

The History of Corrugated In the Beginning...

It all started more than 2,000 years ago, two centuries before the death of Christ. In China, a man named Ts'ai Lun, using waste products such as old rags, pieces of hemp-rope and discarded fishing nets, is credited with one of mankind's great achievements: **the invention of paper**.

From mankind's dawning moments on Earth, he has struggled to communicate. Stones, bones and even leaves were used to carry written messages in primitive times, but all these materials were tenable and difficult to store and transport. Then around 2,200 B.C., the ancient Egyptians discovered that a reed called papyrus could be used to create a much more stable and reliable writing surface.

Although the use of papyrus spread far beyond Egypt, animal hides continued to be used as vessels to carry the written word, as well. The skins of calves, goats and sheep were washed, stretched on frames and coated with chalk and lime paste, which helped to remove grease and hair. After drying they were rubbed with a stone to smooth the surface. The finished material was called parchment and was used throughout Europe from 170 B.C. onward. Fine-quality parchment was quite rare, so it was treated very delicately and was often used more than once.

These early writing materials served an immensely important purpose in the cultural development of mankind, but soon proved impractical. That is when, in 250 B.C., T'sai Lun began his experiments and introduced paper to the world. In the formative years of the second century, early Chinese papermakers laid pieces of the tender inner bark of the mulberry tree in a sturdy vessel, often a hollowed-out stone, and added water. Using hammers or clubs, they pounded the bark into a thick slurry of fibres suspended in water what today would be called pulp. The papermaker then poured this into a shallow mold with a sieve-like cloth bottom. When the water was drained away, a soggy mat of cellulose fibres was left on the mold. This was the first primitive form of paper. It was left to dry in the sun and then peeled from the mold.

In the 13th century, the art of papermaking had made its way to Spain, but it would take another 300 years for it to reach France, Germany, Italy and England where the first known British mill was built in Hertfordshire in 1490. In the European countries, a fine wire screen had taken the place of cloth as the porous bottom of the papermaking mold and linen fibres were substituted for mulberry bark, which is rare and difficult to attain in Europe.

The problem that remained with making paper by hand was that it was painstakingly slow. In the Middle Ages, all books were copied by hand, primarily on parchment and usually by monks who were among the few people who could read and write. The printing press, invented in the 15th century, brought about enormous change in communications. For the first time, books could be mass produced. This meant that great quantities of cheap paper were needed instead of the expensive parchment used for hand-written books. To meet the growing demand, papermakers were encouraged to speed up their production, but no real breakthrough came until the 17th century. That is when Nicholas-Louis Robert, in Essones, France, patented a machine in which a moving wire belt replaced the original wire-bottomed mold and made it possible to manufacture paper continuously and in great quantities. The machine that Robert built was taken to England and patented there in 1801 by Henry Fourdrinier, for whom modern-day machines are still named.

The invention of paper, and the opportunities it opened up for humankind, led eventually to the inception of another material that would open the doors for the advent of corrugated packaging: paperboard. In 1485, a printer in Rome, seeking to replace the wooden slabs that covered early books, made a much lighter, hard cover substitute by posting together the pages of old books and other scrap paper. About 100 years later, this pasteboard went into commercial production. At the tail end of the 15th century, book publishers discovered another method of making hard covers. They poured an unusually heavy layer of pulp onto the hand mold and dried it out to form a product they called “pulpboard,” what today is known as paperboard. This method spread through Europe and crossed the Atlantic with the American settlers.

Although a Fourdrinier papermaking machine was built in the United States as early as 1827, paperboard itself was made by hand until George S. Shyrock installed the first cylinder machine in his plant near Chambersburg, Pennsylvania, in 1831. Shyrock was soon cranking out binders board and boxboard at the rate of one-fifth tons a day.

Paperboard production was executed solely on cylinder machines, like the one below from 1886, until the Fourdrinier endless-belt process was adopted for its production in 1911.

Manual Methods: The nascent days of the corrugated industry were exemplified by pioneers who made everything by hand-including their own machinery-and who dreamed of faster methods of production. Beginning in 1838, Colonel Andrew Dennison used this cobbler’s bench (shown left) in Brunswick, Maine, to manufacture jewelry boxes to complement and protect jewelry and watches sold in his son Aaron’s retail shop in Boston, Massachusetts. Colonel Dennison used a shoe knife and an awl to score whatever stock he could secure.

