

Corrugated 101

Corrugated vs. Cardboard

- The term "cardboard box" is commonly misused when referring to a corrugated box. The correct technical term is "corrugated fiberboard carton."
- *Cardboard boxes* are really chipboard boxes, and used primarily for packaging lightweight products, such as cereal or board games.
- *Corrugated fiberboard* boxes are widely utilized in retail packaging, shipping cartons, product displays and many other applications requiring lightweight, but sturdy materials.

Corrugated Composition

Corrugated fiberboard is comprised of linerboard and heavy paper medium. Linerboard is the flat, outer surface that adheres to the medium. The medium is the wavy, fluted paper between the liners. Both are made of a special kind of heavy paper called containerboard. Board strength will vary depending on the various linerboard and medium combinations.

- **Single Face:** Medium glued to 1 linerboard; flutes exposed
- **Single Wall:** Medium between 2 liners
- **Double Wall:** Varying mediums layered between 3 liners
- **Triple Wall:** Varying mediums layered between 4 liners

Flute Facts

Corrugated board can be created with several different flute profiles. The five most common flute profiles are:

- **A-Flute:** Original corrugated flute design. Contains about 33 flutes per foot.
- **B-Flute:** Developed primarily for packaging canned goods. Contains about 47 flutes per foot and measures 1/8" thick
- **C-Flute:** Commonly used for shipping cartons. Contains about 39 flutes per foot and measures 5/32" thick
- **E-Flute:** Contains about 90 flutes per foot and measures 1/16" thick
- **F-Flute:** Developed for small retail packaging. Contains about 125 flutes per foot and measures 1/32" thick
- Generally, larger flute profiles deliver greater vertical compression strength and cushioning. Smaller flute profiles provide enhanced structural and graphics capabilities for use in retail packaging.

Different flute profiles can be combined in one piece of combined board. For example, a triplewall board may contain one layer of A-flute medium with two layers of C-flute medium. Mixing flute profiles allows designers to adjust compression strength, cushioning strength and total thickness of the combined board.

How to Measure a Box

Boxes are generally measured from the inside, with the dimensions referring to the opening of an assembled box.

Inside dimensions are used for measuring because the corrugated board thickness may vary. A box constructed of B flute will not have the same outer dimensions as a box made from E flute.

When measuring the inside of an existing box, make sure to measure from the center of the score (the crushed fold line).

Dimensions should always be stated in the sequence of Length, Width and Depth (exceptions include bookfolds, bin boxes and dividers, where the sequence is Width, Length and Depth).

The length is always the longer dimension, and the width is always the shortest dimension, measured along the opening of the box. The depth is the distance between the opening and the opposite panel.

Outer dimensions may need to be communicated for shipping and pallet configuration purposes. When listing outer dimensions, always include "OD" with the size (e.g., 10"x22"x12" OD).

Box Style Definitions and Abbreviations

The majority of box styles fall into one of the following general categories: Slotted Boxes, Telescope Boxes, Folders, Rigid (or Bliss) Boxes, Self-Erecting Boxes and Interior Forms. In addition, corrugated boxes can be custom designed to meet the specific needs of the customer.

Slotted Boxes are generally made from a single piece of corrugated fiberboard. The blank is scored and slotted to permit folding. Boxes are shipped and stored flat and assembled as needed by the user. Some of the most common types include:

Regular Slotted Container (RSC) — All flaps have the same length, and the two out flaps are one-half the container's width, so that they meet at the center of the box when folded. The RSC is the most common box style.

Half Slotted Container (HSC) — Same as a Regular Slotted Container (RSC), but without one set of flaps.

Overlap Slotted Container (OSC) — All flaps have the same length; the outer flaps overlap by one inch or more. The box is usually closed with staples driven through the overlap area. This style of box is used when the length of the box is considerably greater than the width, resulting in a long gap between the inner flaps. The sealed overlap helps to keep the outer flaps from pulling apart.

Full overlap Slotted Container (FOL) — All flaps have the same length (the width of the box). When closed, the outer flaps come within one inch of complete overlap. This style is especially resistant to rough handling and provides extra product cushioning and stacking strength.

