The Origins of Paper Based Packaging

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Three key technological inventions in the 1800s set the stage for the mass production of paper based packaging by the end of the century: the paper making machine, the process for pulping wood and lithographic printing.

The paper-making machine and the process for pulping straw, wastepaper and wood provided the cheap materials. Lithographic printing dressed them up to match the advertising that was also largely printed on paper.

These inventions reduced the cost of paper enough to make it useful for a wide range of disposable packages. They stimulated the invention of packaging forms and processes. These inventions came at the right time to supply the growing demand for packaging due to the growth of manufacturing and distribution of consumer goods. Paper gave Marketing the opportunity to capitalize on the Industrial Revolution.

Wood fibers form the basis for the most widely used packaging materials in the world. Paper-based packaging is particularly significant in North America, with its abundant forests and well developed paper industry.

Paper, paperboard and corrugated board account for 55% of the mass and 49% of the value of all of the packaging material used in the United States. Of the nearly $46 billion worth of paper-based packaging materials produced in the US in 2000, the largest in volume and value were corrugated fiberboard shipping containers, representing almost 80% of the mass and over half (54%) of the value. The second largest in volume were folding cartons, at 18% of the value and 14% of the volume, followed by converted wraps (8%), labels (7%) and bags (4%) (EPA 2003 & Rauch 2002).

Worldwide, the pulp and paper industry uses about 42% of the global non-fuel wood harvest. Of that, packaging uses about 48% (Abramovitz & Mattoon 1999). In the US, 33% of the wood harvested is used for paper and paperboard, and 47% of that is used in packaging (US Census 2002).

Paper and paperboard play well-dressed roles in our economy. Their printability is their prime asset. They contain, protect and advertise all kinds of products, from cereal to electronic games. They have been responsible for the dazzling graphic display in retail stores for the past century, providing substrates for colorful brand and advertising communication on bags, cartons and labels. The food pictured on a prepared food package can stimulate appetites and sales. The information can instruct and save lives.

The roles played by corrugated fiberboard and kraft paper are less glamorous, but no less significant. Corrugated fiberboard boxes are the shipping containers of choice for most products in many supply chains in the world today. Efficient transport, material handling, storage and inventory control depend on their strength, dimensions and printed symbols.

Paper, paperboard and corrugated fiberboard are significant materials in the history of packaging. They have played a key role in the development of the USA and its commerce during the 20th century. And commercial growth, in turn, has played a key role in the paper based packaging industry's development.

But wood fibers have been used for only a short part of the history of papermaking. A persistent theme throughout history is that packaging is made from the lowest cost materials. But most paper was, for a long time, too expensive to use for packaging. It was handmade from rags for 17 centuries after its invention. Paper use was hindered by the laborious process of papermaking and the limited supply of raw materials.

This paper aims to show how papermaking inventions in the 19th century played a significant role in the development of the paper based packaging industry which led to the 20th century consumer packaging revolution and the age of modern marketing.

The Invention of Paper for Writing[1]

The earliest paper-like material used for packaging was *papyrus*, used as a writing material by the Egyptians,

[1] The history of papermaking is well documented, especially with respect to printers' paper. Unless otherwise noted, most of the facts in the papermaking sections are found in Hunter 1947, Hills 1988, Weeks 1916 and Bettendorf 1946, although these are not referred to throughout the text. It should also be noted that in some cases reported dates vary by a couple of years from each other since inventions and new equipment installations take place over time, and only patent issue dates are documented.

Romans and Greeks from 3000 B.C. Papyrus is made by laying parallel thin strips from the heart of the tall highly fibrous papyrus plant, with a second ply laid perpendicular to the first The sheet is pressed flat and/or pounded, removing the water and crushing the plant cells, liberating a natural gum adhesive that glues the strips together.

The lowest grades and recycled papyrus were used for packaging. The Romans recycled papyri for wrapping incense, a clever marketing move since the papyrus itself smells nice, especially when burned. They used a cheap grade of papyrus, called *charta emporetica,* for wrapping merchandise. Pliny, writing in the first century AD, tells how it was made from the lower quality outer layer of the plant, useless for writing, and was sold in sheets 4.3" wide, half as wide as finer writing paper (Lewis 1974).

Although our word *paper* comes from the Greek word for it, papyrus is not a true paper in the sense of macerating and blending fibers. But the development of both were motivated by the same need for a writing substrate in cultures where the need for documentation was growing.

Paper as we know it originated in China in 105 A.D. The earliest process known is attributed to Ts'ai Lun. It was invented as a calligraphy substrate, as a substitute for fabric and bamboo strips. Calligraphy was already one of the highest forms of Asian art and scholarship, and it led the craft of papermaking to grow throughout China, Japan and Korea over the next several hundred years.

Ts'ai Lun's method is the essentially same as that used for making paper today. He shredded the inner bark of mulberry trees, softened it with lime, mixed it with scraps of linen and hemp, and then beat it into a pulp. Mulberry was plentiful in China, cultivated as the food source for silkworms, and the inner bark was porous and easy to pulp. Water was added to the pulp, and a sheet mold with a woven floor was dipped into the mixture. The water was allowed to drain through the porous cloth, leaving a mat of fibers. The molded paper was dried in the sun, and then removed from the cloth.

It took several hundred years for the ancient Chinese art of papermaking to reach the West. The reputation of Chinese paper was widespread, but the technique was not. In 750, Chinese knowledge about papermaking reached North Africa from prisoners taken at the battle of Samarkand. The first recorded use of paper for packaging was in 1035, when a Persian traveler visiting markets in Cairo noted that vegetables, spices and hardware were wrapped for the customer after they were sold (Hunter 1947).

The Moors introduced papermaking to Spain and Italy, and the first European paper mill was built in Xativia (on the Mediterranean coast near Valencia) in the 1100s. Papermaking reached Germany and France in the 1300s and 1400s. It came late to England where John Tate's mill in Hertfordshire was the first, built in the early 1490s.

Before that, documents in the West had been written on parchment and vellum, made from the skins of sheep, goats or calves which were treated with lime, scraped and stretched thin. When Gutenberg printed his Bibles in 1450, parchment and vellum were still used for most manuscripts, and only a third of the Gutenberg Bibles were printed on rag paper. The skins of 300 sheep were needed to print one Bible.

Once paper and printing came to Western Europe, literacy followed. Compared to parchment, the use of paper dramatically reduced the cost of printing. In the 1500s, England developed an extensive paper industry, mostly using old linen (and later cotton) rags as raw material. Without paper (and printing), the works of authors like Chaucer and Shakespeare might not have existed and certainly would not have survived.

