Design, Print & Packaging Skillnet

www.dppskillnet.ie

Welcome

The Design, Print & Packaging Skillnet is funded by member companies and the Training Networks Programme, an initiative of Skillnets Ltd. funded from the National Training Fund through the Department of Education and Skills.

1

The Irish PACKAGING SOCIETY
Affiliated with I•M3

Corrugated Fibreboard

Presentation by
David Little

2

2

- The first commercially available corrugated box was created and produced in the USA in 1895.
- Until the early 1900's, nearly all shipping was done in wooden crates.

3

Making and converting Corrugated Board

- Overview
- The Corrugator
- The Sheet Plant

4

4

Global Corrugated Market

- 155.7 million tons
- 246.1 billion square meters
- 500 billion corrugated cases

5

EU Corrugated Market

30.7 million tons	56.2 billion square meters
125 billion corrugated cases	(19.7% of Global Mkt)

6

UK Corrugated Market

2.4 million tons

5.3 billion square meters

13 billion corrugated cases

(Ireland at 10% = 1.3 billion cases)
(9.4% of EU Mkt)
(1.6% of Global Mkt)

7

Benefits of Corrugated Fibreboard

Efficient - Safely Collates, Conveys, Protects Robust, Lightweight, Shock resistant

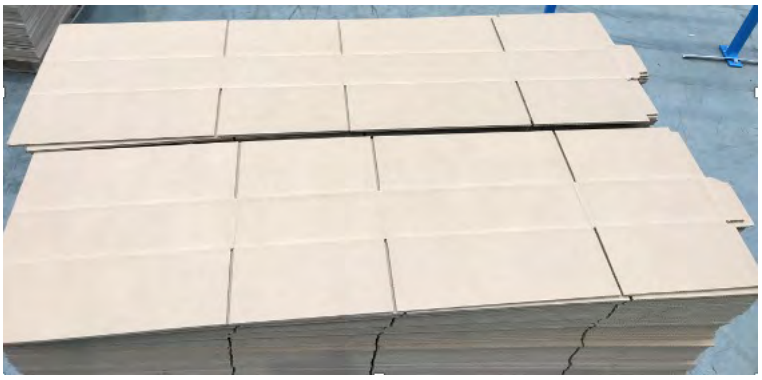
Versatile - Cut & Folded into infinite variety of shapes & sizes, decoratively printed, easily erected

Environmentally Friendly - Natural renewable resource, fully bio-degradeable & recyclable

Cost Effective - Short lead-time, low cost, excellent protection, modular, Sales promotional tool.

8

Typical Slotted Case
RSC / 0201 (before gluing)



9

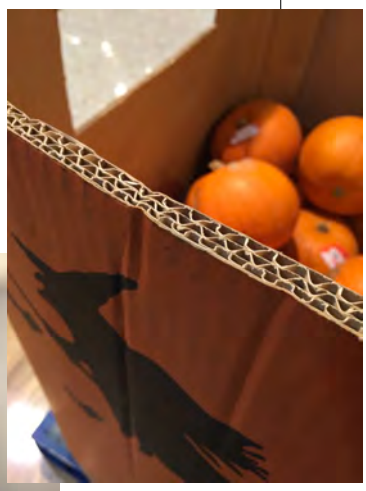
Examples of uses

- Cases or boxes

10

10

Examples of uses



11

Examples of uses

- Trays

Metal cans in a shallow tray

SRP - Case breaks open to give a display tray for these flexible drinks packs

Full height tray for extra protection for these juice packs

12

12

Examples of uses

Shelf ready

13

Examples of uses

Merchandising display unit

14

Examples of uses

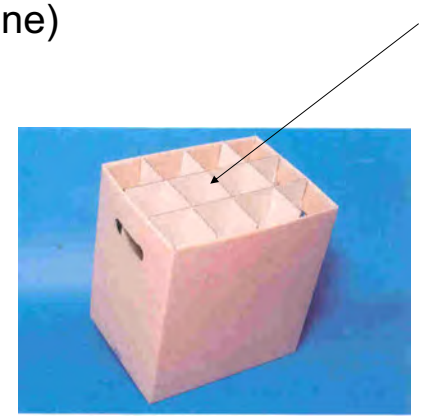
- Point of purchase display cases
  - Used for promotions, often for seasonal products such as Christmas gifts of spirits, confectionery etc.

