimentary idea for the IVM has become an important of the company's present and future growth.

Like its competitors in the industrial supply industry, Fastenal has seen phenomenal growth in the number of IVMs that it has been able to deploy and that it continues to deploy at ever increasing rates. This is not surprising considering the potential for the savings and efficiencies that IVMs at the POW have been shown to provide. Among these are:

- Reduced material cost
- Greater accountability for use of supplies
- Just in time inventory
- Avoidance of obsolete inventory
- Higher inventory turnover rate
- Accurate and timely information feedback in the supply chain
- Readily available management information
- Continuous improvement of process controls
- Assurance of production flow with elimination of stock outs
- Direct and indirect labor savings at the tool crib and the POW

Indeed, with the tremendous strides in management thinking and in digital technology, vending machines have come a long way since the time of Hero and the vending of sacred water at the temple.

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