CHAPTER I
INTRODUCTION TO PACKAGING INDUSTRY IN INDIA

1.1 Introduction:

The technology and art of packaging has a logical origin, arising from the need for processed products to be conveniently transported and stored with no damage. Packaging serves two purposes – promoting the product and protecting it. The promotional effort is to grab the attention of a customer in less than few seconds towards a product on a super market shelf and say “take me home”. The protective function is to protect the product, and in some instances, to keep the product from damaging surrounding items. Centuries ago, packaging meant only cloth bags, wood boxes or crates. Most food was sold in bulk from which the grocer would scoop out the quantity needed and put it in another bag.

Since the Industrial Revolution in the late 18th century, packaging became an important tool for marketing. At that time, so many new products were being manufactured that the consumer had a variety of choices. Often the package determined whether one product would be purchased over another. Nowadays, packaging design is transforming from a creative process to a technical and functional process. Everything from the shape of the packaging to the position and color of the graphics is based around costs and ease of production, transportation and delivery. Brands are paying more attention on packaging because packaging affects the product sale, protect product and facilitate the safe delivery to the consumer’s premises. Product packaging often serves as the first impression of a brand for a consumer that is why companies are trying to make their packaging design something fresh, eye-catching, and unique. New packaging designs trends being followed like seasonal, environment friendly, localized, retro packaging etc. New packaging systems have emerged, such as aseptic packaging, which enables milk, fruit juices, and other liquids to stay fresh without refrigeration for many months.

1 Encyclopedia Britannica : Online Dictionary, available on www.britanica.com/packaging
2 Ibid.
The Indian packaging industry, growing at an annual rate of more than 15 cent, is valued at $ 15.6 billion (INR 85,000 crore) as in 2010-11. In the next five years, the sector is expected to triple to around $ 60 bn. The net profit of the packaging industry spurted 104.5 percent during Q3 FY08, against a growth of 29.5 percent in the December ’06 quarter. The large growing middle class, liberalization and organized retail sector are the catalysts to growth in packaging. More than 80 percent of the total packaging in India constitutes rigid packaging. The remaining 20 percent comprises flexible packaging. There are about 600-700 packaging machinery manufacturers, 95 percent of which are in the small and medium sector located all over India. Indian packaging machinery imports are $125 million. The import (customs) duty for packaging machinery is 25.58 percent for 2007-08. Germany and Italy are the latest suppliers of packaging machinery to Indian but focus is now shifting on Taiwan, Korea and China. Indian packaging machinery exports are rapidly growing. India’s per capita packaging consumption is less than $15 against worldwide average of nearly $ 100. The total demand for paper is estimated to be around 6 million tonnes, of which about 40 percent is consumed by the packaging industry. Laminated products including form-fill-seal pouches, laminated tubes and tetra packs are growing at around 30 percent per year.

“The packaging market in India seems set for the next level of growth. Strong favourable demographics aside, factors such as increasing disposable income levels, rising consumer awareness and demand for processed food, and the multinational giants taking rapid strides in the food, beverages, cosmetics & toiletries and pharmaceuticals space, are expected to be the key drivers of this growth story. These factors are forcing both packaging suppliers and end-user industry to shift from bulk packaging to retail, and unit-level and small-sized packaging. In addition, exploding organized retail growth and newly relaxed Foreign Direct Investment (FDI) norms in retail and other sectors, augur well for packaging market in India.”

3. A report by Indian Association of Corrugated Manufacturer (2012-13), II p.15

“Robust growth in demand for rigid plastic packaging, especially in sectors like drinks, cosmetics, toiletries, and household and personal care products, is stimulating packaging materials are receiving a boost from sectors like perishable foods, healthcare, convenience foods and various industrial markets. Corrugated board consumption is being egged on by the processed food sector and a number of non-food applications including personal and household care, chemicals, electrical goods and others. At the same time, folding carton consumption is benefiting from the growth found in healthcare products, electrical goods, and frozen and chilled foods, among other things5.

Packaging is described as a “Complex, dynamic, scientific, artistic and controversial segment of business”. Packaging is dynamic because it keeps on constantly changing. New materials need new methods, new methods demand new machinery, and new machinery demands better quality and better quality opens up new markets which requires change in packaging6.

According to the Report of Packaging Industry Association of India (2014)7, “The Indian packaging industry is one of the fastest growing sectors spanning across almost every industry segment. Right from packaging of food and beverages, fruits and vegetables, drugs and medicines, to highly dangerous products, the packaging industry has led to greater specialisation and sophistication over a period of years. In fact, packaging involves one of the highest standards of technological expertise, and the entire process from packing to shipment can be right called as the art and science of packaging. At present, Indian Packaging Industry is currently valued at US $13 billion and ranks 11th in the world and industry experts are of the opinion that the Indian packaging industry is expected to grow to US $16.5 billion by 2015. However, it is to be noted that the packaging industry in India is highly fragmented and the above figures quoted represent the official companies that have been registered within

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5 Mariwala Harsh (2012), The Corrugator, Bi-monthly Journal, July-September 2012, FCBM, Bangalore, pp.130-133
the industry forum. The unofficial sector contributes a decent segment and efforts are on to tap this particular segment within the larger purview of the packaging industry”.