15

15

Examples of uses

- Fitments inside cases (e.g. dividers inside a case of wine)



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E- Commerce

17

E-Commerce / on-line

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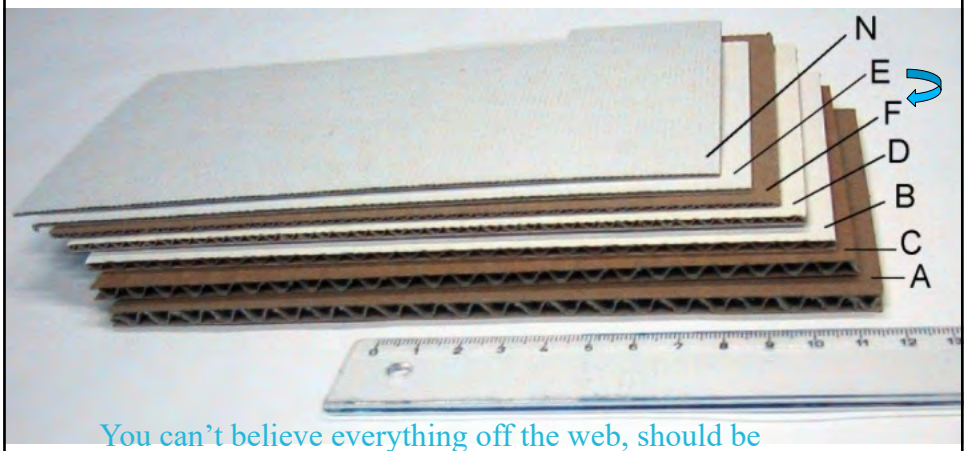
Not alphabetical

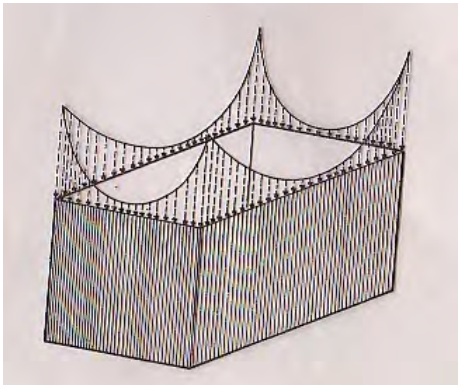


You can't believe everything off the web, should be A,C,B,D?,E, (micro flutes->) F, G, N

19

Packaging For Protection

60% of case strength is in its corners

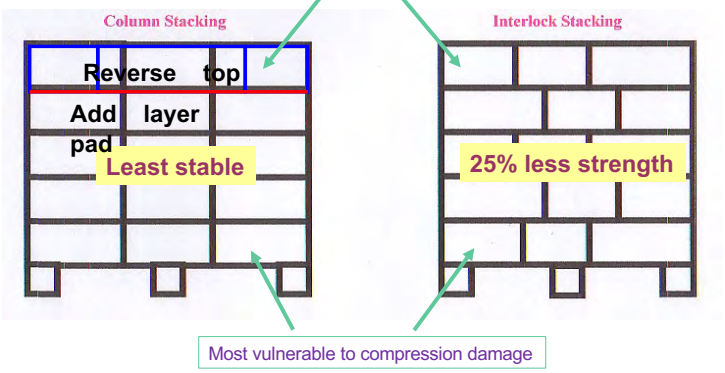


Leonard Little & Associates

20

The Shock Hazard

Most vulnerable to shock damage



Most vulnerable to compression damage

21

21

The Corruguator

22

22

Corrugator

Macarbox Corrugator

23

MACARBOX

PRODUCTS

Main features of Corrugators

- Max. speed 350 m/min.
- Working Width > 2500 mm.
- Single, double and triple wall.
- High productivity and efficiency.
- Low maintenance cost.
- More than 20 years in the market