The first paper mill in the U.S. was built by William Rittenhouse near Philadelphia in 1690. In addition to paper for printing, the Rittenhouse mill later made brown and blue paper for wrapping (Rickards 2000). Benjamin Franklin, as a printer, publisher and forward-thinking patriot, patronized and encouraged the new mills, helping to start 18 of them in Pennsylvania and Virginia. Papermaking provided fuel for the American Revolution against Britain and its Stamp Act, a tax on all paper made in the Colonies.

Little evidence of early paper wrapping survives because it was thrown away. Humans have probably always used wrapping materials in transactions, to contain and protect goods. Prior to the 1800s, most of the references to paper-based packaging are to wrapping or hand-glued bags used by merchants. Retailers would purchase products in barrels and weigh out and wrap up a quantity for each consumer.

Wrapping required skill and time, and many shops provided chairs where the customer could wait while their orders were made up. There were different patterns of wrapping which can still be seen today in many parts of the world. Paper has long been twisted into cones to hold loose items. Most were twisted up by the grocer, a practice still in some British sweet shops, and "the grocer was most dextrous at conjuring up his own bags or twists" (Opie 1989).

An early reference to wrapping paper is in the first English patent pertaining to papermaking, granted to Charles Hildeyerd in 1665 for "the way and art of making blew paper used by sugar-bakers and others" (Hunter 1947). *Sugar blues* were a common type of wrapping paper made from waste paper (dyed blue with logwood, as is litmus paper), used to wrap or bag sugar.

Wrappers were usually the lowest quality paper or reused paper. If a wrapper was printed, the print was probably from a previous use. Books that failed to sell in London in the 1600s were sold as wrapping paper to grocers and apothecaries. This change of use was possible because books were stocked in sheet form, folded but uncut and unbound until they were purchased (Davis 1967). A 1719 History of Kent (England) describes "some Paper-Mills ...which make a great deal of ordinary Wrapping Paper for Tobacco, Grocery Ware, Gloves, and Milleners Goods, etc" (Hills 1988).

Paper grocers bags, glued by hand, were also made from inferior grades. For example, the first mention of grocers' paper bags was in 1630, describing European paper that was such poor quality that it was "not even fit for grocers' paper-bags" (Long 1964).

Paper was expensive. All paper in Western Europe and the Americas was made from rags, which grew increasingly scarce compared to the demand generated by the growth of printing. The process was also costly; each sheet was made by hand. In the papermill, the *vatman* scooped up the pulp on the mold, the *coucher* deposited the wet sheets between sheets of wool felt for pressing, and the *layman* removed the paper from the felt for drying.

There was an extensive collection system of rag pickers. But the rag supply was never very stable. There were many other ways to recycle clothing, and until the processes of spinning, weaving and sewing were mechanized, used clothing was relatively scarce. To make matters worse, the supply was interrupted during the Black Plague by the order to burn rags in the belief that they spread the disease.

In America, there were even fewer rags to recycle. People used their clothes until they wore out, and settlers had plenty of homespun uses for the scraps. Cotton was more prevalent than linen in America, but its rags made weaker pulp. Some coarse inferior papers, made from printed calicos, sack fabric and worn-out sails and tarred rope, were used for wrapping.

Papermaking Machines

The papermaking machine was the first significant invention. In 1799, the earliest machine to make roll-stock paper in a continuous process was invented by Nicholas-Louis Robert in France. The first practical machine was based on Robert's plans and built in England, financed by Henry and Sealy Fourdrinier, two London stationers. An engineer, Bryan Donkin, refined the design, added several patented features, and installed the first production machine at Frogmore mill in Hertfordshire in 1804.

The machine deposited watery pulp onto a moving wire mesh belt mold where it is drained and then fed through a series of felted press rolls and heated dryer rolls to remove the water. It is still the basis for the most common paper forming process used today, named after its investors: fourdrinier. The first American fourdrinier machine was built in England by Donkin, and was put into operation in 1827 at Saugerties, NY, in the mill of Henry Barclay. (Donkin played several important roles in packaging history; he also built the world's first canning factory in the UK.)

The *cylinder* or *vat machine* was invented shortly thereafter, in 1809 by John Dickinson. It operated on the principle of rolling a mesh cylinder mold through the pulp slurry to scoop it up and deposit it onto a moving felt belt. The first cylinder machine was used in Dickinson's Hertfordshire, England mill in 1809. In 1824, he also invented the first machine for pasting sheets of paper together to make 'cardboard.' The first papermaking machine in America was a cylinder machine, installed in 1817 in the Thomas Gilpin mill on Brandywine Creek, near Wilmington, Delaware.

The cylinder process competed with the fourdrinier process to make paper for the next 50 years, with cylinder machines making most of the paper used for wrapping. By 1850, the US Commissioner of Patents reported that "The cylinder machine, more simple and less costly than the other, is in more general use; but the paper made on it is not equal in quality. Notwithstanding it does very well for news, and for the various purposes which a coarse article will answer for" (Weeks 1916).

The great advantage of the cylinder former was not realized until the 1830s when George Shryock's mill near Chambersburg, Pennsylvania, found a way to make thick straw-based paperboard on a machine. In 1870, Shryock was the first to successfully combine a number of the cylinder formers in series to produce multi-ply strawboard.

Mechanization made paper more plentiful and reduced the cost. An 1850 letter notes that the cost of machine-made paper was 1/8 the cost of hand-made. As the price fell, the demand for paper, including wrapping grades, began to rise. The various grades of wrappers increased. Shorter (1993) notes a 1876 reference to British mills making "Browns, Middles, Shops, Wrappers and Skips." Labarre (1952) defines them: *browns* were coarse wrapping paper, *middles* were used in the center of pasteboard and covered with *pasters*, *shops* were white and machine glazed and *skips* were thin packing papers used to line crates. *Bottle wrapping* was a special tissue paper. Wrapping paper was used as sheets or purchased in *counter reels*.

Mechanization did more than simply increase the supply of paper. The continuous web produced by a papermaking machine (a reeling operation was added by Bryan Donkin in 1850) is key to converting all modern paper-based packages in a continuous process.