Packaging industry involves various types of packaging material, one of that is corrugated box packaging industry. This industry is also growing at faster rate and has greater potential. The researcher has selected this industry for the study.

1.2 Packaging Industry in Global Economy:

Packaging Industry is growing worldwide at faster rate. The emerging retailing industries and change in the lifestyle of the people in various countries has led to grow the packaging industry. The World Packaging Organization Report (2010) has explored the global packaging industry. According to the report, the global packaging industry is growing in most of the country and developed countries have larger share in the world economy. Some of the extractions from this report has been given here.

1.3 Packaging Industry in Selected Countries\(^8\):

Including packaging machinery, the global packaging industry turned over around $485 billion in 2004 with packaging container sales of almost $460 billion and machinery sales of around $25 billion. Used in a wide range of industries across food and drink, healthcare, cosmetics and other consumer goods as well as a range of industrial sectors, packaging has become an essential everyday item, with its usage growing broadly in line with the global economy. In 2003, North American markets, including the USA, Canada and Mexico, accounted for the largest share of global packaging at $132 billion (32%), ahead of Western Europe (26%) and Asia (26%). The largest single national packaging market during the same year was the USA with sales of $113 billion. Japan ranked second with sales of $49 billion, ahead of China at $32 billion, Germany at $21 billion and France at $19 billion.

1.4 Packaging Materials\(^9\):


\(^9\) Ibid
Packaging encompasses a wide range of material types across paper, board, plastic, metal, glass, wood and other materials. The largest share of global packaging is accounted for paper and board packaging with sales of $165 billion in 2003, equating to 38% of the market. Paper and board will remain the single largest element of the market into 2009, growing at an annual rate of around 4% in real terms, driven on the one hand by rising demand in fast-growth national markets as well as steady growth in secondary/ bulk packaging across the globe. Plastic packaging accounted for 30% of sales, with rigid plastics alone taking an 18% share of the market. A rigid plastic was the fastest growing sector of the market during the period 1999-2003 at an annual rate of 6.2% to $77.2 billion. This was driven by several factors: rising demand for PET bottles in soft drink and bottled water markets; the consistent substitution of traditional metal, glass and sometimes paper-based materials in food and other markets; increasing incursions by packaging as a whole into food markets, particularly in the case of meat, fish and poultry products; and rising consumption of ready-meals and other convenience-oriented products. Rigid plastic packaging will continue to be the fastest growing sector of the market, with consumption forecast to progress at an annual average rate of 6.5% in the period to 2009 to reach $116 billion, with consumption of flexible plastic packaging also set to grow at an above-average rate, driven by rising demand in fast-growth markets in Asia and other emerging regions.

Across other sectors, metal packaging, accounting for 18% of the market in 2003, is set to grow steadily, but will lose further share to plastics in beverage markets with food cans also losing share. Glass packaging, meanwhile, accounting for 7% of the market, will see only steady growth as further share is lost to plastics across food, beverage, healthcare and other key end-use sectors.

1.5 Paper and Board Packaging$^{10}$:

The world market for paper and board packaging was valued at $164.7 billion in 2003, representing an increase of 10% on 2002 – principally as a result of the weakness of the dollar boosting non-US sales with consumption growing at an annual average rate of 3% since 1999. North American markets accounted for 32% of sales at $52.2 billion, growing at a rate of just 0.4% over the period as US demand fell back.

$^{10}$ Ibid
Growth was of the order of just over 3% in Asia, depressed somewhat by weak Japanese demand where sales fell by almost 3% year-on-year. The fastest growing markets for paper and board packaging between 1999-2003 were in Eastern Europe, with investment in new capacity on the up as major players in this sector – as well as key customers – have shifted the balance of production away from high-cost locations in western Europe. In addition, there has been strong growth in Russian paper and board packaging demand, with consumption rising from $1.2 billion in 1999 to almost $3 billion in 2003. On the whole, the paper and board packaging industry has experienced difficult trading conditions in developed markets in recent years, affected by downward pressure on prices from end-customers, exacerbated by overcapacity within the industry. With only very modest growth in shipment volumes and declining shipment values in some mature markets, there has been a greater focus on developing markets in Asia, Latin America and Eastern Europe. While there was strong output growth in both Asia and eastern Europe in 2003, output fell back in South America with corrugated board volumes down by around 6% on 2002 levels After growth of the order of 7% in 2004, the market for paper and board packaging is forecast to grow at an annual rate of 4.2% in the period 2004-09 to reach $216 billion. Aside from the Middle East, the fastest growing regional markets will be found in Eastern Europe, South America and Asia where annual growth of the order of 6% is anticipated. Asia’s share of the market is set to rise from 34% to 36%, with strong growth in China – overtaking Japan to become the second largest market with sales of $30 billion by 2009 as well as Indonesia (growing at almost 10% annually to $5.4 billion) and India (growing at an annual rate of 12% to reach almost $4.5 billion).