24

CORRUGATOR

MACARBOX

COMPOSED BY THE NEXT UNITS:

01 - SINGLE FACER CASSETTE TYPE CORRUGATOR UNIT
02 - DOUBLE REEL STAND
03- SPLICERS
04- PREHEATERS
05 - CONVEYOR BRIDGE
06 - DOUBLE BRIDGE
07 - DOUBLE BRIDGE BRAKE + DOUBLE AUTOMATIC ALIGNER
08 - DOUBLE GLUE MACHINE
09 - DOUBLE FACER
10 - ROTARY SHEAR
11 - SLITTER
12 - DOUBLE CUT-OFF
13 - STACKER

25

Players

Sheet Feeders (Only make corrugated board)	Integrated Plants (Corrugator & Sheet Plant)	Sheet Plants (Only convert board to boxes)	Others (Box Importers / Distributors / Factoring – Do not manufacture.)

26

Georgia pacific
https://youtu.be/C5nNUPNvWAw

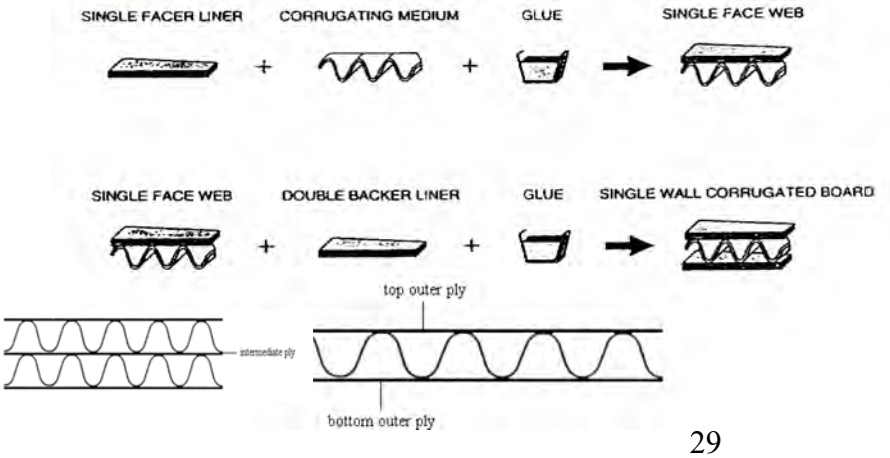
27

Corrugated Construction

Liners	Inside Liner
	Fluting
	Outside Liner
Board Types	Single wall
	Double wall
	Triple wall
	Quadruple wall

28

Single wall construction:



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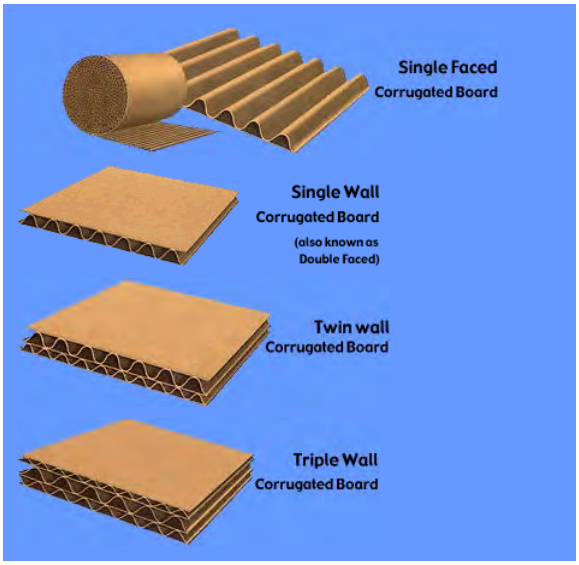