Center Special Slotted Container (CSSC) — Inner and outer flaps are cut to different lengths. Both sets of flaps meet at the center of the box. This style is especially strong because both the top and bottom have double the thickness of corrugated board. The inner flaps, with no gap, provide a level base for products.

Center Special Overlap Slotted Container (CSO) — All flaps have the same length (one-half the length of the box). The length of the box can be no more than twice its width. The inner flaps meet at the center of the box, providing a level base and full top protection.

Center Special Full Overlap Slotted Container (SFF) — Inner and outer flaps are cut to different lengths. When closed, the inner flaps meet at the center of the box, and out flaps fully overlap. With three full layers of combined board over the entire top and bottom, this style provides extra cushioning and stacking strength.

Telescope Boxes usually consist of top and bottom pieces that fit over each other. "Telescope Style" generally describes a box where the cover extends over at least two-thirds of the depth of the bottom piece, where a Box with Cover indicates a box where the cover extends less than two-thirds of the depth. Common types include:

Full Telescope Design Style Container (FTD) and Design Style Container with Cover (DSC) — Two-piece boxes made from two scored and slotted blanks (trays).

Full Telescope Half Slotted Container (FTHS) — The two-piece body is made from two half-slotted containers.

Folders consist of one or more pieces of combined board, with an unbroken bottom surface and scored to fold around the product. Popular styles include:

One Piece Folder (OPF) — One piece of board is cut so that it provides a flat bottom, with flaps forming the sides and ends, and extensions of the side flaps meeting to form the top.

Five Panel Folder (5PF) — A single cut and scored piece features a fifth panel used as the closing flap, completely covering a side panel.

Trays are formed from a single piece of combined board, with the design featuring an unbroken bottom and several layers of corrugated in the end panels. They are frequently used as inner containers for parts, delicate produce or mail pieces.

Rigid (Bliss) Boxes include two identical end panels and a body that folds to form the two side panels, an unbroken bottom and the top. Flaps are used to form the joints. Once the joints are sealed, the box is considered rigid.

Self-Erecting Boxes typically feature regular slotted container or telescope-style tops.

Interior Forms include a wide variety of build-ups, dividers, partitions and other inner packing pieces. They can be used to separate or cushion products, to strengthen the box or to fill voids. They may be simple rectangle, scored, slotted or die-cut shapes. Common formats include:

Pads are plain shapes of corrugated or solid fiberboard, used to fill spaces or separate layers or sections of products.

Tubes are scored rectangles, folded to form a multi-sided structure.

Partitions (or Dividers) provide a separate cell for each item in a box. Primarily used for packaging glassware or other fragile items.

Inner Packing Pieces are scored and/or folded pieces of fiberboard used for cushioning, suspension and separation, and to fill voids.

Inner Pack Forms are usually die cut fiberboard pieces designed to position and support products away from the walls of the box for added protection.

Glossary of Terms

Adhesive: The substance used to hold plies of solid fiberboard together, to hold linerboard to the tips of flutes of corrugated medium, or to hold overlapping flaps together to form the joint or to close a box.

Bale: A shaped unit of materials, enclosed in a fiberboard container or other wrapping, bound by strapping, rope or wire.

Basis Weight: An attribute of containerboard, but the values may be determined from the combined corrugated board. When determining the basis weight from combined board, the take-up factor of the corrugated medium, which varies with flute size, and the weight of the adhesive must be considered.

Bending: The ability of containerboard or combined board to be folded along scorelines without rupture of the surface fibers to the point of seriously weakening the structure.

Blank or Box Blank: A flat sheet of corrugated board that has been cut, scored, and slotted, but not yet glued together.

Box Manufacturer's Certificate (BMC). In the U.S., a statement printed in a round or rectangular design on a corrugated box flap that certifies the box conforms to all applicable standards, and identifies its manufacturer. Sometimes referred to as a class stamp or cert stamp.

Box Style: Distinctive configuration of a box design, without regard to size. A name or number identifies styles in common use.