1.5 History of Corrugated Industry

The corrugated industry has a long history. The Board Containers Magazine (1998) has given the history of corrugated industry in the world. The corrugated industry started more than 2,000 years ago, two centuries before the death of Christ. In China, a man named T’sai Lun, using waste products such as old rags, pieces of hemp-rope and discarded fishing nets for the corrugated packaging paper. Thus T’sai Lun began his experiments and introduced paper to the world in 250 B.C. This was the first primitive form of paper. In the 13th century, the art of papermaking had made

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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 fibers were substituted for mulberry bark, which is rare and difficult to attain in Europe. 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 growing demand, papermakers were encouraged to speed up their production, but no real breakthrough came until the 17th century. 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 to 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 “pulp board,” what today is known as paperboard. This method spread through Europe and crossed the Atlantic with the American settlers.

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.

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, 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.

At the end of the 19th century corrugated paper was used primarily for packing purposes as shipping cases were not yet developed. Robert Gair Co. (in the year 1894) began producing corrugated cartons and bottle boxes. 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. 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.

First came scoring of straw board 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.

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 super stores 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 box makers who had no fear experimenting with printing methods never before attempted in the corrugated industry.
1.6 Corrugated Packaging Industry:\(^{12}\):

In area terms, corrugated packaging shipments grew by 3% in 2003 to reach 144.4 billion m², rising at an annual rate of 1.8% according to data from the International Corrugated Case Association (ICCA). The ICCA anticipates acceleration in output growth in the period to 2008, forecasting annual growth of the order of 3.8% to reach 173.4 billion m², with growth rates rising in all regions with the exception of Oceania. Asian output of corrugated grew at an annual rate of 5.7% between 2000 and 2003, and expected to accelerate to nearer 6% into the second half of the decade. Much of this growth will be attributable to China. Currently standing at around 13 million tonnes, output is forecast to grow by 7% year on year, driven in part by rising output across a range of consumer products. Elsewhere, Russian corrugated capacity is doubled between 1998 and 2003 to around 1.8 million tonnes, and is set to reach around 2.8 million tonnes by 2007. The industry remains principally in the hands of Russian investors, although a number of western companies have set up shop in the country. North American corrugated output declined by 1.4% on average between 2000 and 2003. Into 2004, however, there were signs of a recovery in US demand, reported to have grown by around 5% by mid-year, with inventory levels falling back and many plants operating at full capacity.

1.7 Advantages of Corrugated Packaging:

Corrugated packaging offers a number of advantages. They are right weight and compact, thus resulting in saving of transportation costs. They are strong and sturdy. Being collapsible when empty, they save storage space. The flutings impart cushioning property making it deal for packaging of fragile articles. They are extremely versatile and can be used for packaging of variety of products. Corrugated boxes can be printed in one or more colors to make them attractive and enhance their shelf appeal. They can be surface-coated to offer effective resistance against moisture etc. They are ideal both ass transport packs and as retail packs. More and more products are today being packed in corrugated boxes. Corrugated boxes being successfully used for packaging of fruits and other horticulture products.\(^{13}\).

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\(^{12}\) Ibid

\(^{13}\) Ibid, p. M-9
1.8 The distinctive advantages as listed are as below

i) They consume no wood. Hence, there is no drain on our scarce forest resources.

ii) They are cost effective when compared to other packaging materials when viewed in terms of National loss due to deforestation.

iii) They are biologically pure and free from toxic conditions. Hence fruits packed in corrugated boxes are hygienically better.

iv) They provide better respiration which in turn helps in better and quality preservation of fruits.

v) They ensure better safety and security. Bruising loss and damage to the fruit is negligible as compared to wooden cases.

vi) They can withstand loading and unloading operations besides transportation hazards.

vii) They are lighter in weight, collapsible and occupy lesser area. Even the transport cost is less.

viii) They have standardized dimensions and easy to containerize and palletize.

ix) They are printable, have better sales appeal and publicity. They increase sales opportunity and help establish one’s own trade name.

x) Above all, they are recyclable and repulpable, thus they relieve ecological problems.

1.9 Present Status of Corrugated Packaging Industry in India

In the last decade (1996 – 2006), the corrugated packaging industry has grown at remarkable rate. This shows the potential growth in the future. According to the report of Federation of Corrugated Box Manufacturers, the average number of single facers per company has increased from 1.86 to 2.69 per cent. The average production per day per single facer has increased from 1575 Kgs. to 2724 Kgs. The consumption of 7 ply boxes has reduced from 23 per cent to 11 per cent. The consumption of 3 and

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14 Ibid. pp. M-12-13
5 ply boxes has increased from 54 per cent to 86 per cent in the last decade (1996 – 2006). Significant growth is observed in consumption of paper above 150 GSM\textsuperscript{15}.

