

Technology, Public Policy, and Retailing

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Many people living in Boston, Massachusetts, visit the Mall at Chestnut Hill for their upmarket shopping. The Mall is located at the crossroads of Route 9 and Hammond Pond Parkway in Newton, one of the many upscale western suburbs of Boston. The Mall follows the merchants' dictum of locating stores where it is easy for customers to drive to and park, with attractive merchandise to make their visit a pleasant experience.

The Mall at Chestnut Hill is the present-day embodiment of the 19th and early 20th century department store updated with ample parking for today's suburban shoppers. Richard Woodward of the *New York Times* (2007) suggests that the present-day mall is but a modernized version of the Paris arcades of the 1820s and 1830s, which he describes as:

Diminutive cathedrals to commerce and leisure, the arcades offered unheard of amenities to the emerging class of bourgeois consumers. Gas lighting, heated shelter from rain and mud, a panoply of goods and services in a contained space, cafes and restaurants where you could rest and observe fellow lingerers — these were a decided plus over the shopping experience of hunting and gathering all around town.

The Mall at Chestnut Hill has the conventional two large anchor stores at either end; in this case both anchors are Bloomingdale's stores specializing in different products at opposite ends of the two-story enclosed atrium. Parking spaces surround the Mall and additional spaces are provided in a multi story parking structure with a convenient covered bridge to the Mall. Beyond the Bloomingdale anchors there are 55 other individual stores ranging from Brooks Brothers, Coach, Ann Taylor, Barneys New York, Sur La Table, and Apple Inc., to banks, 3 restaurants, and many small specialty shops.

Shoppers might have done pre-shopping on the WEB before coming to the mall, or they might have come in response to an advertisement sent to them by mail, or they might come just to have a good time enjoying the eye candy and having lunch with a friend to cap off the outing. The Mall does not yet have a coffee shop in the open area to allow restful watching of other shoppers, but there are overstuffed chairs for resting and watching.

Almost all shoppers come to the Mall with just a credit card - avoiding carrying large amounts of cash - so that they can purchase whatever they fancy, provided it's within their credit limit. When they enter the Mall they are most likely unaware of the vast amount and level of sophistication of the technology needed to keep the Mall and the stores running. Most of the technology is hidden from view by careful design – the stores are selling their merchandise, not technology. The Mall owners want to provide a pleasant atmosphere and attractively displayed merchandise to entice shoppers. Technology is visible in the Apple store selling Apple computers, iPhones, and iPods, along with the peripherals that make the iPod the world's most widely used MP3 player. Even here the WiFi system connecting the displayed items to the Web is happily running in the background throughout the store, without sound or announcement.

Almost all of the technology necessary for modern retailing was invented or developed outside of the retail industry for other applications or purposes. Over time, forward looking merchants saw in various technological advances an opportunity to enhance their retail shopping experience, create new retail channels, and provide new and more varied products efficiently. They adapted these technologies for use in their stores

and operations, forever altering the retail environment. In this way, technology has become critical to modern retail market making.

Retail market makers who have exploited technology have done so in two distinct ways. First, technology has been the basis for developing new retail channels that are both pleasing and convenient for customers. This includes enhancing traditional brick-and-mortar stores, as well as new channels such as catalogue, e-commerce, and web boutiques. Second, market makers have used new technology to create more efficient supply channels expanding products for retail selections. The technology has put new products from around the world into retail stores, expanding consumer choices at reasonable prices. This chapter will examine the most prominent technologies responsible for today's retail marketplace.

In later sections of this chapter we will trace the development of several early disruptive technologies that have changed the face of American retailing and manufacturing. We will start with the push of the railroad into the west in the 1860s and the birth of mail-order market making by Montgomery Ward in 1872. Then we will look at the effect of that most disruptive transportation technology – the automobile – on big city retailing and the beginning of suburban shopping lead first by Sears and Roebucks in the 1920s. In 1956 two other important disruptive technologies were introduced, one quietly and the other with all of the fanfare of an act of Congress pushed by the then President Dwight Eisenhower. These two technologies are the shipping container and the container ships that transport material around the world very economically, and the other is the U.S. interstate highway system that was so important to the location of Wal-Mart stores expansion from its early days of serving small local communities. By using bar

code identifiers and the Internet for ordering, Wal-Mart revolutionized supply chains and subsequent expanded to become the world largest retailer. Ports for containers ships, railroads, and interstate highway connections are the basic triad of modern intermodal transportation of global commerce.

But first we will review some of the important contemporary technologies, working partially in the background that make modern retail shopping so attractive.

I. Technology and Retail Channels

a. Stores

Much of the ease of use and the general pleasantness of current retail channels can be attributed to technology and the creative merchants who found novel ways to employ it. The most obvious retail channels are the physical storefronts reached from sidewalks, plazas, and shopping malls. The Mall at Chestnut Hill is just such an example; this type of marketplace leverages technology to create the most enjoyable customer experience possible. Consider the heating, ventilation, and air-conditioning systems (HVAC) that keep the air fresh and free of unpleasant odors, maintain the humidity at acceptable levels, and the temperature at an ideal value for the season. HVAC was invented by Willis Carrier in 1902. His motivation was to control the humidity of a printing plant where he worked. Paper and cardboard change their dimensions as they gain or lose moisture. Carrier realized that controlling the humidity would stabilize the dimensions of paper so that different colors applied sequentially at different times would register properly.

It was a long time before air-conditioning was widely used. One of the authors of this chapter (FHA) still vividly remembers the first time he experienced air conditioning;

it was the unexpected and unexplained physical shock at going from inside an air-conditioned restaurant out onto the very hot St. Louis railroad station platform in the summer of 1936. Nowadays we would all be shocked if to we were to go into a store in the summertime without air-conditioning – it would likely be our last visit. In 50 or 60 years the disruptive technology of air-conditioning has gone from a memorable experience to ubiquity. And that is the nature of most disruptive technologies that are part of the standard retail environment in this country.

Some technologies diffuse more rapidly, electric lighting for example. Edison first commercialized distributed electrical lighting in 1882. Less than 50 years later, the construction of new power plants, fixtures and bulbs had led to electricity replacing gas and oil lighting in U.S. cities and suburbs. John Wanamaker, an important market maker innovator in US retailing, installed electrical lighting in his department store in Philadelphia in 1879 (Gibbons 1926, vol.1 218-219) having already installed arc lighting in outside window displays in 1878. Soon after Edison's demonstration of the system of electrical lighting, Wanamaker went to Menlo Park, New Jersey, to visit with Edison at his research and development laboratory, and arranged for DC motors to power ventilation fans in his stores, long before air was "conditioned."

Along the way, it was necessary for public policy to provide enabling legislation creating local and state building codes to ensure human safety when electrical power was installed and used. We will see this time and time again: public policy - national, local or both - is necessary to allow a new technology to diffuse through our society. We allow one electric power company to have a monopoly of the means of distributing power to our homes. Imagine the mess if there were multiple sets of power poles belonging to

different companies competing for our business. Some standards are set by an industry; the typical standard screw base of an incandescent bulb – called the Edison base – is just one example. It is true that there are several different light-bulb bases, but most are for special lighting fixtures. It would be a household nightmare if every manufacturer of lighting fixtures required a special bulb base.¹

In addition to lighting and air-conditioning the elevator and the escalator are two other common electrical devices in every modern multistory retail building. Both were also invented for other purposes: Elisha Otis invented a steam-powered elevator with safety features in 1853 to move freight; modern elevators now are powered by electricity and controlled by elaborate computer systems along with greatly enhanced safety features from those envisioned in the 1853 patent for the elevator.²

Jesse Reno invented the escalator in 1892 as an electrically powered conveyor belt for moving people at Coney Island, New York. Harrods installed an escalator in their already famous store in London amid great fanfare just two years later. People movers were and are always important for retailers trying to make it as painless as possible for customers to reach the upper floors without the arduous climb of stairs. By 1900, department stores of ten stories became common in the big cities of the U.S. because growing land prices and population increases made large vertical retail space economically viable. Structural steel, electric lighting, electric elevators, and electrically powered ventilation made tall buildings possible. John Wanamaker, the famous 19th and

¹ It is bad enough that automobile lights come in a bewildering array of sizes and bases that make it necessary to shop for new auto lamps with the car's owners' manual in hand

² Public safety in an elevator remains a cause of concern to many, but such fears have been dramatically reduced by yearly safety inspections required by local building codes. The inspection report is normally dated and posted in each cab near the phone for calls to help if the elevator should stall.

early 20th century merchant, had a three-story auditorium seating 1,300 people built into his new New York store in 1907 (Gibbons 1926, vol.2 109-110). In 1911 he topped all that had gone before by installing the world's " finest organ in the world" in the lavishly decorated marble clad 149-foot high Grand Court of his new 1911 building in Center City, Philadelphia. Macy's now owns the store and the organ is currently being refurbished and expanded to 28,543 tubes (Whitney 2007). The store manager, James Kenny, reports:

Every lunch time, people hear the organ and feel good – and people are in a mind to shop when they're feeling good. It is the ultimate feel-good experience.