As paper demand increased, so did the price of rags. They were valuable enough to import to America from abroad, since the foreign rags had a higher linen content. During the Civil war, supply was so scarce that the Stanwood mill in Maine imported boatloads of Egyptian mummies to America in 1855 in order to pulp the cloth wrappings (30-40 lbs each) and papyrus fillers. Stanwood had hoped to make high quality paper, but found that the linen was deeply stained with resin that could not be bleached out. Instead, he made a coarse brown paper that was, in turn, used by grocers and butchers for wrapping food. Recycling of mummy wrapping was not new; in 1140 a Baghdad writer had identified mummies as the source of fiber for paper destined for food markets.

As the 1800s progressed, the need for an alternative source of fiber intensified. Patents were granted for producing paper with fibers from cornstalks, hemp, jute, raw cotton, sugar cane, bamboo, peat, straw and wastepaper. These produced coarse lower grades of paper,

some of which did not have very good printing properties, but were nevertheless suitable for wrapping.

Straw, Jute and Wastepaper Pulp

The ability to commercially pulp straw, jute and wastepaper was developed earlier than wood pulping. The coarse paper made from all three was used for packaging. This left rags to predominate in the publication market.

Jute was first proposed in 1797 as a source of fibers for "useful paper for use of Grocers, Chemists, &c" (Hunter 1947, citing a pamphlet by Thomas Greaves addressed to the East India Company, Importers, Grocers, Drapers, Gunpowder Makers and Paper makers). Jute is a highly fibrous plant used in India, twined to make rope and woven into burlap bags.

Jute paper, also known as *rope paper*, was made from recycled wastepaper reinforced by strong jute fibers which had been recycled from used rope and burlap bags. Old newspapers, rope and burlap were cheap in American port cities. The tough flexible paper came to be used for heavy wrapping paper and bags for seeds and cement (Smith 1939).

In the early 1900s the jute fibers reinforcement would be replaced with long strong kraft wood fibers, but the names "juteboard" and "rope paper" persisted, coming to indicate it was made from reinforced wastepaper. For the next 50 years (up until the 1950s), corrugated board was made with kraft-reinforced "juteboard" facings.

But for over 100 years the most commercially successful pulp used for packaging was straw, the stalky by-product of rye, wheat and oats. Straw had long been a useful material for purposes ranging from thatched roofing to bedding, and it was a plentiful natural resource. Its pulp made a coarse, inexpensive paper and board.

Strawpaper was first produced by Matthias Koops in 1800 (patented in 1802), based on experiments in 1765 by Dr. Jacob Christian Schäffer. Koops established the first straw paper mill in the UK. He also patented the first processes for pulping (and de-inking) wastepaper and wood, and published a book which was printed on papers made from straw, wood and other fibers. Koops was a visionary who saw beyond the world of printing and fine papers to predict the use of straw and wood pulp paperboard as a strong building material. He also envisioned the recycling of paper into a useful material (Koops 1800).

The first commercial straw paper in the US was made in 1831 by George Shryock's Chambersburg, PA Hollywell mill on a cylinder machine. The pulping method involved cooking the straw with potash, and later lime. The process was developed by Col. William Magaw, a potash manufacturer who noticed that it reduced straw to a pulpy mass.

Although it was first used for printing, primarily newspapers and decorative paper like wallpaper, straw paper was coarse, yellow colored and was not worth bleaching to match the whiteness of rag paper for publications. The fibers were short, and so longer fibers were usually added to give strength. Some of the earliest straw paper was only 20% straw, mixed with rope and jute/burlap bagging, and later it was made from 100% straw or straw mixed with waste paper. Paper made from straw has a hard stiffness and "rattle," but low tensile strength and poor tearing resistance.

Strawpaper became a widely used for wrapping paper, butcher paper and "packing paper." Twisted cones of straw paper used by grocers preceded the paper bag, and were common up to 1890.

But straw's greatest use was to be for box board and binder board (book covers). Shyrock describes how he made the first multi-ply strawboard by stacking up wet sheets and pressing them together:

> I soon discovered that when the paper broke between the press roll and layboy it accumulated in (sometimes) six or eight lamina round the press roll, and formed a solid and beautiful binders' board.

Shryock invented a special grooved roll that built up windings of wet paper until a board achieved the desired thickness. A sharp stick was used to cut through the groove, freeing the thick sheet of pulp. The sheets were then pressed and dried. Later, in 1870, the Shryock mill was the first to combine cylinder machines in series to make a multi-layer board (Quoted by Bettendorf 1946, 121-2).

The natural stiffness of strawboard made it well suited for paperboard, a use that persisted long after wood pulp was in common use for paper. Strawboard was used for common items such as setup boxes, egg case partitions and stiffener backing for paper pads. It was used in the first folding cartons and corrugated board, and ultimately became used only for corrugating medium, a use that persisted until the 1950s.

For fifty years, four mills in Columbia County in New York State were the leading producers, using rye straw which was abundant there, and cheap. As demand and the nation expanded, mills were built in the midwestern grain belt: Ohio, Indiana and Illinois (Bettendorf 1946).

An on-site description of the Lafayette Box Board mill in Indiana illustrates the scale of the strawboard business in the early 1900s. In 1909 the plant was known as the largest single machine strawboard factory in the world with the largest output, selling strawboard as far East as Maine, south to Mexico and north to Canada:

> One machine is almost 300' long with 87 huge rollers each weighing 3,000 pounds, around which pulp is run to shape into a board to dry. This machine makes a sheet of strawboard 120" wide.

The factory contained 10 hollow spheres or globes known as rotaries. Each measured 14' in diameter and held 7 tons

of pulp cooking in steam and lime water while the spheres revolved.

> Here is daily produced marketable strawboard in all weights and sizes; mill-lined in all colors; sheet-lined in white and special colors; booklined for high grade candy boxes; black-lined for picture-making; manila-lined for folding suit boxes; double-lined for other requirements. Also heavy strawboard for trunk, case and file manufacturers.

Indiana grain fields supplied the mill with 30,000 tons of straw per year. Every November at harvest time, baled straw arrived and was stored in sheltered sheds. The plant survives and is now a paper recycling plant, apparently a common fate for straw mills (Kriebel 2003, quoting Richard P. DeHarte in a 1909 book about the mill).

In England, straw was not much used for pulp. Rags were more readily available there and were competitive with the cost of the poorer quality paper made from straw. But during roughly the same period, 1860-1950, the British made a great deal of paper from esparto grass, imported from North Africa and Spain. Esparto made a high quality printing paper, but was only economically feasible because it was backhauled in ships sent south with fuel for Britain's fleet. It does not appear to have been used in packaging (Hills 1998).