In the last decade, there is a significant growth in consumption of corrugated box in – ‘Processed Food Industry’, ‘Fruits & Vegetables’, ‘Electronic Industry’ and ‘Consumer Durables’. The large and growing Indian middle class, along with the growth in organized Retail in the country, are driving demand in the packaging industry. Another factor, which has provided substantial stimulus to the packaging industry is, the rapid growth of exports, which requires superior packaging standards for the international market. With this, the need for adopting better packaging methods, materials and machinery to ensure quality, has become imperative for Indian players. Two specific segments can be identified for opportunities in packaging equipment in the Indian market. The Un-organized Sector represents the larger opportunity, given the increasing quality-consciousness of end customers. The cost of equipment and upgrades hold the key to success in this segment\textsuperscript{16}.

1.10 Technical Description of Corrugated Factory:

Corrugated paperboard is the most popular raw material for transport packages of a wide variety of products, varying from fresh fruit and vegetables, consumer-packed manufactured products, household appliances and industrial machinery to semi-bulk transports of various commodities in large bins. It is equally suitable for all the different modes of transport, by sea or by air. This versatility is largely due to the possibility of using different types of raw material combinations and thereby adapting the quality to each particular requirement and distribution system in a tailor-made way.

The manufacture of corrugated paperboard is a very capital-intensive production and consequently, it is not feasible to set up local production facilities at every location. Empty corrugated boxes are also bulky and expensive to transport even in a collapsed state. It seems advisable to set up small, local converting facilities


\textsuperscript{16} Ibid.
(sheet plants), who would buy the corrugated board in large sheets and make the required small quantities of tailor-made boxes locally on simple and inexpensive converting equipment. Standardization of box sizes and quality grades for typical products in the area would certainly also improve the supply situation.

1.10.1 Types of Raw materials

a) Paper:

The outer and inner facings (liners) of corrugated paperboard are usually made from the long softwood fibers of coniferous trees, which have the desired strength properties. These papers, made by the sulphate pulping process, are known as kraftliners (linerboard) and their natural colour is brown. They can also be bleached fully or partly (mottled) white, but the bleaching process reduces the material strength by 5-10%. Linerboards can also contain various amounts of recycled (waste paper) fibres and are then called testliners. Another designation for this material is juteliners, which is improper since it has nothing to do with jute (hessian). The use of recycled fibres in corrugated box liners considerably weakens their strength properties, particularly under tropical conditions. To the layman, testliners might look exactly the same as kraftliners but on close inspection, testliners can be recognized through the presence of miniature black spots (printing ink) or other residues from the waste paper. Sometimes the testliner is made from high quality, selected waste, and dyed to give the appearance of virging kraftliner. Such materials might be denominated as ‘Imitation Kraft’, ‘British Liner’ etc. and often have excellent strength properties.

These values are direct functions of minimum liner weight requirements of the Uniform Freight Classification. By using testliners, substances must be increased to achieve equivalent bursting strength values. The corrugated paper between the facings of corrugated paperboard is called fluting or corrugating medium. The best quality fluting is made from the short hardwood fibres of deciduous trees by a special pulp cooking method. Such fluting is termed as semi-chemical and contains only a small percentage of clean, mill waste called kraft. A large part of the fluting used is manufactured from waste paper and is commonly called bagas medium. This is

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substantially inferior in quality to semi-chemical fluting, unless it is manufactured according to the very latest, specialized technology, including treatment with chemicals etc.

Another very important raw material in corrugated board manufacture is the adhesive used to bond the papers together. Defective application of the adhesive is among the most frequent causes of the failure of corrugated boxes. Sodium silicate, which used to be the main bonding agent used in the corrugated industry, is today almost completely substituted by various forms of starch, mainly corn starch. Chemicals can be added to the adhesive to make it more resistant to moisture in tropical conditions.

b) Adhesives:
- Starch based adhesive are best suited for bonding Kraft paper.
- Sodium Silicate adhesive is not suitable and should be avoided.
- Carrier Starch is used for corrugation and in line lamination, while cooked starch is used for off line lamination.
- Synthetic adhesive is used for pasting manufacturers joint.

c) Stitching Wire
- There are four types of stitching wires used for manufacturers join pins
  - Ordinary
  - Rust Proof
  - Copper Plated
  - Brass

d) Inks
- Oil based inks.
- Polymer based inks.
- Water based inks.
- Inks for Offset printing.
- Inks for Flexo printing.
- Use of water based Flexo inks is increasing globally.