A Family Affair: At times, when Colonel Dennison longed to spend time away from the cobbler’s bench and spend time with family, he would cut the blanks by hand, holding them on his lap. After cutting the blanks, his daughters, working out of their small home, would finish the boxes. A significant interchange of handwritten correspondence between father and son helped to coordinate the family’s efforts.

The Cutting Edge: In 1884, the father and son combined their efforts to create a device called the “half machine,” which spelled the end of hand cutting of corners. Blanks were cut to size and placed into the machine, which scored and cut one corner at a time with four downward motions. It was known as the Dennison scorer and cutter.

Improving the Cutting Edge: In 1850, a hand shear was developed as an improvement over the cobbler’s knife for cutting box blanks. The shear soon became the main tool in the production of boxes and later would inspire George E. Jenks of Lafayette, Indiana, to name his magazine SHEARS. Before power cutters became numerous, a single box plant might have a battery of as many as eight or ten shears, all operating at once.

Peddling Paper: In 1864, immediately after leaving military service during the Civil War, in which he served on the Union side, Robert Gair started a paper merchant business. At that time, before the introduction of Dennison’s jewelry boxes, the paper business was the packaging business because goods were wrapped in single sheets of paper or put into bags fabricated from heavy brown wrap. At right is his first account book. In a decade’s time, Gair would be the foremost pioneer in the production of corrugated.

Patented Pleats: Corrugated packaging was initially produced by young girls who hand-fed sheets of strawboard through very simple bench-mounted machines that closely resembled those then in common use by laundries to pleat and crimp the edges of window curtains and the lace cuffs and collars of shirts and blouses. Samuel G. Cabell received a patent in 1866 for a laundry machine for fluting linen and laces. Comprised essentially of a pair of hollow, fluted brass or bronze rolls that were heated by inserting hot

rods or pokers and driven by hand crank, this machine was soon to be used in the production of the first corrugated.

Flexible Flutes: Corrugated paper material was patented in 1856 in England by Edward C. Healey and Edward E. Allen. The material patented was a form of fluted material for the sweatbands of hats. As a packaging material, it would be another 15 years before its introduction. On December 18, 1871, Albert L. Jones obtained U.S. patent 122,023, which envisions the use of unlined corrugated paper, formed with tubes and small boxes, for packaging small fragile articles such as glass vials and bottles. This packaging was resilient, lightweight, clean and inexpensive, and a market was promptly created for it. But it was dimensionally unstable and difficult to control due to its extremely flexible, stretchy nature.

A Profitable Patent: This disadvantage was brought under control a few years later by Oliver Long, who introduced one stabilizing facing sheet (single face) that helped to strengthen the corrugated sheet (later to become known as medium) and soon thereafter a second facing sheet. And so with Long's issuance of U.S. patent 150,588 on May 5, 1874, double-faced corrugated was invented. Interestingly, his patent clearly illustrates a sheet of double wall. The several patents covering this new product were acquired by three manufacturers-Robert H. Thompson and Henry D. Norris, who subsequently joined forces and formed Thompson and Norris Co., and Robert Gair, who founded the Robert Gair Co. These two companies, which operated in the New York and Boston areas, enjoyed a substantial monopoly for almost two decades due to their control of the patents.

Both companies realized that the protection afforded by their product patents would be short-lived, therefore they made extensive efforts to develop new and better equipment, which was built in their own shops and kept secreted away as much as possible from competitors.

Packaging Pioneer: Robert Gair, (at left, posing in his old Civil War uniform years after the war) is considered the father of the folding carton and was one of the pioneers of the corrugated industry. He is credited with developing the regular slotted style box in addition to the glue-end folding carton.

Gair came to America from Edinburgh, Scotland, on a sailboat to work with his father as a plumber in New Jersey at the age of 14. He later worked in New York at a retail dry goods store in the 1850s before serving in the Union Army and subsequently starting his own business.