Visionary merchants such as Wanamaker quickly adopted new technology to make the shopping experience inviting: concerts, restaurants, and tearooms were added for shoppers' convenience and enjoyment.

b. Charge Cards and Credit

Besides providing a more comfortable marketplace, technology has been adopted to change retail channels in other ways. In particular, the emergence of credit cards has provided consumers with cash-less convenience, means for greater impulse buying, increased buying power, and opportunities to shop new retail markets including catalog, e-commerce stores, Amazon, and more.

American retailers have been making new markets around issuing credit since this nation's founding. By 1924, consumers relied on financing for about 75% of their vehicle purchases (Calder 1999, 158). Large mail order stores and catalogue companies, most notably Montgomery Ward and Sears, Roebuck, and Co., provided a variety of exotic "buy now, pay later" schemes that played a prominent role in the early success of these retail giants (Calder 1999, 200). While the concepts of credit and revolving debt

unquestionably drove important new markets and retail channels, the physical credit card has been creatively leveraged in market making as well. The impressive new retail formats and merchandising possibilities afforded by plastic were made possible only after an impressive array of technological advances were borrowed from a variety of industries.

In 1914, Western Union offered its preferred business customers metal charge cards to be used in lieu of cash (MacDonald 2001, 227). Payment was expected upon invoicing, so the initial attraction was convenience rather than credit. A number of travel and entertainment chains followed suit. In an effort to consolidate the number of charge cards required by a business traveler, Frank McNamara and two friends in 1950 started a credit organization, the Diners' Club, that issued 200 cards (paper, not plastic) which could be used in 27 restaurants throughout New York; the card was gradually accepted by retailers nationwide, becoming Diners Club International (Evans 2005, 53). This general-purpose card, which came to signify membership in Diner's Club International, grew nationwide.

In 1959, San Francisco-based Bank of America (BOA) put its own spin on the charge card by offering card holders immediate, pre-approved credit. The *BankAmericard* became the first nationally recognized bankcard and spawned the credit card industry, as we know it. Merchants funded the nation-wide network by paying a fee for each transaction, a practice that took some getting used to. Customers were permitted to pay for their purchases in monthly installments, incurring a finance charge on the outstanding balance. This type of agreement provided card holders an enhancement

beyond the simple convenience of a charge card; it gave them purchasing power beyond their immediate means. This is a critical element in today's retail market.

BankAmericard eventually grew into Visa by 1976, while MasterCharge, the forerunner to Mastercard, began as a competing network in 1967. The existence of distinct, unconnected networks, high interchange fees, and a general lack of standards continued to hamper merchant acceptance. In turn, consumer adoption was also slow, and a vicious circle would have to be overcome.

The most significant step towards improving credit cards for both merchants and buyers would come from reducing the overall time and cost to approve a purchase and conduct the corresponding transactions between the various agents. In 1970, it could take over five minutes for a merchant to gain an authorization code by telephoning the issuing bank and reading the account and purchase information. At closing, the merchant would capture the day's sales only by submitting to his acquiring bank the paper sales drafts, each with recorded authorization and signature. These would ultimately have to be settled with the appropriate issuing banks. Naturally, this caused enormous workloads for banks, which charged high fees back to the merchant, and errors were frequent.

The overall approval and transaction process was significantly aided in the next three decades by merging a series of new technologies. First, in 1960, the London Transit Authority began encoding data on cards via magnetic strip. Then, in a separate development early that same decade, Bell Labs created touch-tone dialing. This made long-distance calling faster and cheaper. Equally important, touch-tone opened the door for automated telephoning via computer systems, which would come nearly 20 years later. This critical advance could take place only after early generation data modems

invented for U.S. air defense systems in the 1950's evolved into the "smart modems" of today. Released in 1981 by Hayes Communications, "smart modems" could transmit at 300 digital bits per second, and for the first time serve as a dialer by translating digital computer commands directly into the analog telephone network. It should be noted that the adoption of international standards to insure accurate data exchange between modems was crucial in advancing this technology.

The credit industry, led by National BankAmericard, Inc. (NBI)³, leveraged these technologies to automate the data exchange process by developing a fully electronic authorization system which they called Base I (Mandell 1990, 62). An electronic card reader/dial terminal at the Point of Sale (POS) could pull critical information from the "Magstripe", including the issuing bank's phone number, the account number, and expiration date; then place a call answered by a computer; pass purchase information via touch tone; and accept an authorization code—all in less than a minute. On the receiving end, increasingly efficient databases could compare the queried purchase amount to the customer's available credit balance, and if the charge was approved, place immediate holds on the account. NBI's success with Base I in automating the authorization process led to the development of Base II. This complementary touch-tone system allowed merchants to capture sales electronically at day's end, eliminating the need to deposit mountains of paper for processing at the acquiring bank. Acquiring fees were reduced and accuracy was improved throughout the credit system. As a result, merchant acceptance of credit cards continued to grow.

³ National BankAmericard, Inc. (NBI) was spun out of Bank of America in 1970 to run the BankAmericard Program. This provided issuing banks with a share of ownership of the network.

Beyond these benefits, electronic transaction networks also opened the door to 24/7 credit card use and Internet retailing. No longer constrained by banking hours, merchants were able to secure authorizations around the clock. From the consumer perspective, plastic became a preferred substitute for cash, day and night, on both weekdays and weekends. Encryption techniques allow secure credit card transactions online, and electronic signature has become widely accepted. The result has been exciting new markets and retail channels.

Next-generation POS systems are already being used in novel retail applications. Broadband lines and the Internet are permitting more real-time fraud detection routines at the point-of-sale, without a noticeable increase in transaction time. A growing number of chains use electronic signature pads to facilitate credit card use, eliminating the need for cashier identification. These rely on LCD touch-screen technology. Symbol Technologies, now a subsidiary of Motorola, is well known for its handheld POS terminals. Associates at Apple Stores use these wireless devices to process customer credit card purchases on the spot, using IEEE 802.11 wireless protocols for speed and security. Never needing to enter a checkout line enhances shoppers' overall store experience. Rental car companies use the same technology to close agreements within moments of a customer returning a vehicle. Not only is credit card preferred, it is expected.

Not surprisingly, legislation has been and will remain crucial in the marriage of retail market making and credit-cards. To date it has been most pivotal in protecting card-holding consumers. The landmark 1968 Consumer Credit Protection Act, which included the Truth in Lending Act, dictates that all terms be clearly disclosed to card

applicants in a common language. It also limits a cardholder's liability to \$50 per unauthorized charge in cases of loss and theft, provided such events are reported within two days. (15 U.S.C. § 1643(a)(1)(B)) A host of other legislation is constantly being updated to protect consumers from unfair practices of credit card issuers. Presently, laws meant to protect merchants, particularly small businesses, have received considerable attention. These tend to focus on controlling the merchant fees, which are negotiable between a merchant and its acquiring bank. Finally, standardization continues to bolster modern credit card use that is so pivotal in today's evolving retail environment. Due to the prevalence of POS scanning, card dimensions are governed by the International Standards Organization (ISO) 7810 guideline. Smart chip technology used in many newer cards follows ISO 7816, and RFID chips are governed by ISO 14443.