1.10.2 Types of Corrugated Paperboard:
There are four main types of corrugated paperboard:
1.10.2.1 Single-faced Board-

It composes of one flat facing or liner glued to a corrugated medium or fluting. This material is used only for wrapping purposes or as interior fitments/cushioning pads. Single-face corrugated board is not used for box production.

1.10.2.2 Singe-wall or Double-faced Board-

This is made out of two facings or liners, with one corrugated medium or fluting in the middle. More than 90% of all corrugated boxes are manufactured from this type of board.

1.10.2.3 Double-wall Board-

Made out of two facings, two corrugated mediums and an inner liner between the two mediums, i.e. a total of five paper layers. This grade is used for heavy applications, particularly in packaging for exports.

1.10.2.4 Triple-wall Board-

This grade has three corrugated mediums and a total of seven paper layers. Only a few manufacturers make this grade, which is used for very heavy industrial applications: semi-bulk commodity bins etc.

1.11 Types of Flutes\(^{18}\)

There are also four main types of flute configuration for the undulations of the fluting in corrugated paperboard. These are designated by letters, A-flute, B-flute, C-flute and E-flute.

The most popular flute configuration is C-flute, which has replaced most of A-flute corrugated board since less fluting medium (approximately 15%) is required to make C-fluted board. A flute board gives the best top-to-bottom compression resistance, with approximately 15% less for C-flute and 25% less for B-flute. B-flute

\(^{18}\) Ibid. p.93
board, on the other hand, has the best flat crush resistance (50% more than A-flute, 25% more than C-flute) and is used primarily for die-cut boxes, used for fruits and vegetables.

E-flute, which is a very thin grade, finds applications as a raw material for consumer units or display packages, often with a white, multi-coloured printed outer liner. The most common combination of flute types for double-wall corrugated board is B+C. A double-wall box, specified as BC would have the B flute towards the outside and C flute towards the inside of the box.

1.11 Closure of Corrugated Boxes-

Secure closure of corrugated boxes is of utmost importance and every effort should be made to accomplish it effectively. The closure should be at least as strong as the other parts of the box. Three basic closure methods are used for corrugated boxes:

1.11.1 Closing with Adhesive-

Gluing the flaps firmly together, both at the top and the bottom of the corrugated box, is probably the most effective method of closure strength-wise under the conditions prevailing in developing countries. It is labour-intensive, but the costs of raw materials are low. One disadvantage of gluing is that the boxes are difficult to open. Gluing also leaves an opening between the bottom and the top flaps of the box. If the contents have to be protected against dust, it is necessary to use an extra strip of tape to seal the box. Carrier regulations in the United States state that not less than 50% of the flap contact areas must be bonded by the adhesive. To increase the strength of the box it is, however, recommended to have full adhesive coverage of the flap contact areas and to use moisture resistant glue for this purpose.

1.11.2 Closing with Tape-

Various grades of adhesive tapes provide good versatility for closing all types of corrugated boxes. The main grades of tapes are:
a) Plain gummed paper tapes.
b) Reinforced gummed paper tapes.
c) Plastic tapes.

The first two categories have to be activated by moistening with water, a fairly
difficult operation if a good result is to be achieved. Plain paper tapes must be of
heavy substance and good quality Kraft paper grade. Plastic tapes, e.g. vinyl-based,
are self-adhesive, very strong but also very expensive in material costs. Slotted type
boxes can be closed either by two strips (usually reinforced or plastic tapes) or six
strips of tape. United States carrier regulations include detailed strength specifications
for the materials used in both methods. The paper tape used in six strips sealing must
be not less than 2 inches/50 mm wide. Reinforced tapes should be used for two strips
sealing, not less than 3 inches/75 mm wide and extending not less than 2\(\frac{1}{2}\)
inches/60mm over the box ends (in the United Kingdom: 2 inches/50mm). Corrugated
box sealing with tapes provides good protection against contamination of the contents,
tapes can be preprinted with advertising (easy to detect pilferage), the boxes are easy
to open and reusability is facilitated. Quality requirements for the paper and
difficulties in the proper application of the tapes are major disadvantages.

1.11.1.3 Closing with Staples or by Stitching-

Stapling utilizes preformed metal fasteners dispensed from magazine-fed
equipment, whereas stitching forms a wire fastener from a coil of wire during the
fastening process. In closing corrugated boxes, stitching is used only for the bottom
part of the box, stapling can also be used to close the top part with the help of self-
clinching stapling equipment. Carrier regulations in the United States require regular-
sized stitches or staples to be placed on each side of the centre seam and along the end
edges in areas where the outer flaps overlay the inner flaps, and spaced not more than
2\(\frac{1}{2}\) inches/60 mm apart. Large-sized staples (width 1\(\frac{1}{2}\) inch/30 mm) may be used
across the centre seam and along the end edges, spaced not more than 5 inches/127
mm apart.