Most of the strawboard used in the UK for set-up boxes was made in Holland. *Dutch strawboard* was valued for its stiffness, but it had drawbacks: it had a propensity to absorb moisture which made it change dimensions and give off a musty smell which transferred to food wrapped in it. The waste-based *chipboard* made in British mills and used for folding cartons was not as stiff, but was more dimensionally reliable, ensuring that lids consistently fit their boxes. It led the British mills (about the time of WWII) to develop a substitute material, called *rigid board*, which combined the benefits of both Dutch strawboard and the home-produced chipboards (Paine 1991).

Straw is rarely now used for pulp. It is more costly than wood to collect and store, and new varieties of machine-harvested grain have been bred to have short stalks, reducing the supply. But with the worldwide demand for paper rising, papermakers in countries like Denmark, Britain and Japan with few forest resources are discussing reviving the practice (O'Brien 1990, Bower 1996).

On the other hand, the use of waste paper pulp has continued to increase, along with the availability of waste paper. Packaging is one of the major uses for waste paper pulp, especially in paperboard.

Wood Pulp

It is surprising to learn that it wasn't until the 1850s that a method was commercialized for making wood into pulp. Investigations had begun in 1719 when a French naturalist, René Antoine Ferchault de Réaumur, observed that the nest of the American wasp is made from fine white paper made from masticated wood. In the following hundred years, there were many experiments, including Koops' patent in 1802, but there was no commercial process until a grinding machine, which literally grinds the wood to a pulp, was patented by Friedrich Gottlob Keller in 1840 in Germany.

The first U.S. mill producing wood pulp for paper by the mechanical *groundwood* process was not built until 1867. The quality was decidedly inferior to rag paper, and it was not accepted right away. Groundwood fibers are shorter, weaker and darker than those from rags, and some proportion of longer rag fibers had to be added to the wood pulp to strengthen it. (*Rag content* is still used in the finest writing and book papers.) The prejudice was largely overcome when the paper made from wood pulp was found to have good printing qualities and was particularly acceptable as newsprint.

The biggest advantage of groundwood pulp was its dramatically lower cost, especially in heavily forested North America where wood is a plentiful natural resource. In the early 1860s, rag pulp newsprint sold for about 25¢/lb. As groundwood was increasingly added, the price came down to 14¢/lb in 1869, and fell to as low as 2¢/lb by 1897 (Hunter 1947). A high percentage of newsprint pulp is still made by a mechanical process, and most paperboard is now made from recycled newsprint.

The invention of chemical pulping processes for wood quickly followed. These processes separate the wood's cellulosic fibers and dissolve the lignin by cooking it under pressure in hot chemical solutions, like the process that was used for pulping straw. Chemical pulping results in a more durable paper with longer pure cellulosic fibers, but with lower yields.

The *soda process*, the first chemical pulping method, was invented in 1851 by Hugh Burgess and Charles Watt in England; they also established the first plant in America, near Philadelphia.

The *sulfite process*, which dissolves the wood with sulphurous acid, was developed in 1867 by Benjamin Chew Tilghman in Pennsylvania and commercialized in Sweden in 1875. The first commercial production of sulfite pulp on the American continent was in Ontario, Canada, in 1887. International Paper and Fibre Company bought the rights to the patent and the first sulfite mill in the US was built in Alpena, Michigan, developed there to take advantage of lumbermill waste. The sulfite process became the most common chemical pulping method until the 1930s. Its sulphur burner, which makes the chemical liquor, produces the sulphurous smell that in the past has been associated with paper mills.

The new wood pulp and paper supply fueled a creative burst of literature and journalistic publishing after the Civil War (1865). American authors from the second half of the 1800s, such as Herman Melville and Mark Twain, owe some measure of their enduring popularity to wood-based

paper. This is when newspapers, magazines and books became available to common readers.

Paper soon assumed more roles. The 1860s and 70s were known as the "Age of Paper," the title of a popular song in London. Paper was used to make collars, cuffs, aprons, curtains, cups and carpets. Durable items like furniture, luggage, tea trays and even coffins were made from printed sheets that had been glued together and varnished. By 1900, compressed paper had become a standard material used in railway carriages, steamer trunks and building construction.

A third chemical pulping process was to have the greatest significance for shipping containers: the *kraft* (also known as *sulfate*) *process*. It was invented by C.F. Dahl in Germany in 1884 by adding sodium sulfide to the cooking liquor in the soda pulping process. First made in Sweden, *kraft* means "strong" in German and Swedish. The first kraft paper in the U.S. was produced in 1909, and it was soon preferred for uses where strength is valued.

Kraft pulping was able to utilize the almost weed-like growth of pinewood in the Southern US. When they are young (9-10 years old), Southern pines are sufficiently free from pitch to make good pulp. This was the key to unlocking the resinous pinewood forests of the South for making paper and board. Kraft wrapping paper was first made from Southern pine pulp in 1911 in Orange, Texas, and other Southern mills soon followed in Louisiana and Mississippi.

The kraft process has come to predominate for high strength paper-based packaging. The coarse brown paper is not very good for printing, but it has long tough fibers that can be made into a thinner, stronger paper than other pulp, yielding a greater area of paper from a ton of pulp. Furthermore, recycled kraft paper pulp retains much of its strength, increasing the amount of recycled paper and board that can be used in packaging.

Kraft paper quickly became popular for wrapping and shopping bags. It was used to make multiwall bags and corrugated linerboard, replacing jute/rope paper and juteboard. *Solid kraft* board was used to make beverage carriers and the bleached food-grade board used in demanding uses like milk cartons. Kraft pulp is still used in most of these applications.

Although it came a little later, cellophane was also a useful paper for marketing. It was invented by Dr. Jacques Edwin Brandenberger in Switzerland, and he designed a machine to produce it in 1911 by dissolving cellulose and casting it as a film. The first factory to produce cellophane was built in France, and the Dupont Company acquired the American rights to produce it in 1923. It was the ultimate wrapping "paper," the first see-through flexible packaging material, used as a glossy transparent wrap for luxury goods. It was sold as a crisp, shiny wrap for high end candies and cosmetics, and also as a moisture barrier wrap for food products and tobacco. It prepared the way for the plastic film packaging revolution. It was made into "cello" tape by Richard Drew at 3M in the 1930s (Personal Touch 1977).

The use of wood pulp changed more than just the process and the paper's properties. The papermaking supply chain changed dramatically. As wood pulp increased the paper supply, packaging uses for it were also increasing.