Today, total credit card purchases are expected to reach \$2.2T in 2007 in the U.S. alone (Cardweb.com, Inc.). Essentially all Internet commerce is transacted with credit cards or their derivatives. While this impressive volume has been driven partially by convenience and purchasing power, it can also be attributed to an ever-expanding set of global markets accessed through a wider array of retail channels.

c. Bar Codes and Product Identification

A final contemporary technology that dramatically improves physical retailing in several ways is the bar code printed on every retail item. While this breakthrough has enabled faster checkout, more reliable pricing, and more dynamic markdown and promotion strategies, it was developed by the retail food market industry and their suppliers simply to increase the efficiency of the checkout at the front end of food stores.

In the early 1970s, at the dawning of the new computer and robotics age, people in manufacturing and retailing were aware of the need for electronic systems that could recognize a machine part for manufacturing assembly or assist in checkout in food stores. Each group approached the problem in a different way. The manufacturers' approach was to first capture a digital photo as a step in recognizing a desired part. One of this chapter's authors (FHA) was on a review panel at the National Bureau of Standards (now called NIST- National Institute of Science and Technology) viewing attempts being made to solve this recognition problem. The researchers had selected a box of corn flakes of a particular size as a representative target object. By scanning laser beams onto the box in several directions and looking at the scattered signal they hoped to determine the size of the box. Other techniques were being explored to recognize the name of the manufacturer; in this case it was Kellogg. It isn't easy to teach a computer system to find the name of the manufacturer among all of the writing on a breakfast food carton. So their first attempts were to just recognize the **K** of the name, which is always positioned prominently on the carton.

At the time, no one on the review panel was aware that the food market retailers and their suppliers were already solving this problem in a beautifully simple way, and without direct help from government of any level. Their work resulted in the Universal Product Code (U.P.C.), and its 12 numerical digit bar code symbol that identifies the manufacturer and allows an exact description of the item. The focus of the group was solely on improving the efficiency of supermarket checkout. They did not anticipate that they were about to create the tool that would allow the entire retail supply chain to be rationalized. Alfred D. Chandler Jr., writing on the jacket of the definitive book on the

history of the development of the bar code and the supermarket scanners systems,

Revolution at the Checkout Counter - the Explosion of the Bar Code said:

This book tells in intriguing detail the almost unknown history of the coming of the Universal Product Code (U.P.C.) – an innovation that has transformed the process of distribution and production as profoundly as the coming of the railroad and the telegraph did more than a century ago. The book is essential reading for an understanding of the evolution and impact of today's information revolution (Brown 1997).

The bar code in the form that we all know and the Universal Code Council that administers the allocation of codes to manufacturers were the product of an initial meeting in 1969 of the Administrative Systems Committee of the Grocery Manufacturers of America (G.M.A.) and their counterparts in the food market industry, the National Association of Food Chains (N.A.F.C.), to discuss a product code for the food market industries. There was a general belief that a machine-readable product code would increase substantially the productivity of the front end of supermarkets. It was envisioned that each item offered for sale would be marked with a code identifying the manufacturer and uniquely describe the product. The code would be read by a scan system at the checkout; the computer system would then rapidly look up from internal files the name of the manufacturer, the product description, and the price. Individual tagging of each item (item pricing) would no longer be needed for checkout, and the labor cost saving from eliminating item pricing would be available to finance the scanning equipment.

The motivation of grocery firms for such as system is obvious, while that of the grocery manufacturers was equally pressing, if not as direct. There was talk in Europe and in the U.S. that several high tech firms were developing product codes and scanning systems. The grocery manufacturers were worried that if a “universal code” were not

developed and implemented across the industry, some of the larger chains would select an identification code for their products and then pressure their suppliers to use it on all of the products shipped to their stores. Such requirements would introduce huge inefficiencies in suppliers' product inventories and might result in Federal Trade Commission objections that a manufacturer was providing services to one retailer not available to others – something not allowed under the law.⁴ The way forward then was clear: develop one product identification symbol and encourage all food product manufactures to provide it on their products. A reasonable code for the retailer was one that could be scanned at the checkout counter or read by a wand or entered in a register system by a clerk at a store without the necessary technology. Naturally the scanning equipment would have to be priced so that the hard saving from using the system would pay for the equipment in a few years.

John T. Dunlop and Jan Rivkin, in the Introduction to (Brown 1997), describe the general economic and technology conditions in the U.S. when the Universal Product Code (U.P.C.) was being developed. During the time of the U.P.C. development Dunlop had been the Director of the Cost of Living Council appointed by President Nixon to attempt to rein in the then raging national inflationary increases in the cost of living. At that time the food industry was anxious to gain control of costs, and product codes were one step in that direction. The Introduction also documents the penetration of U.P.C. bar codes into almost every product category in the retail sector. By 1994, Food & Beverage had gone from being 100% of all registrations to only about 28% of registrations; the

⁴ If a manufacturer refused to provide a different code format desired by a second retailer the manufacturer feared that might be forced to comply by the Federal Trade Commission under the doctrine of equal treatment. Manufacturers would not want to have separate product inventories for two retailers each carrying special codes.

remainder of the registrations was in 21 different sectors from Audio & Video to Health & Beauty Aids. This diffusion into the overall retail sector was not anticipated in 1969 at the first meeting of the principals of food manufacturers and chain store grocery operators; nor was it foreseen as late as June of 1974 when the first item bearing the U.P.C. code, a package of Wrigley's gum, passed through the checkout scanner of the Marsh's Supermarket in Troy, Ohio.

The groups sponsoring the development of the U.P.C. aimed from the beginning for a *symbol* code that would be in the public domain. They finally came up with a 12-digit bar code, which grew to 14-digits in 2005 and now can be found on virtually everything that we buy. Today the decision to choose a series of bars surrounded by a white border to represent a series of digits may seem an obvious one – obvious because it is simple and has been so successful. Frozen food products with small ice crystals on the package can be scanned as well as the U.P.C. symbol on a crumpled bag of pretzels or potato chips. We see how easily the bar symbols can be machine scanned when we do it ourselves at the self-checkout counters at the local food and home store. Natural abrasion of packages from all of the steps in product handling to the store shelf does not prevent a successful scan.

Clerks at a home store can now easily scan bags of lawn fertilizer with portable wands that automatically sweep a red laser diode light beam across the bars. The light reflected back to the wand creates a corresponding bright and dark pattern on its receiver element, allowing internal deduction of the numerical code that is printed on the base of the symbol. From the sophisticated fundamental structure of the light and dark bars of the code it is possible for scan systems to distinguish the first digits – the manufacturer

code – from the last digits allocated to the item description, even when the code is scanned backwards.

We have to admire the courage of the group from the G.M.A. and N.A.F.C. meeting in 1969: they set out to devise a product code and scanning system for the food market industry by engaging the attention of the U.S. electronic industry. At the time they must have been encouraged by the 1969 moon landing to believe that something seemingly simple as codes and scanning systems could be developed. The 60s was after all the era of the laser, the third generation of computers, and integrated circuits, (Davis 1985, 140-145). The committee used its knowledge of the food industry to insist wisely that detailed requirements for printing code labels be drawn up and tested on actual products. Scanning trials were insisted on for assurance that the codes could be successfully read 999 times out of 1000 under normal conditions at food markets. In the competition between the bull's eye code of RCA and the rectangular code of IBM, the winner was the latter's rectangular bar code with its specified clear surround.

It is hard to imagine now that the adoption of U.P.C. at the checkout counter was rather slow. The necessary scanning and computer equipment then available was deemed very costly. Some food chains were worried that not all food store product manufacturers would voluntarily adopt the U.P.C. code, making some item pricing of products necessary and thereby diminishing labor cost saving and making scanning systems uneconomical. In fact some states had consumer laws requiring individual price markings on each item in the store, as Massachusetts still does.