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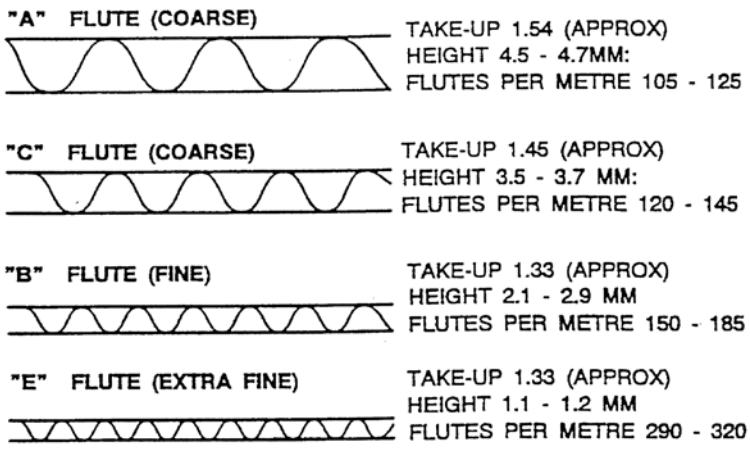
30

Flute Types



Corrugated board grades

Flute height mm (ave)	Flute	Flutes/ Metre (ave)	Compression strength	Puncture resistance	Cushion-ing	Flat crush	Surface print quality
4.5 - 4.7	A	110	Best*	Good	Best	Poor	Poor
3.5 - 3.7	C	129	Good	Best	Good	Fair	Fair
2.4 - 2.6	B	154	Fair	Fair	Fair	Good	Good
1.1 - 1.2	E	295	Poor	Poor	Poor	Fair	V good
0.7 – 0.8	F						Excellent
0.5	N						Excellent
0.4	G						Excellent
0.3	O						

* subject to flat crush limitations due to flute height

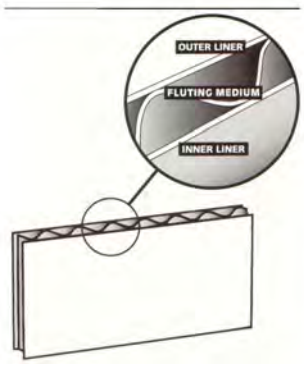
From: Fundamentals of Packaging Technology, Institute of Packaging 1999

Materials

Grades - choice of liners and fluting medium

- Kraft
- Test *
- Chip *

* recycled content



33

Kraft Liners

- Brown
- White Top
- White Mottled
- Bleached

34

Test Liners

Combination of softwood virgin pulp and recycled material

- TL1
- TL2
- TL3

35

Test Liners

- **Test Corrugated**
  - It is becoming common to categorize brown test liners within three classes: TL1, TL2, and TL3.
  - Precise and agreed definitions for the three classes are not yet available across the industry. However, the following definitions should serve as a useful guide between the three classes
  - (NOTE: All types of test liner use predominantly recycled fibre).

36

Test Liners

- **Test Liner 1 (TL1)**
  - This forms the rarest group of liners.
  - They usually have a Ring Crush Test value (RCT) similar to that of Kraft at the same grammage, with a Burst Index of over 3,0 kPa per g/m2. (Kraft is usually over 3,5 kPa per g/m2).
  - The top surface of a TL1 will be almost indistinguishable from a Kraft liner in appearance and will generally contain a high proportion of long fibres.
  - TL1 should normally be suitable for use wherever Kraft liners may be used.

37

Test Liners

- **Test Liner 2 (TL2)**
  - This will usually have the RCT value that is about 90% of that of Kraft at the same grammage, with a Burst index of over 2,5 kPA per g/m2.
  - The top surface of a TL2 will be almost indistinguishable from a Kraft liner in appearance and will contain a high proportion of long fibres.
  - TL2 liners may be suitable for use wherever Kraft liners are used.

38

Test Liners

- **Test Liner 3 (TL3)**
  - This will usually have the RCT value that is about 75% of that of Kraft at the same grammage with a Burst index of over 2,0 kPa per g/m2.
  - TL3 liners vary more widely than TL1 and TL2 liners in colour and appearance (spots etc.) from one source to another.
  - The final shade may be a result of dyes as well as the source of fibre being used.
  - TL3 are most often used as inner liners (or as outer liners where appearance is not critical).