Stapling or stitching is a relatively fast and inexpensive method of closing
corrugated boxes. It is not much affected by climatic conditions, and no drying or
setting time is required. However, it does not provide the same rigidity to the boxes as
gluing since the staples have a tendency to work themselves loose. Top closure requires good precision and good quality boxes. No protection is provided against contamination of the contents. The use of steel or plastic strapping should hence be mentioned, not as a closing method but as a reinforcement of the already closed corrugated box. Strapping can be combined with any of the abovementioned methods of box closure. Considering the conditions in developing countries, the best results would probably be achieved by closing the corrugated boxes with adhesive and afterwards using plastic strapping as reinforcement.

1.12 Economical Dimensions of Corrugated Boxes

The most economical corrugated box style is ‘Regular Slotted Container’ (RSC) with regards to minimizing board utilization while maximizing the enclosed volume. For boxes with identical cubic volume, alteration of box shapes (relation between the length, breadth and height of the box), however, changes the amount of board required to make up the box. The prime reason for this is the different degrees of overlapping in the flap arrangements of the boxes. The most economical shape is achieved when the ratio of length: width: height equals to 2:1:2.

Since the cost of the raw materials (area of the board) stands for 70-80% of the total cost of a corrugated box, it is very important to arrange the proportions of the box in a way which is most economical in board usage. Very often, low and wide boxes are used because they are easier to pack. Taking, metal cans as an example; they could fairly easily be packed from the end of the box with considerable savings in board consumption as a result. Another example, which shows that there are numerous ways of arranging the shape of a box to achieve minimum board usage. In this case, 24 carton (11x4x15 cm) are grouped in different ways and the board usage (in square meters/corrugated box) is shown for the various arrangements. It will be noted that the consumption of the board can vary from 0.494m² to 0.675m², the latter having a board wastage factor of P = 36%.

In this context, it is worth mentioning that although present trends towards metrification favour counting the number of articles in a box in 10s, a better flexibility in choosing economical box dimensions is achieved by counts of 6, 12, 24 etc. It must

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19 Ibid. p.97
be appreciated, however, that a box can be economical in board usage but not necessarily in total costs, due to converting machinery limitations or the standard paper widths that are available. Another factor which, unfortunately, has to be considered is the effect on the stacking strength, which is lower for a box of economical proportions.

We may observe that the most important tests for corrugated fiberboard are the edge crush test and the bursting test. The other two, puncture test and flat crush test, cannot however, be disregarded. In fact, an appropriate balance between the principal corrugated board properties is necessary. Once the corrugated board has been converted into the final product, boxes, these can be submitted (with or without their contents) to various performance tests which give indications about the expected strength of the boxes under various handling conditions. Following are the most important performance tests:

1.13 Types of Test:

1.13.1 Compression Test-

A box, either empty or with its eventual interior fitments, is compressed between the plateaux of a large compression tester. The results can be reported as alternatively.

- Maximum load sustained (Kp or lbs).
- Maximum load (kp) and deflection in (mm or inches) at failure.
- Maximum load within specified deflection.

The compression strength values recorded by this test method cannot be used as such to determine the actual stacking performance of a box, i.e. how much load it will safely take. The following additional factors must be taken into consideration. The increase in humidity between the laboratory atmosphere and the actual shipping atmosphere. It might be noted that with an increase in RH from 50% to 95%, the box compression strength will decrease by approximately 60%. The effect of storage time. After, say, 30 days storage, the boxes may have only about 80% of their original stacking strength. The stacking pattern or types of pallets used. Displacement of 2cm in stacking can result in a loss of compression strength of about 40%. Interlocking stacking of the boxes can give as much as 50% loss of stacking strength, and the use
of pallets with an open under deck, a loss of up to 65%. The residual strength factors can be mathematically combined by multiplication and the result shows that the box retains only 14% of its original, laboratory measured compression strength value. However, in this case, no account has been taken of the stacking support provided by the contents of the box.

1.13.2 Drop Test-

A box with its actual or simulated contents is dropped from a specified height and in predetermined position. A test cycle usually consists of a number of drops with the box in different positions. The results are recorded as visual observations. The drop test is very simple to carry out, even without equipment, and, whatever test cycle is used, will give valuable information about the strength and performance of the boxes.

1.13.3 Vibration Test-

This test provides an accelerated simulation of transportation vibration effects. A box, or a stack of boxes or even a full pallet-load of boxes, with normal or simulated contents is subjected to controlled vibrations on a special vibration table. This test is used to find out the expected damage by vibration during transport, the efficiency of the interior fitments and cushioning materials, the closures of the boxes etc. the equipment for the test is highly specialized and expensive.