By 1984, ten years after the first package of gum passed a scanner in March's supermarket, only 33% of supermarkets had scanners (Haberman 2001, 27). But a

tipping point was soon reached and bar code scanners appeared in nearly every store. In the 1992 presidential campaign the *New York Times*, the *Washington Post*, and many other national publications ran stories about President George H. W. Bush's apparent wonderment upon seeing a new supermarket scanner operating at a National Grocers Association convention in Orlando, Florida (Brinkley 1992). Whether the President was really seeing a scanner for the first time was not the point of the story for us now. Rather, by 1992 almost all newspaper readers were familiar with bar codes and scanners in food stores; hence the President's reaction suggested that he was out of touch with everyday life in the country. We can now all agree that bar codes and scanners are universal in Western retailing. We see only one aspect of the effect of bar codes on the printed sales receipts for every retail purchase: the item description accompanies the sales price. Later in this chapter we will write about the role of bar codes in improving the efficiency of product supply chains and the prominent role Wal-Mart has played in driving change.

We will also explain how the disruptive technologies of bar codes and the Internet, coupled with containers and container shipping, railroads, and trucking have helped to revolutionize worldwide product sourcing. But first we are going to visit the history of much earlier disruptive technologies: the railroad that gave us mail order retailing, and the automobile that led to suburban mall retailing. In 1956, when container shipping started and Congress passed and President Eisenhower signed the bill starting the Interstate highway system, no one saw how these two events would change where manufacturing was done. These events allowed electronic and other manufacturers to create new markets for parts and assembly that never would have existed without the disruptive shipping technologies.

II Early Disruptive Technologies

a. Railroad Expansion to the West and Mail Order

We are all aware that railroads bring merchandise from factories to the freight yards and then to trucks that deliver the merchandise to the retail stores. While the role of the railroad in allowing the West to be settled is well known, railroad's role in the introduction of mail order merchandising is perhaps just as important to retailing yet less widely recognized. In 1850 the railroads in the US were principally located on the East Coast; by 1860 they were branching out to the Midwest and connecting the manufacturing centers in upper New York State with large markets along the East Coast. In 1850 there were already over 9,000 miles of railroads, and within the next decade this network had expanded by a factor of three (Soloman 2001, 29). This westward expansion made Chicago the focal point of the intercontinental rail system and, consequently, an important merchandising center. By 1860 more than a dozen rail lines connected Chicago with the East and with points in Indiana, Illinois, Ohio, and points west (Soloman 2001, 40). Because of the railroad and the corresponding westward expansion of the US population, Chicago became a dynamic and important city growing from an estimated population of only 100 in 1830; to 29,963 in 1850; to 298,977 in 1870; to 503,185 in 1880; and to 1,099,850 in 1890 ("Chicago Population"). By 1872, Chicago had many retail establishments catering to the local demand for clothing and practical items of everyday use. In 1872, a young clerk with an entrepreneurial spirit named Montgomery Ward was working for the prominent and expanding *Field, Palmer, and Leiter* (FPL) store. The "Field" partner of FPL was the Marshall Field whose fame in Chicago as a merchant grew to allow him to open the then largest department store in

the world on State Street in Chicago in 1907 (Wikipedia, “Marshall Field’s”). As a clerk for FPL, Montgomery Ward traveled by train and horse and buggy to service the country stores which were the major clients of FPL:

He found that the country store, with its pot-bellied stove and cracker barrel, was a snug place for farmers to sit and swap gossip on stormy days. But it was not so comfortable for the farmer when he went to the counter to buy goods. Prices were high and the choice of goods small. When the farmer complained, the storekeeper pointed out that he had to buy what the wholesaler offered at the prices set by the wholesaler. The farmer could take it or leave it and, since the storekeeper usually was the only merchant in the area, the farmer had to take it (Latham 1927, 3).

Ward understood the farmers’ and the shop owners’ dilemma. The long chain from manufacturer to wholesaler, to jobber, and finally to the retailer at the crossroad store had too many steps in the supply chain, each step marking up the product to cover its costs. He conceived of direct mail order sales. He would be located in Chicago close to the manufacturers and wholesalers; and by combining many mail orders together he could buy in bulk at a discount and sell directly to the farmers. He would write a catalogue with detailed listing of the items for sale, at a fixed price, with a money-back guarantee if the customers were not satisfied with the merchandise. Ward began with two partners and just \$1,600 in August of 1872. An early catalogue listed 163 items, ranging from yard goods of flannel and jeans fabric to an ostrich plume. In time, the catalogue expanded to contain more than 130, 000 items in 1967 (Latham 1972, 91).

There is always a problem of locating potential customers, and the early mail order company was no exception. There was certainly no easy way to find listings of people in the farming communities in the rural west. Ward solved this problem by sending his catalogue – in the beginning really just a list of items offered with their price – to the local Granges. The first local Granges, founded as the National Grange of the

Patrons of Husbandry in 1867, were established as social and educational organizations but rapidly became political organizations for the voice of the western farmers to protest against the abuses of the day. Ward was familiar with Granges from his sales trips in the farm communities for FLT. Ward encouraged the local Granges to aggregate their members' orders and send a single order to Montgomery Ward, who would ship the order to the nearest rail station c/o the Grange. Since the minimum rail shipping order then was 100 pounds, this aggregation of individual orders minimized the shipping cost to the farmers. The high cost of rail shipments was always a concern to the farmers, both for the things they purchased and for shipping their farm products to markets. The railroads at this time had monopoly control of shipping to and from the rural farms. The farmers, through their Granges, lobbied successfully in 1887 for a federal law establishing the Interstate Commerce Commission (I.C.C.) to regulate railroad shipping rates (Interstate Commerce Commission).

At that time postal mail was delivered only to the nearest post office. Direct rural delivery to the home was years off; free city delivery of mail would come only in 1863. The consumers' cost of mail-ordered items is the sum of the merchants' selling price and the cost of delivery. Even after the I.C.C. regulated freight rates, farmers complained that they were poorly and expensively served. Merchandise could be shipped by freight at a cost by weight and distance, with a 100-pound minimum charge; by express with one of the many express companies with unregulated rates; and by U.S. Post, with a 4-pound limit. Post was by far the cheapest, but not many orders could meet the low weight limit. And for all three modes of shipment the package was only delivered to the post office or train station. In many communities the rail station was the post office and often the

general store as well. If a farmer bought from Ward's, his local merchant and postmaster would know. But farmers' often-needed credit at the general store to buy essential items before the harvest, and they had reason to worry that buying from Ward's might jeopardize their credit.

The local merchants in the rural communities did not take kindly to their customers going around them to Ward's for dry goods and other staples of farm life, but they could not match the prices offered by Ward. As Ward's volume of business expanded, prices would fall because of Ward's volume discounts from manufacturers. Ward's prices in 1878 were lower than they were in 1872 (Latham 1972, 10). Every few years the volume of business expanded, forcing Ward to move to ever-larger quarters along with expanded catalogue offerings. Ward offered almost everything: farm machinery, saddles and harnesses, to fine fashions for the ladies. Business grew and by 1908 Ward's mail order house in Chicago contained more than 2 million square feet of space, with other service centers in other western cities.

While Ward's was expanding, competition grew. Sears & Roebuck grew from Richard Sears' small operation of selling watches to other rail station agents in 1886 into a firm with a large general catalogue in 1896. This was also the year that Rural Free Delivery (RFD) was first tried in a few regions of the country on a very limited experimental basis. The sales of both Ward's and Sears were constrained because of the inflated expense of shipping orders to rural customers. John Wanamaker, the famous Philadelphia merchant, appointed Post Master General in 1889 in the Benjamin Harrison administration, tried without success to obtain Congress's approval in 1891 for an expanded RFD. In 1890, 1891, and 1892 Wanamaker (Gibbons 1927, vol.1 282-283)

also sought permission for the Postal Service to offer parcel post, without success.⁵

When he was asked: “Mr. Wanamaker, why can you not inaugurate parcels post?” He answered:

There are five insurmountable obstacles: first is the American Express Company; second, the United States Express Company; third, the Adams Express Company; fourth, the Wells-Fargo Express Company; fifth, the Southern Express Company (Gibbons 1926, vol.1 283).