39

Test Liners

- White Top
  - A two-ply sheet comprised of one bleached and one unbleached layer.
- White Mottled
  - White Mottled Krafts (sometimes known as 'Oyster') are produced by the same process as White Top liners with the skin of white being randomly distributed to give a mottled appearance.
- Coated White Top Liner
  - White liner that is coated with a clay or Calcium Carbonate layer to produce superior printability.

40

Test Liners

- White Top
- White Mottled

- Key Attributes of Test liners

Feature	Benefit
Exceptional cleanliness	Good for bar codes and other print applications
Consistent product	Proven runnability and convertability
Wide range of grammages	Ideal for a variety of applications
100% recycled papers	Helps green credentials

41

Chip Liners

- Brown (dyed)
- Grey (undyed)

- Key Attributes of Chip

Feature	Benefit
Available in a range of lightweight grammages	Suitable for a variety of packaging applications
High absorbency results in excellent glue take-up	Perfect for single face or as a middle liner in double wall board
100% recycled papers	Helps 'green' credentials

42

Fluting

- Recycled papers and hardwood fibres, with chemical and starch additive for strength. Usually natural brown colour

43

Fluting

- **Semi-chemical**

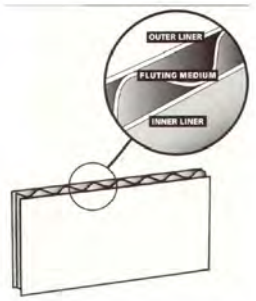
(Virgin fibres using a combination of mechanical and chemical treatments to the fibres.)

44

Board Specification

The European industry defines the finished sheet by combined paperweight, e.g.

- 150k – 115 – 125 tl3



However performance based specs are becoming popular, where the individual components layer are less important than the combined total performance ability. This allows the manufacture more latitude in the choice of liners and more flexibility in deckling board orders.

45

Liner Grades

Fluting and liners are designated in GSM Grams per Square Metre

Typical Grades

Liners	**125**	**Fluting**	**100**
	150		**105**
	200		**112**
	300		**125 sc**

46

46

Corrugating Adhesives

- Function
- Types
  - Vegetable Starch
    - Potatoe
    - Corn / Maize / Wheat
  - PVA (7 times more expensive)
- Preparation - Starch Kitchen
- Application - 2 Roll System

47

Corrugating Adhesives - Preparation

- Starch Kitchen - Mixing & Holding Tanks
- Slurry Mix - 20-25% Solids
  - Starch
  - Water
  - Caustic Soda - to act as carrier for starch granules
  - Boric Acid - to act as neutraliser when correct viscosity reached
  - Biocide - to kill bacteria

48

Corrugating Adhesives - Application

- Slurry temperature is raised
- Starch Gel temperature is 56-61 degrees C
- Paper must be Warm & Moist and 10-30 degrees above Gel temperature
- Slurry is applied by Wipe Roll / Doctor Roll system
- Starch granules burst while being absorbed by Hot Papers
- Starch Gels, moisture moves into papers, starch hardens as it dries
- Starch Consumption is 10 to 14 grams per square metre

49

Corrugated Board Manufacture

- Ingredients
  - Conditioning of fluting
  - Corrugation of fluting
  - Use of Starch
  - Pressure and heat to develop the board
- Corrugator
  - Wet End
  - Dry End
  - Sheet Preparation
- Special Features

50

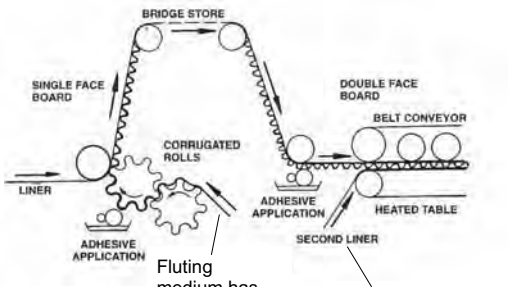
Corrugated Board Manufacture - Ingredients