Label and Bag Printing Innovations

At the same time as the papermaking process was developing in the 1800s, new printing processes were developing too. Although some printed wrappers predated 1800, they were rare. As the use of paper for wrapping increased, so did the options for printing and using it to develop a brand identity.

Germans had been leaders in printing from the time of Gutenberg, and the earliest printed labels were also German. The first recorded use of printed labels was by the Fugger family of German traders in 1500. They traded throughout Europe and the East in silks, spices and wool which were wrapped and identified for shipment.

Some of the earliest printed wrappers were used by the paper industry itself. German papermakers in the 1550s used printed wrappers for their reams of paper. The wrappers were practically a by-product of the papermaking process, using the dregs at the bottom of the vat to make a coarse paper that was then printed in the center with the papermaker's design or crest. Likewise, some of the earliest printed wrappers in America were for paper reams.

In the 1700s, printed trade cards and wrappers for tobacco, powdered medicines, health aids, and pins began to be used throughout Europe. Tobacco papers identified the retailer who blended and measured out the tobacco into the wrapper (Davis 1967).

Some of the first consumer packages made from paper were printed and pasted seed envelopes made by members of Shaker communities in New York, Connecticut and Ohio beginning in the 1790s. They were packed in a multi-sectioned wooden box with a colorful label, and were displayed in country stores throughout the US. The Shakers were also the first to make colored picture labels for canned food.

The French word for label is *etiquette*, which began as the designation for manners at court in the 1600s. The court used the word to indicate a paper list of permitted modes of behavior, and these were the predecessors of the modern label. Early labels were affixed by glue or water-activated gum, or fastened mechanically with string or rivets (Bükle & Leykamm 2001).

The earliest known wine label dates from 1756, used for Port from Real Companhia (Rickards 2000). By the late 1700s, printed paper labels were used on glass bottles for patent medicine, wine and condiments like sauces. The first labels were merely used to identify the maker. As products began to be sold further from their place of origin, labels gave buyers a means of identifying their manufacturer and tracking their quality (Long 1964).

Early wrappers and labels were printed in one color by letterpress, with the illustrations printed using woodcuts or engraved copper or steel plates. All-over colored and patterned papers, like the marbled paper used for bookbinding, were sometimes used to give color, and some labels for perfume and pomade in the early 1800s were hand-colored. But most packaging was black-and-white (and usually a greyish-white at that) (Davis 1967).

A third significant invention in the early 1800s was required to set the stage for modern packaging: color printing of illustrations. Lithographic printing was to become particularly well suited to mass reproducing multi-colored designs on packages at a relatively low cost. Combined with the papermaking machine and the straw and wood pulping processes, it brought the cost of illustrated paper-based packaging low enough so that its marketing value outweighed its cost.

Lithography, from the Greek and Latin words for "stone writing" was invented by Alois Senfelder in Munich in 1796, who was experimenting with printing. He wrote his laundry list on a stone with greasy wax, and then wetted the surface with a mixture of gum arabic and water, so that the design area repelled the mixture and the blank areas absorbed it. An oily ink rolled onto the stone then coated the greasy design but not the wet blank area. It made a clean impression of the design when a sheet of paper was pressed against the surface of the stone. The quality became sharper yet when the offset process was added, first for printing tinplate cans and boxes in the 1880s (Meggs 1998).

Lithography's clean impressions are ideal for reproducing illustrations, and this enabled pictures to be added to packages. Black-and-white illustrations on labels, probably for cigars and tea, were the earliest lithographed packaging materials. By the 1830s one-color lithographed or letterpress labels were used on a wide range of products and packages including glass bottles, metal boxes and early paperboard boxes. Paper printing was widespread--most towns had printers, and labels were cheap (Meggs 1998).

Color printing began with letterpress and engraved plates about the same time, and color labels made their first appearance on matchboxes in the 1830s (Davis 1967). This was quickly followed in 1837 by the invention of chromolithography by the French printer Godefroy Englemann, who invented the means for analyzing colors in a subject and separating them into component *process colors* to be printed in sequence. Chromolithography was first known as a fine art medium, and got its biggest boost toward recognition when Currier & Ives popularized it for art reproductions in the 1850s (Meggs 1998).

Early American printers were some of the earliest paper-based packaging makers. For example, Robert Gair, who played a central role in the development of paper bags, folding cartons and corrugated fiberboard boxes, was also a lithographer.

Paper bags developed from grocers' wraps. Printed paper grocery bags that advertised the individual department store or small shop became popular in the mid 1800s as paper availability grew. At first the paper bags were hand made and printed with the retailer's name or an illustration of the shop. James Mardon, a UK bag maker, noted that many customers in the grocery and drapery trades "desired to have views of their premises on their billheads, bags and tea papers" (Davis, 1967).

From the 1840s to the early 1900s, chromolithography was the predominant way to print award-winning labels. At the Great Exhibition in England in 1862, printed packaging was on display: labels, wrappings and box tops reportedly "in gold and colors." There were also set-up boxes covered with fancy papers from France (Davis 1962). In 1863 Ferdinand Revoul, Valréas' lithographer and carton-maker, received a bronze medal at an exposition in Nimes (Locci 1994). Fig 1.8 shows a cigar box with lithographed label.

Some of the earliest chromolithographed labels were for gifts like handkerchiefs and chocolates. Fry and Cadbury, in 1868, was the first to print special labels for Christmas and Easter candy. Christmas wrapping paper also originated in Europe during this period (Opie 1987).

Some of the best commercial printing was on cigar bands and box labels in the 1870s to 1890s; these are highly collectable because of their beauty and the fact that people have prized them for over a century. But ordinary products were also dressing up:

> Victorian design was often ebullient, frivolous, detailed and colorful. Such delightful 'jewels' on the grocer's shelf must have added greatly to the appeal of more mundane products like washing soap or health salts (Opie 1989).

Some of the lithographic label masterpieces from the late 1800s were produced in up to 14 different color printing operations (Bükle & Leykamm 2001).

When the invention in the 1870s of photoengraving and half-tone engraving was also applied to labels and cartons, illustrated labels became even more commonplace. By then, decorative labels could be mass produced in a variety of sizes. Cans for heat processed food had some of the most elaborately printed labels by the 1890s. Most metal boxes (also called canisters, which are not heat processed) were being directly printed by transfer decal or offset lithography, an effect that printed labels and cartons sought to emulate. The brilliant lithography was essential for selling canned food which was not visible during a purchase based on faith. Butter, cigarettes and soap were packaged in lithographed wrappers. Fruit crate producers in California began another colorful labeling trend, creating a way to brand fruit (Opie 1987).