Parcels Post became an official activity of the Postal Service only in 1913, with approximately 300 million parcels handled in the first 6 months. The weight limit was upped from the original 4 to 11 pounds, with increases to 20 pounds soon after (Precious Packages-America’s Parcel Post Service). The current Parcel Post weight limit is 70 pounds, and other delivery systems such as UPS allow heavier and larger package.

b. The Coming of Suburban Living

With most mail-order delivery problems solved and the U.S. population expanding, the future appeared bright for Ward’s and Sears & Roebucks, the two biggest mail order firms, but a new disruptive technology was already on its way. It was the internal combustion engine and the widespread use of automobiles. Henry Ford alone sold more than 15,000,000 Model T cars between 1908 and 1927, when their production stopped, with most sales going to the home market of 106 million citizens in 1920 to a bit over 123 million in 1930. Few in retailing saw the implications of the automobile and the massive building of local roads. General Robert Wood was one of the exceptions. He joined Ward’s in 1919 and quickly was promoted from his initial position of merchandising manager to that of vice president. He was a West Point graduate who had

⁵ The service was originally called Parcels Post, implying parcels by post. Now it is called simply Parcel Post

served in the US army quartermaster corps in World War I and had been promoted to Brigadier General by war's end. From then on he was called General Wood. He thought strategically about the future of mail-order retailing, observing that with increases in farm productivity people were moving to the cities and the suburbs, and that their automobiles enabled them to live in the suburbs and drive to downtown department stores. He believed that people in the cities and suburbs would prefer to shop in retail stores rather than buying by mail. In a retail store they could actually touch the fabric and try on apparel before purchasing, or get the feel of a hammer or wrench. This was not possible in a mail-order-only business.

General Wood was unable to convince Ward's management of the validity of his vision for retail merchandising - Ward's likely believed that they should stick to their core competencies - mail-order retailing. Wood left Ward's in 1924 and went to Sears, first as head of factory operations. The first retail store experiment followed in 1925 and was a huge success leading to a dramatic expansion of retail stores. The 1928 Sears had opened 192 retail stores, and General Wood was promoted to president. General Wood imagined Sears retail stores would carry both hard and soft goods and be located not in the center of the city but near its perimeter, with easy access by car. He believed that people in the suburbs would always need shoes and hammers. Sears' retail stores naturally led to the mall form of retailing that we have today, and to combined store and mail-order retailing, a common retail marketing approach today.

By 1931 Sears had more than 350 retail establishments in addition to their thriving mail-order business. Ward's soon followed the Sears' retailing approach and

opened their own stores, but they were never able to catch up with Sears and closed for good in 2001.

III Modern Disruptive Technologies

The years of the great depression and World War II saw few major changes in retailing technology⁶. But in 1956 two seemingly disconnected events occurred that were to have profound effects on modern retailing and global sourcing of retail products: our Interstate Highway System and the shipping container.

a) The Interstate Highway System

Certainly when Congress passed the Federal-Aid Highway Act of 1956 no one could have foreseen clearly the future economic impact of the program designed to build 41,000 miles of broad and wide interstate highways. Perhaps President Eisenhower, the strongest backer of the Act, came closest when saying of the highway-building program in his memoirs:

More than any single action by the government ... this one would change the face of America. ... Its impact on the American economy – the jobs it would open up – was beyond calculation (McNichol 2006, 107).

It is now difficult to realize that as recently as 1953 only 53% of our 3,000,000 miles of highways – many just two lanes at best – were paved (McNichol 2006, 103). President Eisenhower came by his understanding of the importance of paved highways from his long military career. First, in 1919 he was part of a three-mile long convoy of U.S. Army vehicles - cargo trucks, ambulances, four kitchen trailers etc. It was undertaken in July 1919, just after WWI, to highlight the need for better highways for

⁶ Birdseye frozen food came on the market in 1930 but few could afford premium food products in the Great Depression. The super food stores of today with fresh produce and products from around the world were for the future.

defense. It took the convoy two months to make the 3000-mile trip across the country, over half the distance on unpaved roads. Then again in WWII General Eisenhower saw at first hand the value of the Autobahn to the German army. When he became president, he proposed building the interstate highway system as necessary for national defense, a very significant public policy undertaking.

The U.S. Interstate Highway system opened the Midwest and South to road transportation. The original system plan was to link all of the state capitals by interstate highways, and in time most were. The interstate highways, improved local and state highways, and the expansion of the U.S. fleet of cars and light trucks allowed people living in urban America to have great mobility. Sam Walton understood this and built his stores on the inexpensive land near local crossroads. He turned urban locations to his advantage. Governments paid for the roads that brought customers to his doors, and allowed trailer-loads of goods from U.S. and overseas factories to be brought quickly and easily, first to the distribution centers and then on to his stores. Figures 3a and b are maps showing the location of a typical Wal-Mart store at the crossroad of two Interstate highways or many stores near intersecting Interstate Highways and state highways.

Montgomery Ward in the 19th century used the then new disruptive technology of railroads to introduce mail-order retailing and achieve a comparative advantage with the rural local merchants located at rural crossroads. Then Sears Roebuck and Co. combined mail-order retailing with urban stores for suburban customers with cars in the 1920s and achieved a competitive advantage over Wards. Sam Walton used the disruptive technology of the U.S. modern highway system to provide low cost locations near urban and rural customers who could drive their cars and light trucks to his stores. Great locations in combination with forward looking supply chain practices, advanced technology of distribution centers, mainframe computers, bar codes, and tight inventory control through technology allowed Wal-Mart to grow to be the largest U.S. retailer by 1990. Naturally other factors and business practices were important to the growth of Wal-Mart; we have only mentioned a few of the technological contributors to Walton's success.

b) Shipping Containers

The second great disruptive innovation of 1956 was the birth of shipping with ocean-going containers. There have been articles in our newspapers for decades about the importance of intermodal transportation hubs bringing subway, rail, and surface bus service together at city centers. For the global flow of manufactured goods and produce the ocean link with rail and trucking has been the most difficult to achieve, and it took most of the last five decades to succeed.

Ocean-going containers, like most technological innovations important to retailing, did not begin with the goal of improving the way goods are shipped across the oceans. Rather it all began when Malcom McLean, the owner of one of the largest

trucking firms in the U.S. in the early 1950s, attempted to find a cheaper way to ship products to New York from the South. Because the Interstate Commerce Commission (I.C.C.) set trucking rates for all firms, a persistent focus on reducing operating costs was a primary path to higher profits and further expansion. In 1953 McLean had the revolutionary idea of sending his trailer trucks from North Carolina to New York and Boston by putting them on old WWII cargo ships. The I.C.C. had jurisdiction over coastal shipping and had allowed shipping rates to be significantly lower than highway trailer shipping because water way shipping was slower. McLean was the only person who saw the value of this rate discrepancy and he moved to take advantage of it. The Port of New York Authority was looking to expand its port activities and welcomed McLean to create a terminal at the Newark docks. McLean first thought to send trailers onto the ships, then trailers without their wheels, and finally special containers designed to allow them to be stacked and lifted from and onto trailers at each end of the sea trip. The first test of this final concept was held in April 1956 with the sailing of a converted WWII tanker, the *Ideal-X*.

The first voyage was from Port Newark to Houston with 58 containers on board. Special extra large dockside cranes had to be placed on shore to load and unload the 33-foot containers, but the trip was a great success. And as Levinson wrote:

For McLean, though, the real triumph came only when the costs were tallied. Loading loose cargo on a medium-size cargo ship cost \$5.83 per ton in 1956. McLean's experts pegged the cost of loading the *Ideal-X* at 15.8 cents per ton. With numbers like that, the container seemed to have a future (Levinson 2006, 52).

The entrepreneurial energy, drive, and skill required by McLean to make this into a successful venture is described in detail in Marc Levinson's marvelous, insightful, and

heavily documented book, *The Box*, Princeton University Press, 2006.