- Paper
  - Storage
  - Fed from Reel Stands
  - Continuous Web - Autosplicers
- Starch
  - Mixed in In Starch Kitchen
  - Continuous Agitation
- Heat, Moisture & Pressure
  - Boiler
  - Hot Chests , Steam showers (nearly obsolete)

51

Corrugated board production

Bridge acts as a store or accumulator between the two halves of the corrugating machine



First liner has been pre-conditioned

Fluting medium has been pre-conditioned

After this section the board is chopped into sheets and may be scored for making cases

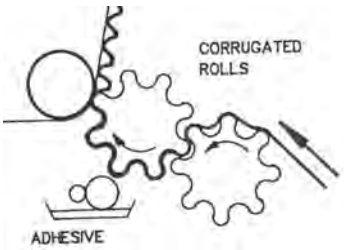
Second liner will form the outside of the case or tray - corrugations will be less prominent than on the inside liner

52

Corrugated Board Manufacture - Corrugator

Wet End

- C Flute Station - Single Face stage
  - Corrugating Rollers
  - Finger / Fingerless
  - Glue application
  - Fluting Tension
  - Top Bridge
- B Flute Station (as above)
  - Middle Bridge
- Double Backer
  - Glue application

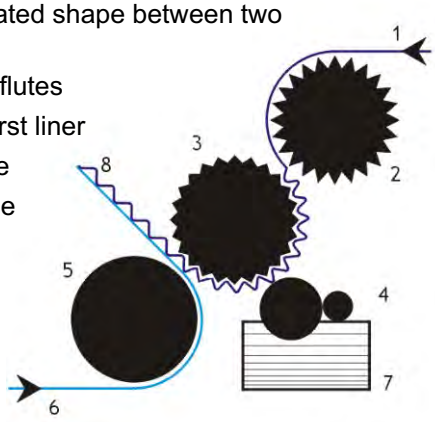


53

53

Corrugated board production

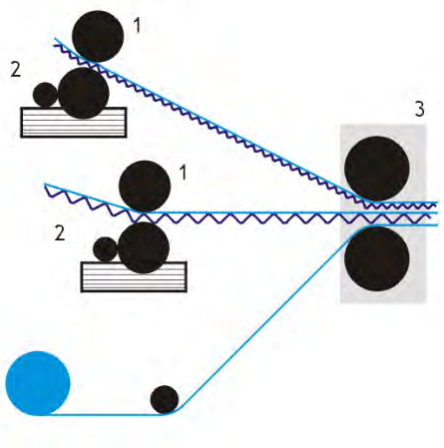
- First station - the single facer
  - Fluting medium and first liner brought to same temperature and moisture level
  - Fluting medium forced into corrugated shape between two geared rollers
  - Line of adhesive applied to tips of flutes
  - Fluting pressed into contact with first liner
  - Heated to dry and set the adhesive
  - Single faced board travels to bridge



54

Corrugated board production

- Second station - the backer or double backer
  - Single faced board travels down from bridge
  - Line of adhesive applied to opposite tips of fluting
  - Second liner brought into contact with flutes
  - Heat and gentle pressure to develop bond



55

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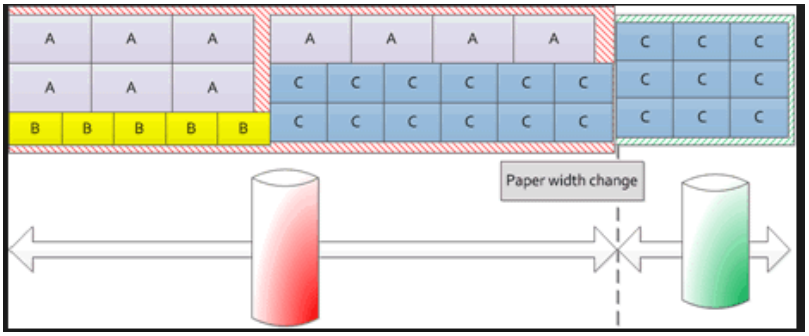
Corrugated Board Manufacture - Corrugator