1.14 Certification Schemes for Fibre board Boxes

In Europe and the United States, most fibreboard boxes are certified in compliance with existing standardized requirements. These requirements are usually specified by the rail or road freight organizations, by industry organizations or by standards institutes. The importance of the certification system to the box user is that once the optimum quality requirements for performance by the box to successfully ship the goods have been established, the user is then assured that the future supplies ordered to that specification would be of the same quality. Criteria for the quality control of the boxes delivered have thereby been established and tests can be carried
out to control that the quality specifications have been observed by the supplier. Most corrugated box manufacturers have, at least, some of the basic equipment for this purpose. Neutral testing with more elaborate equipment can be carried out by an independent testing laboratory at reasonable costs.

The bursting strength value is still the dominating factor in official box specifications, of which the most widely used is Rule 41 of the Uniform Freight Classification in the United States.

The minimum requirement for corrugated boxes is concerned with the specifications for rail transport. Equivalent requirements for road transport are contained in the U.S. National Motor Freight Classification (Rule 222). Both rules have been developed for domestic shipments, while in the United Kingdom different specifications have been established for export shipments. It should also be noted that boxes for fresh fruit and vegetables (except bananas, onion sets and papayas) are exempted and separate specifications have been laid down under item 41816 of the U.S. Uniform Freight Classification. There are no general specifications for corrugated boxes used in air or sea transport.

1.15 Performance of Corrugated Boxes in Tropical Climates

Although the corrugated box is the most widely used shipping container for all kinds of products, it has one definite drawback, its susceptibility to moisture in the air (Relative Humidity: RH). Paper is a very hygroscopic material and the lower the quality of the paper, the more moisture it absorbs. Consequently, the user of corrugated boxes cannot expect satisfactory performance out of the boxes unless they are made out of first-class paper raw materials, preferably even especially treated to be moisture-resistant, combined with waterproof adhesives and possibly even surface treated with wax or plastic to make them water repellent.

A particular difficulty in determining corrugated box quality is to relate laboratory test results to performance in the field under tropical conditions. Laboratory tests, in order to be reproducible, must be carried out under controlled atmospheric conditions (conditioning of the samples to be tested).
It is obviously far from the existing field conditions in the tropics. The Technical Association of the Pulp and Paper Industry of the United States (TAPPI) has, therefore, adapted three additional standard atmospheres for testing.

1.16 Emerging Trends in Packaging Industry\textsuperscript{20}

The global packaging market stood at USD 799 billion (bn) in 2012 and is estimated to have reached USD 824 bn in 2013. On the other hand, the Indian packaging industry is estimated to be USD 27.6 bn in 2013 and is expected to grow to USD 43.7 bn by 2016. Indian packaging industry has been growing at 12\% per annum in the last few years. India’s per capita consumption of packaging is 4.3 Kg per person per annum, as against 42.0 Kg for Germany and 20.0 Kg for China. This offers immense opportunity to the units operating in the packaging industry. The Indian packaging industry is dominated by the unorganized sector. As per an estimate of Indian Institute of Packaging (IIP), there are roughly 22000 units operating in the packaging industry in India and nearly 85\% of them are MSMEs. The contribution of the MSMEs to the total revenue of the industry is approx. 50\%.

The Indian packaging industry is predominated by the rigid packaging, which constitutes approx. 80\% of the total packaging demand. Rigid packaging is the oldest and most conventional form of packaging in India. Corrugated packaging is an important slug-segment of the rigid packaging accounting for the majority share in the Indian packaging industry. India is currently ranked 15th in the world for its paper and paperboard consumption. End-user wise, food packaging contributes the maximum share in the packaging industry.

1.16.1 Corrugated Packaging\textsuperscript{21}

The Indian corrugated packaging is presently worth USD 6.6 bn and has shown an annual growth of 12-14\% in the last five years. While India accounts for 3-4\% of total packaging supply of the world, almost 43\% of the total volume of world-wide corrugated packaging is produced by India. This underscores the importance of

\textsuperscript{20} A New Role Packed and Delivered- A Report by Onicra Credit Agency of India, New Delhi, accessed on http://www.onicra.com/images/pdf/Publications/PackagingIndustryfinal.pdf

\textsuperscript{21} Ibid
corrugated packaging in India. Corrugated packaging plays an important role in supply chain management when used as shipping containers. With the advancement of technology in manufacturing of corrugated boxes and printing on the same, use of corrugated boxes for display/promotional packs, point of purchase packaging (POPs) and dispensers is going up. The total demand for paper in India is estimated to be 6 million tonnes, of which 40% is consumed by the packaging industry. There are over 4000 corrugated packaging units in India employing approx. 0.5 million population and converting about 2.4 mn ton of kraft paper into corrugated boxes. Most of these units are SMEs operating in remote locations near the units driving their demand. Due to the low level of technology being used by these units, they can be set up anywhere but suffer from over capacity, high manual operations, low productivity and do not meet the international standards.