Boxboard: The types of paperboard used to manufacture folding cartons and set up (rigid) boxes.

Built-up: Multiple layers of corrugated board glued together to form a pad of desired thickness, normally used for interior packing.

Bulk: Unpackaged goods within a shipping container. Also, a large box used to contain a volume of product (e.g., "bulk box").

Bundle. A small group of boxes grouped together for shipment, usually with plastic banding.

Caliper: Usually expressed in thousandths of an inch (mils) or sometimes referred to as "points." Caliper measurements are also used as an indirect measure of manufacturing quality.

Cardboard: A thin, stiff pasteboard used in the creation of playing cards, signs, etc. Term is often misused to refer to Boxboard (folding cartons) and Containerboard (corrugated boxes).

Carton: A folding box made from boxboard, used for consumer quantities of product. A carton is not recognized as a shipping container.

Case: As used by the packaging industry, a corrugated or solid fiberboard box.

Chipboard: A paperboard generally made from recycled paper stock. Uses include backing sheets for padded writing paper, partitions within boxes and the center ply or plies of solid fiberboard.

Combined Board: A fabricated sheet assembled from several components, such as corrugated or solid fiberboard.

Compression Strength: A corrugated box's resistance to uniformly applied external forces. Top-to-bottom compression strength is related to the load a container may encounter when stacked. End-to-end or side-to-side compression may also be of interest for particular applications.

Containerboard: The paperboard components (linerboard, corrugating material and chipboard) used to manufacture corrugated and solid fiberboard. The raw materials used to make containerboard may be virgin cellulose fiber, recycled fiber or a combination of both.

Corrugated Board, Corrugated Fiberboard. Corrugated board is comprised of one or more layer of wavy corrugated medium (fluting) and one or more layer of flat corrugated linerboard.

Corrugator: The machine that unwinds two or more continuous sheets of containerboard from rolls, presses flutes into the sheet(s) of corrugating medium, applies adhesive to the tips of the flutes and affixes the sheet(s) of linerboard to form corrugated board. The continuous sheet of board may be slit to desired widths, cut off to desired lengths and scored in one direction.

Design Style: A style of fiberboard trays or caps having flaps scored, folded and secured at flange side walls forming the depth, as opposed to a slotted style having a set of major and minor closing flaps.

Die-Cut. A box that is stamped out from a steel rule die, as opposed to being produced on a flexo folder gluer. Die-cut boxes provide greater design options and tighter size tolerances.

Dimensions. For a regular slotted containers (RSC), box dimensions are expressed as length x width x height, always using inside dimensions.

Double Wall. A corrugated board construction where two layers of medium are glued between three layers of flat linerboard facing.

Edge Crush Test – ECT. The Edge Crush Test is a standard industry measure of the stacking strength of corrugated board. The amount of force needed to crush on-edge combined board is a primary factor in predicting the compression strength of the completed box. When using certain specifications in the carrier classifications, minimum edge crush values must be certified.

Facings: Sheets of linerboard used as the flat outer members of combined corrugated board. Sometimes called inside and outside liners.

Fiberboard: A general term describing combined paperboard (corrugated or solid) used to manufacture containers.

Flaps: Extension of the side wall panels that, when sealed, close the remaining openings of a box. Usually defined by one scoreline and three edges.

Flexo Folder Gluer: A machine, usually capable of running at high speed that prints, folds, cuts, and glues sheets of corrugated board, converting them into shipping boxes.

Flute: The wavy layer of corrugated medium that is glued between the flat inner and outer sheets of linerboard to create corrugated board. Fluting generally runs parallel to the height of a shipping box.

Joint: The opposite edges of the blank glued, stapled, wire stitched, or taped together to form a box.

Kraft: German word meaning "strength"; designating pulp, paper or paperboard produced from wood fibers.

Liner: A creased fiberboard sheet inserted as a sleeve in a container and covering all side walls. Used to provide extra stacking strength or cushioning.

Linerboard: The flat sheets of paper that comprise the outer surfaces of a sheet of corrugated board.

Medium: The paperboard used to make the fluted layer of corrugated board.