In 1956 few might have been willing to bet that McLean and others would be able to overcome the objections of the International Longshoremen's and Warehousemen's Union, the various port authorities, the I.C.C., the railroads and the local communities that had to allow the huge areas needed for current intermodal port facilities. But succeed they did, and now the biggest ports in the world are no longer London or New York. Singapore, Hong Kong, and Shanghai are the top three in terms of containers handled per year. In 2005, Singapore (List of busiest container ports) is reported to have handled 23,200,000 TEUs (twenty foot equivalent units)⁷.

The two largest U.S. ports, Los Angeles and Long Beach, are numbers 10 and 11 on the list of the busiest container ports in 2005; New York/New Jersey is number 17 with only 20% of the volume of Singapore. The port facilities to handle millions of containers per year can only be called gigantic. The cranes that lift the containers from the ship one at a time must be able to lift the 30,480kg of a fully loaded container and place it on a trailer that drives on the roadway between the legs of the crane. Seeing the cranes and the stacked containers in the port area waiting to be put on trains or truck trailers is believing; one can see them all at the Wikipedia site devoted to intermodal freight handling equipment:

http://en.wikipedia.org/wiki/Intermodal_freight_transport#Handling_equipment:

(accessed June 19 2008).

The Wikipedia "Container Ship" site lists the largest container ships in the world

⁷ While most containers are 40 feet long, 8 feet wide, and 8.5 feet high, container ship capacity is always reported in TEUs: a single 40 foot container is counted as 2 TEUs. Reflecting McLean's background in trucking, the container is sized for highway trucking and is wide and high enough for loading with standard forklifts.

through 2006. Loading container ships requires very large and specialized dockside cranes and Google Images responding to a search using “Container Ship Loading” shows many hundreds of images from which the scale can be deduced.

Currently (2008) the largest ship in the worldwide container fleet is the Emma Maersk, a part of the Maersk Line fleet; information about the ship can be found on the Maersk WEB site, and a picture and specification of the fully loaded ship at a container terminal is available at <http://www.kgomez.com/mystery/maersk.php>: (accessed June 19 2008). The ship is 397 meters long and 56 meters wide. It can carry 10,500 TEUs according to the company, but others list the capacity as 15,200 TEUs. The weight of the ship is about 1.5 times the weight of a modern U.S.A. aircraft carrier. The ship has 1,000 plugs for refrigerated containers, making it possible to ship vast quantities of meat and produce around the world. This class of vessel expends just 1 kWh of energy to transport one ton a distance of 66 kilometers; a jumbo jet, in comparison, could only transport one ton of cargo ½ kilometer on 1 kWh of energy. In other words, the largest and newest ocean going container vessel is 132 times as efficient in using energy to transport cargo as a modern airplane carrying freight. The ship requires a crew of only 13, making the operating cost very low. World-wide shipment by container continues to expand from 137.2 million of TEU in 1995 to 417 million TUEs in 2006 while the share of shipping to and from the U.S. ports has fallen from 16.3% in 1995 to only 11.1% in 2006 (U.S. Department of Transportation).

There are risks of loss of cargo with any method of shipping, and container shipping is no exception. *USA Today* wrote of thousands of bananas recently washing up on two Dutch North Sea islands after at least six containers fell from a ship during a

storm at sea (“Thousands of bananas wash up on shore”).

c) Railroads, Trailer Trucks, Shipping Containers, and Standardization

The shipping revolution caused by containers has allowed a corresponding revolution in retail sourcing. The impact on retailing would have been greatly diminished if it were not for the intermodal transportation facilities at major U.S.A. ports. McLean recognized this at the very beginning of the container revolution in 1956. Port Newark/Elizabeth has rail and road connections and a part of his original plan was to take his trailers off the ships at the port and put them on the New Jersey Turnpike, which has a ramp nearby. Rail connections to Port Newark predated McLean’s container activity. In 1953, when McLean was planning at first to ship truck trailer to Newark, he did not consider the Port of New York. Connections to highways from New York City are poor and it takes time to get out of the city, and time is money for shippers using any mode of transportation. For that reason container shipping is done at Port Newark and at the adjacent Elizabeth Marine Terminal in New Jersey. From the Port, containers can be sent by trucks on the highway or put on special railcars that can carry ISO containers double stacked. Having containers that meet international standards requires dimensional, strength, openings, and capacity standards. Perhaps the most important standards for container shipping are the details of corner posts with their special block at each end with holes at specified locations allowing the crane to connect with the container. The ISO corner blocks mean that cranes at container ports anywhere in the world can lower a frame over the container and engage the container after the operator flips a switch. Only internationally agreed upon standards make it possible to have ISO containers loaded and unloaded with a standard fixture on the crane. ISO containers can

be stacked one upon another with the load properly supported, and shipped double stacked on special low slung rail cars.

There are other ISO features that allow special forklifts to move containers around in the storage area and to stack them on rail cars. The electrical connections on a refrigerated container must be in the same specified place to allow electrical connection on board ship and on ground transportation. Global transportation requires that containers must be essentially interchangeable in all important features except for the name and identification code painted on the outside. Getting agreement on all of these container features took decades of discussion and persuasion. Some firms surrendered patent rights to make it possible for the “best” design to be adopted as the standard. Without standards of both hardware and documentation the current smooth international flow of goods would not be possible.

Without standards for containers and for communications the present international sourcing of products would likely have been greatly impeded. The international trade agreement worked out under the auspices of the World Trade Organization (WTO) has removed many of the import quotas on entire categories of manufactured products. For example, the WTO trade agreement removed quotas on apparel and textile imports from all WTO member countries on January 1, 2005. With the ISO standards in place for containers, imports into the U.S. have expanded despite remaining import tariffs. Exports of textiles and apparel from South Asia flow into the U.S. on container ships and then move onto railcars or truck at our large intermodal ports. They are carried on trucks to their final destination most likely on the Interstate Highway system. For long distance shipping the containers generally are stacked two high on trains. This shipping of goods

of all kinds happens without the product being touched by human hands from the factory in South Asia or farm in Chile to the nearby retail store. The present volume of global product sourcing has been made possible in large part because of international standards of all sorts of systems: hardware, software, electronic, communications, legal, and clear communication back and forth along the entire sourcing channel. International trade benefits from vast prior investments in multi-purpose infrastructures.

IV Technology and Supply Channels

a) Bar Codes – Internet - Lean Retailing

We have just described how products can be efficiently shipped from anywhere in the world to retail stores in the U.S., but we have not mentioned how the stores are able to efficiently manage inventory and order products from remote suppliers. The primary tools for modern supply chain management are product bar codes, Electronic Data Interchange (EDI) and the Internet coupled with modern computer networks. Again, most of these technologies were not developed for the market making purposes that we wish to write about.

The Internet, now an indispensable part of all of our lives, was begun in 1969 by the Department of Defense's office of Advanced Research Projects Agency (ARPA) as a project for researchers at one place to communicate with computers at another place. This led to the development of a communication network called ARPAnet. Soon after interconnection was achieved it was realized that messages could be sent, and email was created. Then, in the span of a few years, methods and standards for transferring files electronically were created and called FTP (File Transfer Protocol) and before that IP (Internet Protocol) and TCP (Transmission Control Protocol.) These initials are still with