Dry End

- Drive
  - Blanket (Belt Section)
- Hot Plates
  - Purpose
    - Set Adhesive
    - Warp Control
    - Dry Board

56

56

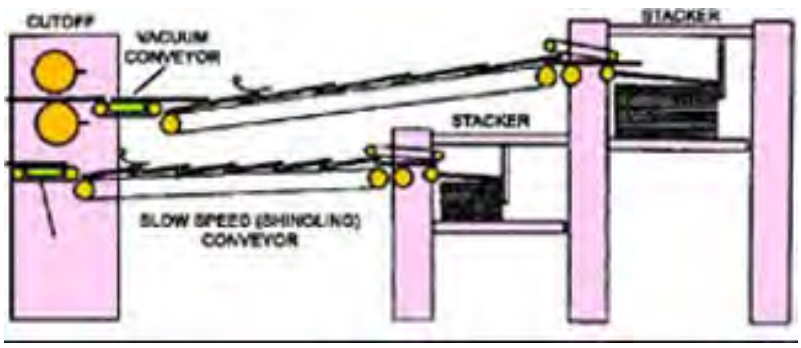


Sheet Preparation

- Scoring / Creasing
- Trimming – waste typical target <25mm c. 1.4%
- Deckle the Web - (plan/layout) the jobs
- Sheet dimensions - Slit dimension – across / perpendicular to flute direction
  - Chop dimension - with the flute direction
    (usually when box open out - long dimension)
- Shingling & Stacking - Separate orders
- Quality Checks - Dimensional, Warp, Delamination 57

57

Corrugator delivery end



58

Corrugated Board Manufacture - Special Features

- 3 Point and 5 Point Scores
- Coatings
- Tape applications
  - Tear Tapes
  - Reinforcing
- Laminations
  - Plastic film
- PrePrint - High Volume, High Quality Print, Floating or Close Register

59

Quality Control - Corrugated Board

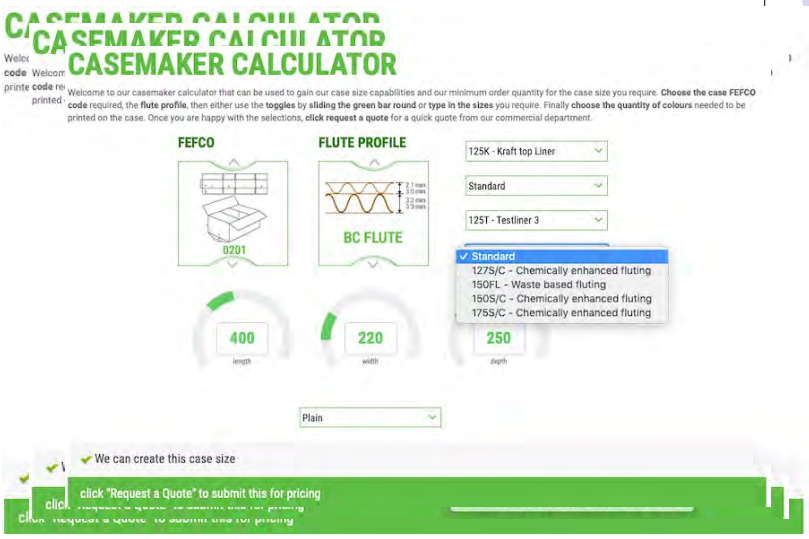
There are a number of standard Tests that are used to ensure the Corrugated Board is meeting the required packaging performance the main tests are listed here

- Burst Strength - Mullen Test
- Compression Strength - Edge Crush Test
- Flute Rigidity - Flat Crush or Ring Crush Test
- Caliper Value
- Porosity of Board - Gurley Test
- Water Absorption - Cobb Test
- Puncture Resistance Test

New DST favoured by DS Smith

60

Liner & Fluting Choice – Example of one suppliers range



61

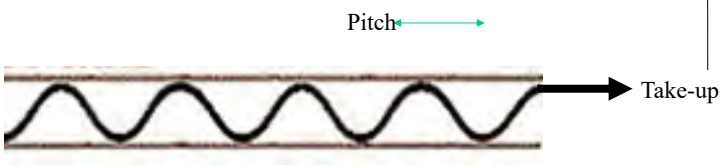
Paper and board technology is improving all the time. One of the key trends developing now, is the growth of 'light-weighting' – the move towards ever lower grammage corrugated board, possibly as low as 70-80 gsm.