Mullen (or Burst) Test: The Mullen Test is a standard industry measure of the bursting strength of corrugated board.

Overlap: A design feature wherein the top and/or bottom flaps of a box do not butt, but extend one over the other. The amount of overlap is measured from flap edge to flap edge.

Pad: A corrugated or solid fiberboard sheet, or sheet of other authorized material, used for extra protection or for separating tiers or layers of articles when packed for shipment.

Palletizing: Securing and loading containers on pallets for shipment as a single unit load, typically for handling by mechanical equipment.

Panel: A "face" or "side" of a box.

Paperboard: One of the two major product categories of the paper industry. Includes the broad classification of materials made of cellulose fibers, primarily wood pulp and recycled paper stock, on board machines. The major types are containerboard and boxboard. (The other major product group of the paper industry is paper, including printing and writing papers, packaging papers, newsprint and tissue.)

Partition: A set of corrugated, solid fiberboard or chipboard pieces that interlock when assembled to form a number of cells into which articles may be placed for shipment.

Ply: Any of the several layers of linerboard or solid fiberboard.

Point: Term used to describe the thickness or caliper of paperboard, where one point equals one thousandth of an inch.

Puncture Resistance: The puncture resistance of combined board indicates the ability of the finished container to withstand external and internal point pressure forces and to protect the product during rough handling. This method is used on heavy double wall and triple wall as an alternative to burst.

Regular Slotted Container (RSC): A box style created from a single sheet of corrugated board. The sheet is scored and slotted to permit folding. Flaps extending from the side and end panels form the top and bottom of the box. The two outer flaps are one-half the container's width in order to meet at the center of the box when folded. Flute direction may be perpendicular to the length of the sheet (usually for top-opening RSCs) or parallel to the length of the sheet (usually for end-opening RSCs).

Score or Scoreline: An impression or crease in corrugated or solid fiberboard, made to position and facilitate folds.

Scored and Slotted Sheet: A sheet of corrugated fiberboard with one or more scorelines, slots or slits. May be further defined as a box blank, a box part, a tray or wrap, a partition piece, or an inner packing piece.

Seam: The junction created by any free edge of a container flap or panel where it abuts or rests on another portion of the container and to which it may be fastened by tape, stitches or adhesive in the process of closing the container.

Set-up Boxes: Boxes that have been squared, with one set of end flaps sealed, ready to be filled with product. An article that is packed for shipment in a fully assembled or erected form.

Sheet: A rectangle of combined board, untrimmed or trimmed, and sometimes scored across the corrugations when that operation is done on the corrugator. Also, a rectangle of any of the component layers of containerboard, or of paper or a web of paperboard as it is being unwound from the roll.

Slit: A cut made in a fiberboard sheet without removal of material.

Slit Score: Shallow knife cuts made in a box blank to allow its flaps and sides to be folded into a shipping box.

Slip Sheet: A flat sheet of material used as a base upon which goods and materials may be assembled, stored and transported.

Slot: A wide cut, or pair of closely spaced parallel cuts including removal of a narrow strip of material made in a fiberboard sheet, usually to form flaps and permit folding without bulges caused by the thickness of the material. Common widths are 1/4 in. (6 mm) and 3/8 in. (9 mm).

Stacking Strength: The maximum compressive load a container can bear over a given length of time, under given environmental/distribution conditions, without failing.

Tensile Strength: Indicates the containerboard's resistance to breaking when it is pulled into or through equipment during the converting and printing processes.

Tube: A sheet of combined boards, scored and folded to a multi-sided form with open ends. It may be an element of a box style or a unit of interior packing that provides protection and compression strength.

Unit: A large group of bundled or unbundled boxes, banded and/or stretch filmed together for shipment.

Unitized Load: A load of a number of articles or containers, bound together by means of tension strapping, plastic shrink or stretch films.

Web: A continuous sheet of paperboard or paper.

Wrap-around Blank: A scored and slotted sheet of corrugated fiberboard that is formed into a box by folding it around its contents. The user makes both the flap and joint closure.