1.16.2 Food Packaging\textsuperscript{22}

Food packaging accounts for 48% of the total packaging industry, contributing the largest share in the industry. Moreover, the area is highly unexplored as the value addition to food in India is only 7% as compared to 23% in China, 45% in Philippines, and 188% in the UK. The food processing industry is growing at 6-7% and the retail sector is also expected to grow at 14-15% per annum till 2020. The food packaging segment is expected to grow at 15-20% backed by surging demand from the nuclear family system, increasing young population and per capita income, a higher propensity to spend, health awareness and a higher acceptance of new products. The food packaging segment in India faces competition from China and Thailand, where the taxes and import duties are comparatively lower. India needs to depend upon imports for latest packing technology and packaging material of international standards. Higher taxes and import duties affect the cost competitiveness of the food packaging units in India.

1.17 Emerging Trends in Indian Packaging Industry\textsuperscript{23}

\textsuperscript{22} Ibid.
\textsuperscript{23} Ibid
The packaging industry has evolved from ‘packing’ in its naive form to ‘packaging’ which supports the distribution and marketing functions for the packed product. Primitive packaging refers to wooden barrels, baskets of reeds, woven bags etc. Presently, with the advancement of technology, packaging can be of several types, executing several functions at the same time. Flexible packaging, resalable packaging, tamper-resistant packaging, Radio Frequency Identification (RFID) tags on packaging are a few examples of how the industry has evolved over the years.

1.17 Flexible Packaging

Flexible packaging material market is approx. USD 671 mn in FY13. It includes custom designed film, foil and paper based laminate or coextruded structures for primary packaging of products in solid, liquid or powder form in consumer size packs. Rigid containers and pet bottles are being fast replaced by flexible packaging. The material being used is also changing rapidly. From paper to cellophane plastic wrappers to aluminium foil to metalized and coextruded foils: the change has been quite rapid and new features are being built into the packaging material to add value for its customers. Advancement in technology has led to the propagation of metalized film (laminate and co extrusion based) packaging material that combines the benefits of both metals and plastics. Apart from being more cost effective, it offers versatility in the packaging material with improved protection against light, water, moisture and gases thereby increasing the aroma and the shelf life of the products. The metallic base allows for high gloss and eye-catching aesthetic packaging. The metalized film production world-wide is 0.45 mn. ton per year and is expected to grow at 7-8% per annum, ultimately boxes are also required on large scale.

1.18 Demand Drivers

1.18.1 Growth in Retail

Increased presence of global multinational companies has increased the demand in the processed food, beverages, cosmetics, consumer products, toiletries

\[24\text{ Ibid}\]
\[25\text{ Ibid}\]
and pharmaceutical space. The manufacturing units, especially the fast moving consumer goods (FMCG) manufacturers are exploring new markets through newer retail models. This in turn, has not only widened the markets but also increased the demand of packaging of the products.

1.18.2 Growth of Smaller Packaging

Emerging nuclear families, increasing number of working women, rising per capita income, and growing urbanization have lead to an increase in the demand of the daily use products in smaller packages. The growth in retail sector in India, especially driven by growth in rural segment and the lower income group has also pushed up the demand for smaller units of the products.

1.18.3 Changing Lifestyle

India has been witness to a lot of cultural change since globalization. Women are spending more time outside their home and people are having less time to cook and are trying newer cuisines. ‘On the go’ lifestyle, resulting from less time at the disposal of people and a change in the taste of the consumers has encouraged fast food and ready to cook food. People are buying more of branded products, which may be due to their being more health conscious and/ or trendy. Packaging plays an important role in creating and sustaining the brand equity. With a higher per capita income, the demand of certain products has also increased, such as personal hygiene products and convenience products.

1.19 Conclusion:

The packaging industry, especially corrugation packaging industry has grown at remarkable rate in the world and even in India. This industry has higher potential growth in the future. The consumption of packaging material is increasing as the economy is moving towards more commercialization. The various types of packaging materials have larger demand in India. Corrugated boxes are best for packaging all types of materials, since this does not create environmental problems. Emerging retailing industry also has led growth of corrugated packaging industry in India. There has been a significant growth in consumption of corrugated box in ‘Processed Food
Industry’, ‘Fruits & Vegetables’, ‘Electronic Industry’, ‘Pharma Industry’, ‘Automobile Industry’, ‘Chemical Industry’ and ‘Consumer Durables’. The large and growing Indian middle class, along with the growth in organized Retail in the country, are driving demand in the packaging industry. Another factor, which has provided substantial stimulus to the packaging industry is, the rapid growth of exports, which requires superior packaging standards for the international market. With this, the need for adopting better packaging methods, materials and machinery to ensure quality, has become imperative for Indian players. Two specific segments can be identified for opportunities in packaging equipment in the Indian market. The Un-organized Sector represents the larger opportunity, given the increasing quality-consciousness of end customers. Therefore, the researcher has selected corrugated industry for the study. The corrugated factories have been located in and around Pune city, which is the study area of the researcher.