The Origins of Mass-Produced Paper Bags and Folding Cartons

In the latter part of the 1800s, the developments in printing and papermaking gave birth to the package converting and filling industries. Paper-based packaging

was getting ready to move onto the center stage of grocery shelves.

At the same time, the marketing system (especially in America) was being transformed. The relationship to the consumer was passing from shopkeepers to brand manufacturers. Mass production required mass produced packages. Packing in a factory gave the incentive to develop mechanized methods for high volume packing, wrapping and labeling. Mass marketing required a print media to carry the sales message. And mass distribution required an inexpensive disposable shipping container. The new paper supply was well positioned to meet the new demand for packaging.

The mid 1800s were a creative period for paper converting inventions, and many were related to machinery for making or filling packages. For example, John Horniman, the British tea merchant in 1826 was one of the first packers to invent an elementary device to accurately fill tea packets (Davis 1967).

According to an 1874 US index, by that time there had been 79 patents issued for making paper bags and 66 issued for making paper boxes (Weeks 1916). The new mass-produced paper grocery bags speeded up retail transactions. In 1889, Professor David Wells noted:

> Nothing has had a greater influence in making possible the rapidity with which certain branches of retail business are conducted, as compared with 10 years ago – more especially in the sale of groceries – than the cheap and rapid production of paper bags....With machinery have also come many improvements: square bags that stand up of themselves and need only ...to have the top edges turned down to make the package at once ready for delivery" (Wells' *Recent Economic Changes*, 1889, quoted by Smith 1939).

After the 1850s, manufacturers began to use paper bags too. They were first used for flour and sugar when the Civil War disrupted the supply of cotton for textile bags from the South (PSSMA 1991). Paper flour bags gained popularity fastest in the smaller sizes. Because of their strength and reusability, cotton and burlap were often preferred for larger quantities until a tubing machine to make multiwall paper sacks was invented in 1917 (Personal Touch 1977).

Letterpress printing methods could not keep up with bag making machines. This provided the impetus for the invention of the most significant printing process used in packaging today: flexography. The bag makers Bibby & Baron in Lancashire, England designed, in 1890, the first press to print a continuous web from rubber blocks or plates, using fast drying aniline inks and a central impression cylinder (Davis 1967). Flexographic bag printing was introduced in the U.S. in 1925. Flexography is now used for corrugated board, milk cartons, paper bags, folding cartons, and plastics of all kinds.

Paper bag making technology revolutionized paper-based package converting. It was for bags that the practice of straight line automatic folding and gluing was first developed. The straight line tubing concept has been used ever since for flexible package converting, including the form-fill-seal process that is most common for small bags. Furthermore, straight line folding, tubing and gluing went on to be used in almost all folding carton and shipping container converting to this day.

A notable exception to the straight line tubing operation is the *rigid set-up box*, which pre-dates the 1800 paper inventions. Rigid paperboard boxes are believed to have been first used in China, as a package for fine teas. The first paperboard set-up boxes in the West were made in the 1700s, when Germany was a leading producer, and many were imported to America.

The paperboard was either made with a very thick layer of pulp, or from several sheets pasted together, and the box was usually covered with decorative paper. Pulpboard cartons were made in France before 1751, and our word *carton* is from the French word for pasteboard box. Decorated *band boxes* (cylindrical set-up boxes, so named because they were originally made to hold gentlemen's collar ruffs, called bands) were popular during the early 1800s, with their greatest popularity during 1820-1945 (Lynn 1981).

But box making was a labor-intensive craft until machines were developed. Much of the assembly work was performed by women, sometimes working from their homes. Before strawboard was made on cylinder machines, the paperboard was made by hand too.

The commercialization of set-up boxes is generally credited to the Dennison family in Boston, still a leading name in paper labels. Although he did not invent the package form, Aaron L Dennison, a jeweler, in 1839 began making set-up boxes in his shop using a jack knife, rule, paste and wooden forms. He made them for himself and other jewelers, competing with imported boxes from Germany. His father, Col. Andrew Dennison who was a cobbler, took over the production and invented tools to make the job easier, like the first corner cutter and scorer, a hand shear which was a lever-type paper cutter equipped with gauges for cutting at predetermined angles, and a clamping device.

By 1850, Dennison's business had expanded to include boxes for a wide assortment of small products including cakes, combs, spectacles, pencils, hairpins, plaster, soda, needles and botany samples, as well as mailing boxes. For jewelers, they developed display cards and price tags, which led to shipping tags and to Dennison's eventual leadership in the gummed label industry (Hayes 1929).

By 1860 others in Philadelphia, Chicago and New England had established box-making plants and began developing their own specialized equipment to speed production and reduce costs. Fancy set-up boxes began to be used for drugs, candy, jewelry, cosmetics, and larger items like hats and wedding cakes. The boxes were

rectangular, cylindrical or oval. Even coffins were made from laminated sheets in 1869. By the 1870s, set-up boxes were being used by candy and match manufacturers to differentiate their goods.

Shoes were one of the early products to be sold in set-up boxes. In the early 1870s, George Kieth, a shoe manufacturer in Brockton, Massachusetts, was the first to have the idea. He established a box plant and other shoemakers followed, as did a number of shoe box plants, supplied with strawboard and cover paper by Spaulding and Tewksbury, a leading mill in New England. The shoebox has been an essential element in shoe retailing ever since.

Set-up boxes had a major disadvantage. Since the set-up box is set up by the box maker, it cannot be shipped to the packer/filler in a flattened form. As set-up boxes became popular, American inventors looked for a more efficient way to pack products in boxes, which led to the folding carton. A folding carton is more efficient than a set-up box; it uses less paperboard, has a simpler manufacturing process and is shipped knocked-down, saving transport and storage costs.

The predecessor of the folding carton appeared in about 1850. Carpet tacks, which are obviously hard to handle, were packed by the store clerk in folded paperboard that was shaped into a tube around a wooden form. One end was folded in and held in place with a glued label. The shape was removed from the form, filled with tacks, and the other end was secured. The package, which was then tied up with string, was known as a *paper of tacks*. Although it had no preliminary creasing, this package influenced the eventual development of the folding carton.

The *folding carton* developed, primarily in the US, over the next 2 decades. The first folding cartons were scored on a platen printing press from which the typeset had been removed and replaced with metal strips (brass printing *rules*). The cartons were cut in a separate operation with a guillotine knife.