In 1879, an improper make-ready by one of his pressmen, who was printing seed bags, led Gair to the discovery of the cutting and creasing process. Gair noticed that the printing rule, which was built up too high and had cut through the sheet, could be replaced by a specially made set of knives and rules and could intentionally be used to cut and crease box blanks. This was a decided improvement in comparison to the previous method of diecutting a lift of blanks and then hand-feeding them through a platen press for creasing. Later that same year, on April 10th, he applied for a patent (below left), but over the years he would never pursue it. In his patent application, Gair stated that he was the first inventor of an "improved apparatus for cutting and creasing paper in the manufacture of paper boxes." On a drawing that accompanied the application, Gair had clearly outlined his plans for cutting knives and creasing rules. The sketch of dies, locked in chase, outlines a carton blank, while profile views show how cuts and creases coordinate to shape a blank, ready for folding. Gair's Aldine press (below right), which currently resides in the Franklin Institute's museum of inventions in Philadelphia, Pennsylvania, was the first machine that he converted to cutting and creasing following his discovery of that technique.

A Sticking Point in History: The early machines in the Thompson & Norris and Robert Gair plants, who controlled the early corrugated (ate patents were 12 in to 18 in. wide, and as they grew Parger were belt-driven from overhead line shafts. Larger diameter rolls were heated first by gas jets and then, because of the fire hazard, by steam.

The facing sheet or sheets were coated by hand, using brushes similar to the paperhanger brushes still in use today, with a cooked flour paste. The fluted sheet was then carefully placed in position and patted-or gently rubbed-down. Since the adhesive set-or bonded-by evaporation, and a very considerable amount of water had to be disposed of, a drying period of 24 hours or more had to precede any subsequent operation. Sheet sizes were quite small because corrugated was used only for inner packing. The outer container was typically a wooden box, shoox or barrel.

Single face was first produced in a continuous web in approximately 1880, one face of the liner being completely coated with adhesive applied by a row of stationary brushes. One of the first machines to apply adhesive to flute tips was patented by Robert Thompson on June 7, 1890 (U.S. patent 430,447, shown above). In this process, the fluted web was drawn over a driven adhesive applicator roll, allowed to drop down on the liner, and the resulting single-face web was wound up into a roll and taken to a drying room.

Basically these machines, in addition to the adhesive mechanism, comprised two or three hollow, fluted, heated rolls, vertically disposed, running in plain brass bearings, all carried in rather light cast-iron side frames. Rolls of both medium and liner were carried on shafts mounted on the side frames so as to provide for as short a draw as possible.

A Marketing Tool: Gair understood early on the mass-merchandising significance of box and carton packaging, such as the cartons shown above that his company was producing in the 1890s. In a letter Gair wrote to an acquaintance in England, he clearly prophesizes the ways in which the corrugated industry would struggle with graphics in a changing retail environment much later in the 21 st century. "I added designs by printing, lithographing and embossing to the exterior of the folding box, thus establishing a standard whereby the merits of the contents could be judged. I began with one artist; today there are 30, and throughout the industry there is competition in the aesthetic, as well as the practical phase."

A Variety of Applications: At the end of the 20th century, as evidenced by these illustrations from one of Robert Gair's catalogues from the mid-1890s, corrugated paper was used primarily for packing purposes as shipping cases were not yet developed. About his company's corrugated products Gair wrote in the catalogue, "The dry goods trade will find our single-backed corrugated paper packing just the thing for protecting silks, satins, velvets, plushes, etc." The material shown at top left was available in 250-ft. rolls, in widths ranging from 25 in. to 40 in. Gair is credited with the first manufacture of AAute corrugated in 1897.

Square, round and octagon corrugated tubes (center left) were manufactured by Robert Gair Co. and supplied with top and bottom pads to fit into packing cases. But the company advised that top pads were not necessary if the bottle to be wrapped in the tube had a projecting cork. "Proprietors of patent medicines and others engaged in the bottling will find these tubes invaluable," read the catalogue.

Both single- and double-faced corrugated (center right) were recommended for use inside wooden cases for protecting bottles. Partitions were provided between bottles.

In the waning years of the century, Robert Gair Co. began producing corrugated cartons and bottle boxes (bottom left). These containers featured not only side protection but also "absolutely safe covers," according to the company. "Bottles so packed may be relied on to reach their destination intact." Corrugated wrappers featured an outer paper with a gummed surface for sealing purposes (bottom right). Corrugated packers were manufactured for such uses as outer protection for candy boxes being expressed or mailed. The company emphasized both strength and economy as features of these packers.