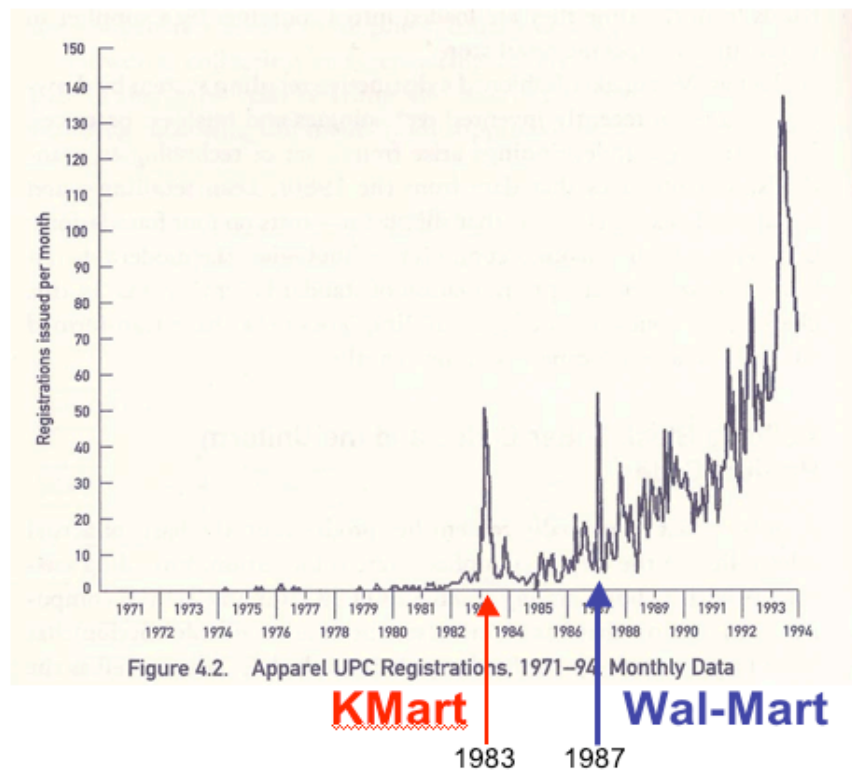
us and many more have since been added. Researchers created all of this to send messages to colleagues who had access to the ARPAnet. In 1986 the National Science Foundation created a high-speed network, first connecting just supercomputers and then other university sites. In December 2007, there were 383,702,883 Internet users in all of the Americas and 1,408 million users world wide according to (Internet World Stats). The Internet has become an essential tool of everyday communication in just a decade; now few would willingly give up the Internet.

The development of bar codes has been discussed earlier in this chapter. We wish to focus not on the role of bar codes at the checkout counter but its unique role in inventory and supply chain management. As mentioned before, bar codes were slow to diffuse into general retailing for a number of reasons. Chief among them were: 1) scanner systems were expensive and suited only for the checkout at supermarkets; 2) there was no incentive for non-food product manufacturers to purchase code identifications and to put the code on each item they made; and 3) general retailers did not at first see so-called hard saving if they adopted bar codes and scanners. The food product manufacturers were a part of the original industrial group that led the effort to develop bar codes and scanner systems. In fact, R. Burt Gookin, President of H. J. Heinz, was the chairman of the Ad Hoc Committee that led the development (Brown 1997, 42). The Heinz Company's leadership and its willingness to affix bar codes on its entire product line nearly assured other food product manufacturers' cooperation.

Food markets developed bar codes and scanners to increase the efficiency at the front end of their stores –the checkout counters - and reap hard saving from eliminating the item pricing in the states and communities that allowed simply shelf pricing.

Department stores and boutiques do not have checkout counters but mass merchants such as Kmart and Wal-Mart do. Not surprisingly, then, they were the first to try using bar codes. Figure 2 shows the monthly record of apparel manufacturers' registrations from the beginning of the UCC.

Apparel Bar Code Registrations*



* *A Stitch In Time*, Abernathy et.al, Oxford Univ.Press, 1999, p58

Figure 2 Apparel Bar Code Monthly Registrations

Mass merchants faced an immediate question of where cost savings were going to come from if they were to adopt bar codes and scanning, and who would put the bar codes on all of the items. There was also the problem of scanning large and heavy objects that would not easily pass the scanner at the checkout. There were only simple hand held scanners in the mid 1980s, and their operation was not as simple as the wands used today in most retail stores to supplement the laser scanners at the checkouts. The

pen-like scanning laser diode devices similar to hand held laser pointers required the clerk to sweep the pen across the bar codes to get a reading. But in 1987, patent number 4,694,182 called *Hand held bar code reader with modulated laser diode and detector* was issued to P. Guy Howard of Spectra – Physics, Inc. of San Jose, CA, that would lead, in time, to the ubiquitous hand held scanners in every department store and home center today. With these new scanners clerks need only aim the red laser light onto the code to be read. Generally a beep equals a successful read. The eventual availability of hand held scanners allowed each electronic register in a department store to easily use the bar code systems to check out customer purchases, and helped drive the adoption of bar codes and scanners in all retail stores.

The mass merchants had another far-reaching plan to recover the capital cost of the bar code scanner systems, and that was to shift some of their inventory risk to their suppliers. First Kmart in 1983, and soon after Wal-Mart in 1987, began to demand that their apparel suppliers affix bar codes on each item of apparel that they supplied. Naturally apparel manufacturers objected, saying that they did not need to do it for all of their customers and asking why they should do it for Kmart or Wal-Mart alone. There was the question as to who was going to pay for this new service. The Marts told their apparel suppliers that they, the manufacturers, were going to bear the cost; they must treat it simply as a cost of doing business with them. The Marts were very important and highly valued customers even though the manufacturers' margins were smaller with them than with their other customers. Manufacturers of branded merchandise and private label products reluctantly complied, and so bar coding began in the apparel retail trade. Mass merchants and department stores faced more daunting inventory tasks than did food

stores because of the low rate of yearly turns of their inventory. The Marts forced the apparel industry to be the first adopters of the bar code identification system after the food stores.

Bar codes and retailers' Point-of-Sale (POS) data from electronic cash registers made it possible to have accurate real-time inventory status. Inventory control is important for any retailer, but especially for department stores. Food stores might have 40,000 Stock Keeping Units (SKUs) while department stores might have 500,000 to several million. Macy's on New York City's 34th Street might have 2 or 3 million SKUs. The scale of the inventory problem is immense. Great university research libraries might have several million different books or SKUs on their shelves, but for a store it is important to know how many units they have of each SKU. A single volume of a given book is generally enough for a library, but more than one T-shirt of a given size is absolutely essential for the store.

To meet expected demand with an adequate number of units across an entire apparel collection is a staggering task. Over 10% of material in the classic book on retailing used at the Harvard Business School in the late 1930s is devoted to Merchandise Control (McNair et al. 1937, 211-262), the term used then for inventory control. If a food store has sold all of their cans of a particular kind of soup they can often get more in the next-day delivery from a chain's warehouse/distribution center where the necessary inventory of high turnover items is carried for next-day delivery. Most food stores' items outside of produce are in fact replenishable items. That is not the case for department stores: only a fraction of their items are replenishable. Before bar codes and lean retailing, a department store might need to carry a substantial inventory of popular basic

items such as jeans and underwear on the shelves of the store, in the back room, and in the central warehouse/distribution center. This is no longer the case.

Modern lean retailing requires detailed and complex relationships between a retailer and each of his suppliers of basic items (Abernathy et al. 1999). The retailer's central computer places orders with a supplier's computers on Sunday evening for a specified number of units of each SKU for each store in the area served by that retailer's distribution center. The manufacturer must pick and pack the order for each store placing the items in a carton for each store, with the correct bar coded shipping label. The code on the shipping container is a scannable bar code but not in the U.P.C. format. The code on the carton designates the particular store for which it is intended. All of the cartons for the many stores are loaded onto a trailer for delivery to the retailer's distribution center. Each distribution center might service 100 or more individual stores. At the distribution center the trailer backs into a specified loading dock at a time prespecified to the minute. A portion of the distribution center's power-driven conveyor system extends into the manufacturer's trailer and the driver unloads the cartons onto the conveyor. As a given carton moves along the power driven conveyors, laser beams scan the five visible surfaces of the carton looking for the bar code containing the precise code to allow automatic sorting. Gates automatically switch the carton onto the trailer designated for that store. More automated paperwork is actually done than has been just described; for example, there must be an open-to-buy order from the retailer to the manufacturer, etc., before any shipment will be accepted. The checking, verifying, and recording that at one time was all hand paper work is now accomplished with bar codes, laser scans, and computers. Cartons go from the manufacturer's distribution center to the designated

store's trailer without human intervention except for loading on and off the conveyor on opposite sides of the distribution center. Products are not stored in a distribution center; rather they are automatically transferred from the supplier trailers to the retailer trailers. A distribution center might have 100 or more docks on each side of a long narrow building; suppliers' trailers on one side of the building and retailers' delivery trailers on the other. Such distribution centers allow supplies to be "cross docked" – to go from the manufacturer's trailer to the appropriate merchant's trailers without human intervention.