Since most folding cartons are made in the form of a tube, similar to paper bags, it is no surprise that it was the paper bag maker, Robert Gair, who made some of the first folding cartons. The first versions were expensive and could not be produced in large quantities since they were manually cut and scored, but they offered great advantages.

Gair's greatest role in packaging history was inventing a mechanized method for die cutting and scoring folding paperboard cartons in a single stroke. The idea resulted from a mistake in 1879. A careless pressman in Gair's paper bag factory in Brooklyn failed to notice that a type rule had been set too high and had cut through and ruined 20,000 seed bags. Rather than igniting Gair's thrifty Scottish wrath, it fired his imagination:

> The clean incisions across the seed bags struck the eye of Robert Gair at a moment when his mind was ready and receptive for the sight. It came to him, in a flash, that there was a way of constructing a multiple die that would cut and crease box board in a single operation" (Smith 1939).

The ruined bags gave Gair the simple idea to set sharp cutting blades a little higher than blunt creasing rules in the same press to mass produce folding carton blanks. His first $30 press could cut 750 sheets/hour, each with 10 dies. This one press produced as many cartons in 2½ hours as his whole factory had previously made in one day. (Smith 1939)

At first unprinted folding cartons were used for containing small items that were formerly packed in bags. The first cartons used by manufacturers were labeled or were covered with a printed wrapper.

The decade of the 1890s was a period of folding carton market penetration. Gair at first made cartons for retailers, like Bloomingdales and the Great Atlantic & Pacific Tea Company, for cosmetics companies like Colgate and Ponds, and for the tobacco manufacturer P. Lorillard. The cigarette carton was developed in the 1890s and replaced the printed stiffener cards that had been added to cigarette wrappers since 1879. At first cartons were used for local products, frequently bottled products with a snake oil reputation, such as "Hungarian Cough Balsam" and "Plantation Chill Cure" (Smith 1939).

The folding carton earned prestige in 1896, when the National Biscuit Company began to sell Uneeda Biscuits in cartons. The crackers were wrapped inside a waxed paper liner inside a tray-style carton, and the colorful brand-printed wrapper featured a boy in a raincoat to emphasize the moisture barrier. The package had been developed and tested by Frank Peters in the first documented water vapor transmission test (Twede 1997). Robert Gair's factory produced the initial order of 2 million cartons, and his son, George, takes credit for inspiring the name for the new cartoned crackers when he counseled, "You need a name" (Smith 1939).

For the first time, the consumer could buy crackers in a clean unit-size package, rather than having the retailer measure out a quantity from the large cracker-barrel where they were exposed to moisture, odors, vermin and breakage. The Uneeda Biscuit package is often cited as the birth of "consumer packaging" (which it is not--there were plenty of bottles, cans, set-up boxes and bags before this) because of its widespread distribution and the dramatic effect that folding cartons were to have on the retailing business in the century to come. From 1896-1903, cereal and crackers pioneered modern consumer packaging in paperboard cartons.

The Uneeda Biscuit carton represents the birth of brand advertising that relies on the package as a sales tool tied to an advertising campaign. It symbolizes the shift in power from retailers to manufacturers. By packaging at the factory instead of in the store, advertising directly to consumers in magazines and on billboards, and by making their packages easy to recognize, manufacturers were able to take control of the market.

With the increasing demand for graphics to identify food and drug manufacturers and stimulate sales, Gair foresaw the value of printing cartons directly:

> On the theory of Polonius that 'the apparel oft proclaims the man,' 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" (Quoted by Bettendorf 1946).

Printed cartons assured consumers of the consistency and quality of the product. However, most early folding cartons were only printed in one or two colors, using wood engravings and letterpress. Print was limited to names and decorative borders. In the 1890s, Gair's catalog listed cartons printed for candy, Smith Brothers' cough drops, and Sweetheart Soap.

Lithographically printed cartons with illustrations were introduced in about 1900. Cereal companies were among the earliest adopters; clean cartons contributed to the healthful image that they cultivated, and the branded graphics promised consistency and quality. In 1903 a machine that converted a roll of printed board to tray style cartons was invented for Quaker Oats and used later for other cereals. (Quaker Oats, in 1877, was the first cereal marketed in a carton; the familiar cylindrical Quaker Oats fiber cannister was introduced later.)

The first cartons were folded, glued and labeled by hand, but mechanization soon ramped the carton industry fully into mass production. There were many inventions to automatically fold and glue cartons from 1895 to 1910. All of the machinery inventions were based on the idea of straight line folding and gluing similar to that used in tube style bag making machines.

The folding carton innovation was slow to move to Europe where many products were already packed in decorated metal boxes, but once American products in cartons began to be sold in English shops and two American box makers established factories in England, the British and continental manufacturers began to follow the trend, buying mostly American made machinery (Davis 1967).

Paperboard was a good use for waste paper, and in 1918 systems for more efficiently pulping wastepaper began to be developed. The first successful breaker-beater was installed that year in the Haverhill Boxboard division of the Robert Gair Co. In 1939 the hydra pulper, developed by the Dilts Machine Works, Fulton, NY, permitted the pulping of wastepaper in higher quantities in one batch. The design was based on an early washing machine. This started a whole new segment of the paperboard industry by establishing paperboard factories in cities near consumers, rather than near forests or farms.

Other significant innovations were in automatic filling and sealing equipment. The first companies that developed the machines were primarily scale manufacturers such as Pneumatic Scale Corp. and Automatic Weighing Machine Co., as well as midwestern specialists like the Automatic Carton Sealing Machine Co. in Chicago and the Johnson Automatic Sealer Co. in Battle Creek, Michigan. This was the beginning of packaging systems that integrated machinery and material, like Klik Lok, Mead, Olin and Ex-Cell-O.

Folding cartons, of all package forms, played the most central role in the branded consumer product revolution. Consumers came to trust the reliability of brands, and found that shopping could be done more quickly with packaged products. Retailers sold more when the merchandise was clean and attractive, and packages reduced their handling cost. Instead of bulk bins, products could be displayed on shelves. Manufacturers could mechanize the packing operation at the factory, replacing the use of costly manual packing in the retail store.

Bettendorf sings in praise of the humble paperboard carton:

> Man could not have achieved his present high level of mental, spiritual and physical welfare without paperboard, for the paperboard box today is a vital key to orderly and sanitary transportation and distribution of goods....Without the mass production box, there would be no mass production....we'd move and count things in piles instead of units; and in general we'd 'coolie' our way through life.
>
> And thus, out of the piles, confusion and dirt of the earlier period came the cleanliness, order, precision and efficiency of mass production goods through the employment of mass production packages of paperboard. (Bettendorf 1946).