A Bright Idea: In 1894, C.W. Gay, a machinist from Brightwood, Massachusetts, invented an automatic box machine that would later become known as "The Brightwood." Gay was aided in his endeavor by L.W. Brown, a Springfield, Massachusetts, box manufacturer. An article in the Springfield Republican

reported that “in the upper story of the Birnie Paper Works Co., Brightwood, Massachusetts, there is a newly invented automatic box machine that seems likely to revolutionize the box industry. Paper boxes from 2 in. x 3 in. to 8 in. x 18 in. can be turned out, complete with bottoms and covers, at a rate of 20,000 a day. The machine feeds itself from a pile of cardboard, picks up a sheet at a time, glues the corners and carries the paper under a plunger. In an instant, the operation of folding and pressing the corner together is done in a folding throat.” It was then expected that Brown and Gay would form a company to manufacture these boxes. The reporter at the times struck an enthusiastic note: “Paper boxes in the future will be used by tradesmen of all sorts and will be so cheap that every day a laborer can have one in which to carry his dinner.” When first developed the Brightwood was capable of producing 5,000 to 7,000 boxes daily.

A Freight Ticket: The Climax bottle wrapper, produced by pioneer box manufacturer Hinde and Dauch Paper Co., was a patented bottle wrap that was later used as a lamp chimney wrapper. The Climax is important because in 1897, through a technicality, it introduced corrugated boxes to rail freight shipment. The first official exception to freight classifications. the use of corrugated boxes for cereal shipments, was made in 1903. An exception was made for fruit jars in 1905.

From Start to Finish: A main attraction of the 1893 World’s Fair in Chicago was an exhibit provided by American Box Machinery Co. that showed a complete box factory in operation, making finished boxes from raw board. American Box was given a diploma for its efforts as was Inman Manufacturing Co., Amsterdam, New York, (above) for its telescope box machine.

Full Steam Ahead: Philip Hauck operated this “steam paper box factory,” which had an 80-hp steam engine powering its machinery. Hauck moved to the location pictured at left, on North Fourth Street in Philadelphia, Pennsylvania, in 1885. It was subdivided into four floors and a basement, each 60 ft. x 100 (t. Steam served Hauck well as in busy times his plant employed 200 workers and had a capacity of 20,000 boxes a day.

Enter: Independent Machine Shops: In 1895, Charles F. Langston built a single-face corrugated paper machine for David Weber, a pioneer Philadelphia, Pennsylvania-based corrugated board manufacturer, who used the machine to make board for packing material. It was the first such equipment built by an independent machine shop rather than by a board manufacturer.

One of the first of the new machine concepts in this first decade of the 20th century-and certainly one of the most important-was the pressure roll single facer (above), built and patented by Jeffrey T. Ferres of Sefton Manufacturing in Anderson, Indiana, on September 4, 1900 (U.S. patent 657,100). It produced single- and doublefaced corrugated in a continuous operation.

Brewery Tours Were Popular: A common activity for box manufacturers assembled at early convention meetings were tours of breweries. The Western Paper Box Maker Association, shown above, took a trip to the Anheuser-Busch brewery at a meeting in 1895. Records of other conventions indicate that streetcar rides to the local breweries became ritual. The conventions of the time were attended primarily by top management.

Praise for Corrugated: The use of corrugated containers was gaining momentum as evidenced in this letter received by Thompson & Norris from Lydia Pinkhams Vegetable Compound in February 1895:

“Your letter of Feb. 4 regarding our long use of your corrugated cartons is received. Yes, it is a long time. We commenced their use in January 1881-over 14 years ago. Before using them, we lost a great deal from breakage especially in our Winter shipments to Canada and the Northwest from freezing, but since that time we have not had a single loss from that cause that I can remember.”

"I have several times known a case of our Compound falling on the pavement from the top of a full load without breaking one single bottle out of the dozen.

"As compared with our former method, I do not think that the corrugated cartons cost us anything, as the saving from breakage together with their other advantages, I consider a full equivalent.