Lean retailing and weekly replenishment of the basic items sold during the past week has shifted the risk of carrying inventory that did not sell from the retailer to the manufacturer of basic apparel. Manufacturers in turn minimize their inventory risk by maintaining short supply lines. Consequently most T-shirts, undergarments, and jeans sold in the U.S. are assembled in North America, while most fashion garments are single order and come from Asia. Communication in this global industry is rarely by surface mail; rather it is done electronically as Electronic Data Interchange (EDI), a vast system of formats for interchanging data electronically. *Wikipedia* has a brief but comprehensive discussion of EDI and a listing of the most common formats (*Wikipedia*, "Electronic Data Interchange").

EDI documents generally contain the same information that would normally be found in the paper documents that were used for the same organizational function. For example, an EDI 940 ship-from-warehouse order is used by a manufacturer to tell their warehouse to ship products to a designated retailer. It typically has a "ship to" address, "bill to" address, a list of product numbers (usually UPC codes) and quantities. It may have other information if the parties agree to include it.

There is one EDI standard in the US and another internationally. There are many different electronic forms; Figure 3 is but a single listing from *Wikipedia* of the EDI forms in the order series.

Order Series (ORD)

180	Return Merchandise Authorization and Notification
290	Cooperative Advertising Agreements
810	Invoice
816	Organizational Relationships
832	Price/Sales Catalog
850	Purchase Order
855	Purchase Order Acknowledgment
856	Ship Notice/Manifest
857	Shipment and Billing Notice
860	Purchase Order Change Request - Buyer Initiated
865	Purchase Order Change Acknowledgment/Request - Seller Initiated
875	Grocery Products Purchase Order
876	Grocery Products Purchase Order Change
877	Manufacturer Coupon Family Code Structure
880	Grocery Products Invoice
881	Manufacturer Coupon Redemption Detail
885	Retail Account Characteristics
887	Coupon Notification
888	Item Maintenance

Figure 3. EDI Order Forms

EDI and U.P.C. codes avoid the ambiguity and misunderstanding that plagued the supply and retail industries before the codes and the standards of electronic communication. Standards have increased the efficiency of the industry enormously. The old days, before bar codes, are described in the book celebrating the 25th anniversary of the development of the U.P.C. called *Twenty Five Years Behind Bars* (Haberman, 2001). A chapter titled *Scanning's Silver Celebration* by John E. Nelson describes what it was like for food retailers and manufacturers:

The retailers do have memories. They remember the armies of stock clerks stamping prices on every candy bar, and then restamping them when the next sale came along – every one of them! They remember the checkout clerks trying to read the handwritten pricing on those packages of T-bone steak, and reading \$1.45 instead of \$4.45, and losing three dollars on every sale. And they remember taking endless inventories; filling out paper reorder pads so that they'd know how much to reorder; and the huge amount of counting that went on as merchandise was received in the stores. All that tedious effort!...And the manufacturers remember. They remember receiving all those paper orders through the mail. Processing the returns and reductions when we didn't ship exactly what the customer had asked for because we couldn't keep track of all customers' numbering schemes, and we transcribed those orders incorrectly as they came in the door. And remember how difficult it was to track all of the inventory in our warehouses as it was picked and loaded onto our customer's trucks? (Haberma 2001, 26-7)

New Tools for the Market Makers

Buyers from North American department stores were sent to Europe on shopping trips in the middle of the 19th century. John Wanamaker could advertise in the Philadelphia papers that his store had the finest men's woolen fabrics from England and Italy and the latest women's fashions from Paris. Most of the sewn products were sewn locally from imported and domestic fabrics. Shipping costs from Europe were expensive relative to the value of the goods, giving an extra financial incentive to produce locally. The risks of carrying finished merchandise were entirely carried by the merchant, giving yet another incentive to produce locally – generally in the city itself – and order more if demand grew. In some ways 19th century cities were nearly self sufficient: near-by farmers provided produce for city populations, while cotton and woolen fabrics primarily came Lowell and Lawrence factories along the Merrimack River in Massachusetts and were shipped to New York and Philadelphia by boat and rail. The major factories of the time were located in sections of the cities closest to shipping centers, whether by rail,

boat, or barge.

The rate of change accelerated with the invention of the telephone, distributed electric power and lighting, and the automobile and with shipment by trucks over paved highways. The geographic reach of American retailers correspondingly increased. Manufacturers moved out of the city to less expensive real estate for their factories and workers. We have already discussed how the automobile led to suburban living, which put pressure on Wards because it remained too long an exclusively mail-order retailer. Detroit, because of its location close to steel mills, became the capital of US auto production. Cars were shipped from the factory to retailers by special rail cars and special trucks. At the beginning of World War II the federal government encouraged manufacturers to disperse their factories plants as a defense strategy.

For strategic reasons, after World War II the U.S. government expanded quotas for textile and apparel products from South Korea, Taiwan, Japan, and Hong Kong (but not China.) As described in Chapter 6, business people in these countries took advantage of this opportunity, and in collaboration with retailers they developed the capability of designing and sewing fashion garments for the U.S. market. These countries combined low factory wages with reduced costs of container shipping to create a comparative cost advantage in textiles and apparel. Visionary entrepreneurs of these countries became the new suppliers for buyers from U.S. department and discount stores. They became what are now called “full package dealers.” They began by offering to find desired fabric and sewing factories to produce fashion designed in the U.S. With the Internet, the details of the complete design with photographs and parts layout were sent instantaneously from the U.S. to South Asia’s full package dealers. The emailed information contained not

only pictures of model garments, but also the details of the layout of the individual pattern pieces ready for cutting. The Internet and its associated software created a fully integrated information supply channel, (cf. Abernathy et al.1999, Chapter 14: *Suppliers in a Lean World: Firm and Industry Performance in an Integrated Channel*, 263-280.)

The last piece of information technology integrating the ultimate customers to world-wide markets, and linking manufactures together with all of their vendors, is the World Wide Web. Like most of the technologies mentioned in this chapter, the WEB was not invented to help retailers or other market makers. Rather it was invented by Sir J. Timothy Berners-Lee, an English researcher at the European laboratory for particle physics in Geneva (CERN). This Internet-based tool was invented to allow researchers at CERN to share complex files, including hypermedia, that is, text, graphics, video, etc.. Berners-Lee did not file for a patent, making his invention available to all, and this spirit of openness has no doubt contributed to the explosive growth of the WEB. He was knighted by Queen Elizabeth of England for his invention, and in 2007 he received the highest US award for technology, the Charles Stark Draper Prize of the American National Academy of Engineering.

The WEB along with high-speed broadband communication networks, fast microprocessors, and the software search engines the WEB has spawned— such as Google and Yahoo— allow Internet users to find very detailed product information before making a purchase. Many WEB sites allow consumers, at their computers, to price-shop branded merchandise at retail, mail order, and e-commerce stores. Consumers can now look on the WEB at manufacturers catalogues, find lost product instruction manuals, and become nearly the economists’ old ideal of “the informed consumer.”

Most corporations and other organizations worldwide maintain WEB sites to provide information to the public and to allow authorized personnel easy access to proprietary information. The size of the WEB is growing with explosive speed as new uses continue to be developed. You can search the WEB to discover the current number of individual WEB sites and find several estimates putting the number over 100 million and the number of individual pages to be several billion. Certainly the market makers, described in later chapters, all find their activities enhanced by ready access to the ever-expanding Web from computers and cell phones. Our shopping opportunities have been expanded by the nearly limitless offerings of items, old and new, on eBay.

It is impossible to anticipate what new technology will be developed that will impact retailing, but this chapter gives example after example of technology developed for one purpose that was later incorporated into retailing. We can, however, confidently assume that new technology will be invented that will change retailing in important ways. New laws will be passed from time to time that impact retailing in one form or another, and retailers will respond just as they have in the past. New paradigms of market making will be developed which, like the market makers described in this book, were not on the horizon just a few decades ago. We can only be certain that changes will come.

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