For all of their great graphics, folding cartons have hidden as much as they revealed. They hide the product and fill level, which led to the Fair Packaging and Labeling Act. They hide the fact that they are made from wastepaper with a brilliant clay coating and colorful print. They might also hide a prize, and there is a long history of premiums inside the package as well as boxtop redemption schemes. Toys in cereal, Cracker Jack and Happy Meal cartons, and games on the surface, have enticed purchase as much as the product itself. For much of their history, cartons have implied a treat that goes beyond the product.

Probably the biggest surprise is the value that an antique carton now adds to antique toys. Rather than hiding the prize, the carton now has become the prize. Appraisers such as those on *Antiques Roadshow* always find that the value of an old toy increases if it is in the original box.

Corrugated and Solid Fiberboard/ Fibreboard Shipping Containers

The papermaking inventions of the 1800s gave birth to the corrugated fiberboard shipping container in the early 1900s. Corrugated boxes were to play an essential role in developing mass distribution throughout the 1900s.[2]

In 1856 in England, the first patent was issued for making corrugated paper. It was formed on the same kind of fluted irons used to make ruffled collars in Elizabethan times. Like the earliest paperboard, it was used in men's hats. The fluted band of paper served as cushioning for the hat's sweat band.

The first patent issued for corrugated paper as a packaging material was granted in 1871 to an American, Albert L. Jones. It was a textured cushioning material for wrapping glass bottles to protect against breakage. In 1874, Oliver Long's patents added the single and double facings to prevent stretching.

The British hatband patent was used as evidence of prior art in a patent infringement settlement that led to an alliance of three entrepreneurs: Robert H. Thompson, Henry D. Norris and (yes, here he is again) Robert Gair. They maintained a manufacturing and sales monopoly on corrugated bottle-wrapping paper for the life of the patents, until the1890s. The Thompson Norris Company and Gair developed machinery, processes, and various forms of wrappers. The early corrugated wrapping materials were made from thin straw sheets, like the straw wrapping paper of the period.

When the bottle wrap patents ran out in the 1890s, Thompson and Norris developed the first double-faced board. Single-faced board would be unrolled, glue was applied to the second liner by a series of brushes, and the plies would be combined as they were pulled through the machine, which was stopped to cut off the sheet; in later machines, glue would be applied only to the tips of the flutes. They invented a rudimentary process for setting the glue under pressure: the machine operators piled up several sheets, covered them with boards and "would tramp around this board to give the necessary weight to make the liners adhere" (W. G. Chapin, quoted by Howell 1940).

In 1894 Thompson and Norris produced the first double-faced corrugated boxes for light express deliveries in New York City. The new box was tested by a Wells Fargo office that was "pleased to say has borne without damage, such handling as it would probably be called upon to stand in ordinary transportation," and their agent recommended them to other Wells Fargo shippers (W. B. Lindsay, quoted by Bettendorf 1946).

For the boxes, Thompson and Norris used a thick stiff strawboard corrugated medium. The first liners made from thick "boiled wood pulp." Several box styles were designed, including the economical one-piece regular slotted container (RSC), which is still the most popular box style today. It is based on the idea of straight line folding and gluing similar to that used in tube style bag and carton folder-gluer machines.

Experimentation with different liner stocks continued until about 1906 when jute liners were first made. From then until 1936, so called jute linerboard was most common, made from wastepaper reinforced at first with jute and later with kraft fibers.

After 1895, corrugator machinery developments quickly multiplied. The first independent machinery manufacturer was S. F. Langston in Philadelphia; his first machine, in 1895 was a singlefacer. The first machine to corrugate the medium and affix both faces was invented by in 1895 by Jefferson T. Ferres for the Sefton Manufacturing Company in Anderson, Indiana; he improved it in 1900 by adding steam-heated hot plates for drying the board and setting the glue. His machine, although it operated at only 10 feet/minute, is the basis for the corrugating machines used today.

RSC box-making equipment was also developed in the early 1900s. Rotary slitters and scorers were developed in 1905 by George Swift for making the blanks into tubes. Slotting was mechanized by using saws in 1902, by the Sefton Manufacturing Company, a dusty practice that continued into the 1920s along with the up-and-down slotter developed in about 1905.

The widespread adoption of corrugated fiberboard shipping containers required a great deal of political negotiation and technical development. It is a story of battles and collusion with freight carriers, the Interstate Commerce Commission, and competitors -- a story to be saved for another Marketing History conference.

More and more types of goods began to be shipped in fiberboard boxes. Mass production and distribution were multiplying markets. By 1906, RSCs were used for cereal, lamp chimneys, glass-packed goods, starch, sugar, baking powder, candy, hardware, housewares, drugs, stationery, rubber goods, shoes and soap. By 1916 they were also used for canned foods, matches, cigarettes and other tobacco products, blankets, clothing, chewing gum, chemicals, kitchen cabinets and other furniture. In the 1920s their use would extend to products like radios, paint and department store goods (Browder 1935).

The low cost and light weight of corrugated boxes enabled more producers to economically employ wider distribution than ever before in history. Indeed, the exponential expansion of distribution throughout the 1900s would not have been possible without the help of the self-effacing brown corrugated RSC.

[2] Reference note: The history of corrugated fiberboard boxes is well documented; the primary sources for this section are Bettendorf (1946) and Howell (1940), unless otherwise noted. They were eyewitnesses to some the industry's early development. Koning (1995) presents a more comprehensive bibliography.

CONCLUSION

Paper gave Marketing the opportunity to capitalize on the Industrial Revolution.

Today, paper-based packaging is by far the most commonly used packaging material in the world. Three key technological inventions in the1800s set the stage for the mass production of the paper-based packaging: the paper making machine, the process for pulping wood and lithographic printing.

The paper-making machine and the process for pulping straw, wastepaper and wood provided the cheap materials. Lithographic printing dressed them up to match the advertising that was also largely printed on paper.

These inventions reduced the cost of paper enough to make it useful for a wide range of disposable packages. They fueled the burst of creative and journalistic writing during the second half of the 1800s through widespread distribution of books, newspapers and magazine advertising media. These inventions came at the right time to supply the growing demand for packaging due to the growth of manufacturing and distribution of consumer goods.

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