"You have doubtless noticed by our increased orders that we still live, 1894 being our banner year; but from present indications, 1895 will be better still. By the way, I have the same young man rolling up bottles in the cartons and it would pay you to come on here just to see him work; he very often does 2,000 a day and you know we use the open cartons, which cannot be wrapped as quickly as those closed at the corners.

"I do not doubt but that the closed cartons would be preferable in many respects, but our hands have worked into the way of wrapping the kind originally adopted and we have never thought best to make any changes, particularly as the effect and appearance when wrapped is the same in both cases.

*"Very truly yours,
The Lydia E. Pinkham Med. Co.,
By C.H. Pinkham President."*

Corrugated "A Good Thing": In the early years of corrugated development it was discriminated against by many customers as well as freight carriers. After drivers had refused to accept corrugated containers, express carriers approved their use as evidenced in the letter (at left) to Thompson & Norris from Wells Fargo & Co., Express, New York, in May 1895. States the letter, "Replying to your favor inquiring as to the reason your boxes are refused by our N.Y. drivers, while we have accepted them without any controversy.

"I cannot see why our men should refuse, as I consider your box fully strong enough to stand even more than ordinary handling, and we will accept all you can give us, with pleasure.

"If the drivers still refuse to accept some, kindly so advise me and I will take the matter up with our General Agent, Mr. Stedman in N.Y. city, at once.

"I have tested your box, and the resistance it shows is surprising. As the expression goes, I think you have a good thing. Push it along.

*Yours truly,
W.B. Lindsay, agent"*

A "Modern" Box Plant: Late Victorian box manufacturing is exemplified by the drawings (at left) of scenes in a paper box plant in 1894. First came scoring of strawboard and, after that, gluing took place. As boards were pasted, blanks were formed that made ends and sides of boxes. Next, on a rotary cutter, board was cut to sizes required for box depths. Corner-cutting (by machine) followed, and after that came ending of the boxes. The final operation was the covering of boxes, unless box orders called for pasting or gumming of labels. Steam power ran machines at the plant, which typified large-scale production of paper boxes of this time. Other features included the use of flour paste at gluing tables and straw board for raw material. From 10,000 to 50,000 boards could be scored daily; competent corner-cutting operators could cut out some 20,000 boxes a day; expert covering operators could cover 3,000 boxes daily, and for labeling, machines could glue from 10,000 to 40,000 labels per day.

"Elegance" in Paper: Eugene Gerbereux, New York paper box entrepreneur, operated his company from this building at 214-218 Sullivan St. In front can be seen two heavily-loaded box wagons with their

tailboards down and boxes stacked to ends. This building, regarded as “elegant” by observers of the day, went up in 1899. As there were no alleys, wagons loaded in front.

At the Turn of the Century: The average box plant looked much like this (above) in 1901. This photo was taken at the Kansas City Paper Box Co., Kansas City, Missouri, not long before the company was sold to National Paper Box Co., a branch of the A. George Shulz Co. in Milwaukee, Wisconsin.

The Pridham Case: A landmark decision for the future of the corrugated box as a shipping container came in 1914 with the Pridham Case. Until that time, the railroads, which had vested interests in lumber, demanded a penalty on shipments in fibre boxes. Seeking to remove the penalty, in 1912, the R.W. Pridham Co., which planned to locate a plant in Los Angeles, California, petitioned the Pacific Coast railroads for the same rates eastbound for goods packed in fibre boxes as goods packed in wood boxes. Pacific Coast railroads denied the petition, and the Pridham Co.-backed by other fibre box plants-appealed to the Interstate Commerce Commission, which subsequently ruled on April 6, 1914, that there were no differences between the movement of commodities in fibre and wood boxes and removed the excessive tariff. This decision came in spite of the power held by the railroad and lumber industries at the time and paved the way for the young corrugated box industry to compete with its wooden counterparts. In ending the discrimination against corrugated shipping containers, the Pridham decision allowed corrugated to evolve from its earlier role as merely a substitute material into the shipping vehicle of choice.

The Double Facer: On February 4, 1908, Samuel M. Langston received a patent (U.S. patent 878,403) for a double facer. In this machine, the single face web, after an applicator mechanism had applied adhesive to the flute tips, was brought into contact with the double-face liner at the entry of the machine, and the combined webs were then drawn over a series of heated plates by an arrangement of top-and-bottom heavy woven cotton belts.