Box Certificates

Max Wt. Box/Contents (lbs.)	Min. Burst Test Single/Double Wall (lbs. per sq. in.)*	Min. Edge Crush Test (ECT) (lbs. per in. width)
Single Wall Corrugated Boxes		
20	125	23
35	150	26
50	175	29
65	200	32
80	250	40
95	275	44
120	350	55
Double Wall Corrugated Boxes		
80	200	42
100	275	48
120	350	51
140	400	61
160	500	71
180	600	82
Triple Wall Corrugated Boxes		
240	700	67
260	900	80
280	1100	90
300	1300	112

The Box Maker's Certificate (BMC) is placed on an outside bottom flap. This symbol identifies the manufacturer and serves as a symbol of compliance with the stated specifics. The stamp identifies the material and certifies the results of the Mullen Bursting Test or the Edge Crush Test.

The Mullen Bursting Test measures a box's ability to withstand external or internal forces, and to contain the contents during handling. The test certifies that the box can withstand the stated pressure (lbs. per sq. in.) as applied by a Mullen Tester.

The Edge Crush Test measures the amount of force (lbs. per in.) needed to cause compressive failure of an on-edge specimen of corrugated board. The result is a primary factor in determining the compression strength of a completed box.

Printing 101

Why Have a Printed Box?

1. Brand Recognition
2. Consumers respond to graphic packaging
3. Communicate Environmental Focus
4. Ease for Retailers

Printing Methods

Direct Print

Direct Print either onto the combined board or onto the linerboard before being glued to the fluted medium:

Printing onto Combined Board – Commonly known as post print, this printing is performed after the board is combined and cut into sheets.

Advantage: It is typically the least expensive way to print, making it ideal for short runs or where cost is the primary consideration.

Printing onto the Linerboard – before being glued to fluted medium. This can result in a more refined image than printing directly onto the combined board.

Advantage: It is the middle ground between direct printing and sheet printing in terms of both price and quality.

Sheet Printing

Sheet is printing on a separate sheet, which is then glued to the combined board. There are two ways to print on a separate sheet which is later glued to the box: Single Face Laminating and Labeling Combined Board:

Single Face Laminating – This method laminates a prepared sheet directly to the open flutes of a single face. White-coated or solid bleached top sheets (ranging from .008 to .012 in) printed on web or sheet-fed presses can be used to obtain litho-quality graphics on containers and displays.

Advantage: In addition to excellent graphics, this method offers large format capabilities and excellent cut-to-print registration.

Labeling Combined Board – This method prints onto a sheet of paper or label stock that is later glued to the combined board. It is also known as litho labeling. The downside is that it is limited by sheet size.

Advantage: Printing on a separate sheet offers a choice of materials and design options. This process also results in excellent graphics, high quality images with bright colors and sharp pictures.

Flexography

Flexography: This process uses flexible rubber or polymer plates, or an image etched into a rubber roller, to transfer images. Similar to letterpress, it uses raised images on the rubber plate, and the plate is pressed against the printing material, sometimes leaving a ring of ink impression around the image as the rubber lifts away from the paper.

Fast-drying, water-based inks are generally used, which allow for fast running speeds. The print quality depends on many variables in the flexo process, but is very influenced by the absorbency of the stock or material being printed.

Flexographic presses are web fed, so size is not limited. Flexography easily prints onto rough materials like fiberboard, and is well suited for printing large areas of solid color with high gloss and brilliance. It is possible to obtain line and half-tone quality from this process using direct-to-plate digitally imaged plates and UV inks for higher resolution dots during four-color process printing.

Advantage: Fast printing speed, quick set-ups, cost-efficient, large format capability.

Line Screen

The higher the line screen, the more refined your graphics will look. Choose a line screen that will meet the demands of your design.

Tooling and Plates

Print plate costs range from \$500 to \$5,000 depending on graphics.

Coatings

Coatings or finishes to be added to the box after printing.

Water and Moisture resistance – protect from water

Oil and grease resistance – protect from oil and grease

Abrasion resistance – reduce scuffing on inner packages

Gloss and color – change color or add gloss coating in flexographic process.