Immediately following the hot plate section was a tractor, cooling-tempering section, where the combined web was supported by a bottom belt carried on a bed of idlers. Both top and bottom belts were powered by a pair of driven pulleys at the rear of the machine.

The top belt, ballasted by a series of idlers, extended the full length of the machine. Over the heating section this arrangement kept the corrugated web in intimate contact with the heated plates, providing for good heat transfer and holding the single face web and the bottom liner in firm engagement. This firm engagement, vital to a good bond, was maintained also in the tractor, cooling-tempering section, which conveyed the web without slippage and crushing to the cut-off mechanism.

Mergers and Acquisitions Nothing New: The trend of mergers and acquisitions within the corrugated industry is not a recent one. This “Superman” of folding carton and corrugated boxes was anticipated in 1902 with a huge merger of as many as 15 companies, many of them illustrated above. With a capitalization of \$9 million, the newly formed company was to be called Paper Goods Co. of America. The merger was never to materialize, but the mentality that went into its creation clearly was a harbinger of things to come.

Industry Associations Always Strong: The industry associations were an integral part of the industry from the beginning. The opportunity to mingle with peers, to learn from one another and to share operating experiences was a strong draw. This 1917 announcement was sent out to encourage boxmakers to participate in the Western Paper Box Manufacturers Association meeting in Chicago of that year.

Alternative Packaging Always a Threat: The corrugated industry has always felt strong competitive pressure from suppliers of alternative packaging. In the 1920s, a 48-page booklet was published in opposition to paperboard packages. The anonymous publication never referred to corrugated by name but instead simply referred to it as “the substitute.”

Perpetual Price Cutting: Perhaps no topic has been such a great source of discussion--and anger--through the years as that of price cutting. The illustration (above right) shows the level of infighting that occurred as each boxmaker in the circle blames the next guy in line for cutting prices. In the middle is George R. Browder, a long-time association executive, who maintains his neutrality.

Only the clothing dates the accompanying cartoon, which was published in the August 1922 edition of SHEARS. It shows the ageless character, the price cutter, bearing an axe marked with the word "Ignorance", chopping into a tree that represents the paper box industry. The man on the ladder, which is marked as the "Knowledge of Costs" is picking money from the tree and putting it into his "Legitimate Profits" basket. At the bottom right corner, "Greed" is seen encouraging the price cutter to "Hurry, Hurry."

Decades of Innovation: Completely automatic folding, squaring and taping made its debut in 1947. Maximum production of 150 blanks per minute was achieved, sharply reducing labor to two or three men. But at higher speeds, tape placement was inaccurate; this, among other factors, led to the development of the glue lap joint around 1955.

The next 10 to 12 years then saw a flurry of development in the corrugated industry, with the introduction of the CMT test for medium in 1952; the introduction of triple-wall corrugated board in 1953 and preprinted liners for corrugated in 1955. The fully automatic diecutter appeared in 1956, and E-flute corrugated entered the scene in 1957. By 1958, speeds of 500 fpm were achieved on corrugators and in 1962, rotary diecutting of corrugated was born.

Flexographic printing inks then added a new dimension to the corrugated industry: printer-slotter operations were added to the foldergluer to produce a single printer-slotter-folder-gluer. In 1959, S&S introduced the first complete finishing machine that featured fully automatic operation.

In 1967, in an historical article written for Boxboard CONTAINERS, author Harry L. Cohen, suggested that "with the continuing trend toward consumer acceptance of products in corrugated, there will be increasing emphasis by box buyers on the design of the shipping container. The box will be viewed as a display-shipper, rather than merely as a container. As a result, there will be more interest in printing, diecutting and other specialty operations. Trends in merchandising include greater use of shippers which will also serve as displays." This perceived trend proved to be true, leading the industry into the development of graphics technology that could be applied to corrugated and launched the graphics revolution.

Few packed items appeared in the shelves of this A&P store (facing page, top) in 1890. Most foods and goods were sold in bulk; customers carried home their coffee, tea, spices and dry foods in paper bags. The major trend from bulk merchandising to unit-packaged distribution had not yet started at this point.

By 1910, as evidenced in this A&P store (facing page, middle), unit packages had come into their own. Although a large number of items were now packaged in individual-sized packages, barrels had not yet passed from the scene.

By 1950, the shelf of this A&P store (facing page, bottom) reflects the attention to marketing that now went into box and carton design as each product vied competitively for the eye of the consumer.

By the 1990s (above), the clerks were gone from stores, and it was up to the package, more so than ever, to be the sole salesperson for that product.

Perhaps the largest explosion of change ever experienced by members of the corrugated industry has occurred in only the past 10 years. Dramatic shifts in the retail environment in markets around the

world have led to the need for corrugated packaging to function-and communicate-in ways never before imaginable. These developments have also caused the irrevocable blending of the historically segregated corrugated and folding markets into one inclusive packaging industry.

Throughout the long history of corrugated packaging, the retail environment remained fairly static. Every store had a clerk, or a multitude of clerks, who assisted shoppers with their purchases, explaining all the products to them, providing them with important buyer information on everything from teapots to toasters. That changed in the 1980s. Large superstores soon dotted the landscapes of many cities, in metropolitan and suburban areas alike. The way in which goods were being sold to the consuming public had changed, and it appears that the metamorphosis is irreparable.

The road to high graphics on corrugated has been strewn with innovative machinery introductions and pioneering boxmakers who &6 no fear experimenting with printing methods never before attempted in the corrugated industry.

In the late 1800s, Francis X. Hooper designed and built a press for stamping ink identification marks onto the wooden planks of shipping crates using inked metal type known as printing dies. These presses were similar to the modern printer-slotter. Around the turn of the century, the George W. Swift Co. made presses that could print on solid fibreboard.

Printing dies actually were embossing dies that printed by making an identifying mark; they embossed the wood and left the ink behind. This later was adopted by the corrugated industry and developed into the "longway" letterpress printer. For many years, only letterpress paste inks were used. Ink drying was slow and caused diecutting and finishing delays until the ink was dry. By the early 1950s, most box plants had two or three letterpresses that were the main-if not the only--way to print on corrugated. By the early 1960s, flexography stood on the threshold of a new field-printing on corrugated. Today, approximately 95% of corrugated printing is done flexographically.

The driving force behind flexo printing was the move to increase speed and combine printing and finishing into one step, not to improve quality. Letterpress machines used oil-based ink. With the introduction of the flexo printer folder-gluer in 1955, there was a need for fast-drying fluid inks. The waterbased formulations used in flexo inks were soaked up by the thirsty board, making for nearly instantaneous drying (6-10 seconds), fast enough to cope with the increasing operating speeds of the new machinery.

The introduction of bar codes for product identification during shipping and warehousing was one of the first major developments that led to the increased need for better printing on corrugated. The intricate and detailed nature of the bar codes required increasingly accurate printing. Registration accuracy of machinery had improved to 0.0001 of an inch, and many boxmakers experienced their first taste of fine printing.

Then, seemingly overnight, the retail environment changed, and so did the corrugated industry. The challenges inherent in printing on combined board, most notably the effects of fluting, drove the need for a substrate more accommodating to direct print. And so the small-flutes were born E-flute, followed by F-flute and more recently such specialty flutes as G- and N flute, allowed corrugated boxmakers to attain levels of quality that would have been impossible just years earlier. There was another residual effect of these smaller flutes, one that sent tremors through two industries. The lines between the corrugated and folding carton markets had been blurred for years, but with corrugated's rising level of printing quality-and its superiority in strengththe wall that separated these two industries weakened. And now that many folding carton plants in the past few years have started running these smallflute corrugated sheets through their own existing equipment, that wall may finally have tumbled forever.

In fact, an increasing number of both "boxmakers" and "cartonmakers" have opted to relinquish this nomenclature in favor of more generic-and all encompassing-monikers such as "packaging professionals."

Paperboard packagers are more attuned than ever to the needs of customers and to the urgency of remaining flexible. The methods of printing on corrugated will undoubtedly continue to improve, to become more refined. This market-driven phenomenon has only just begun, and it seems certain that the story the corrugated market will tell in the 21st century will be a colorful one indeed.