Minimising the use of raw materials in this way is more sustainable and will drive down prices to the customer and help address growing environmental concerns.

The key, is the achievement of the same strength and protection from thinner boards with a combination of smaller fluting profiles and /or light weight liners. Focussing on strength and performance is therefore more important than on liner weight.

But this means testing is crucial.

62



Corrugate Flute Profiles

Flutes	Av. Number of flutes per m	Pitch (mm)	Take-up Factor
A	110	8.60	1.53
C	129	7.95	1.42
B	154	6.5	1.31
E	295	3.5	1.24

63

Testing a provided sample for grade.

Table 1: Weight results.

	Weight (g) / 100cm²			
	Overall	Inner	Flute	Outer
1	4.073	1.267	1.480	1.285
2	4.108	1.262	1.502	1.299
3	4.089	1.257	1.472	1.295
4	4.109	1.262	1.493	1.292
5	4.115	1.261	1.483	1.275
Mean	**4.099**	**1.262**	**1.486**	**1.289**
S.D.	**0.017**	**0.004**	**0.012**	**0.009**

Ideally this is a laboratory test where conditions are controlled at 23C and 50% RH

Table 2: Summary of Grammage results.

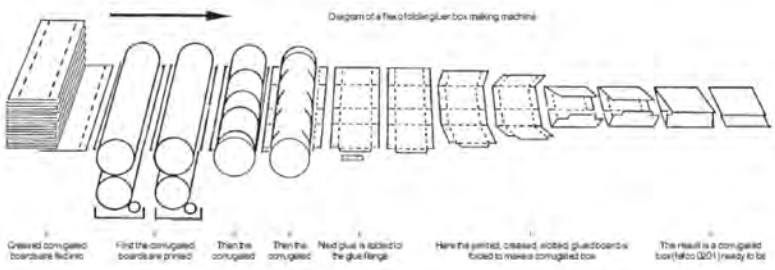
Inner Liner	126g/m²
Fluting	113g/m²
Outer Liner	129g/m²

Example:
Av. Fluting 1.486 / 1.31= 1.13 x100 =
Fluting weight in m2 = 113

64

The Sheet Plant

FFG



65

Corrugated board production

- Sheets are printed, cut to shape and made into cases and trays as required
- These processes may be carried out by the corrugated board manufacturer, or they may be done by other companies - called ‘sheet plants’
- Typically sheets are Slotted and Glued / Stitched or are Die-Cut (RDC or Flat-bed)

66

The Corrugated Case / Tray

- Selecting the Correct Grade
- Case design
  - Regular Slotted Case -RSC
  - Die-Cut
  - Minimal flap Assembled Cases - e.g. Bliss
  - FEFCO styles
- Printing 1-3 or full colour?
- Joining
  - Gluing
  - Stitching
  - Tape with Glue

67

Corrugated Cases - Case Design - RSC

- 'Workhorse of the Corrugated Case Industry'
- Dedicated Machines - Printer Slotter
- Typically less than 3% wastage of sheet
- Usually specified by Internal dimensions

Length, Width (breadth) and Height

- Layout
  - 4 Main Panels plus Glue Flap
  - 4 Top Flaps, 4 Bottom Flaps,
  - 8 mm Slots between flaps
  - Long Flaps meet - Box is typically sealed by tape
- Allowances to *establish Internal dimensions from product.*
  - B Flute - 3mm, 3mm, 6mm
  - C Flute - 5mm, 5mm, 8mm
  - BC Flute - 8mm, 8mm, 14mm

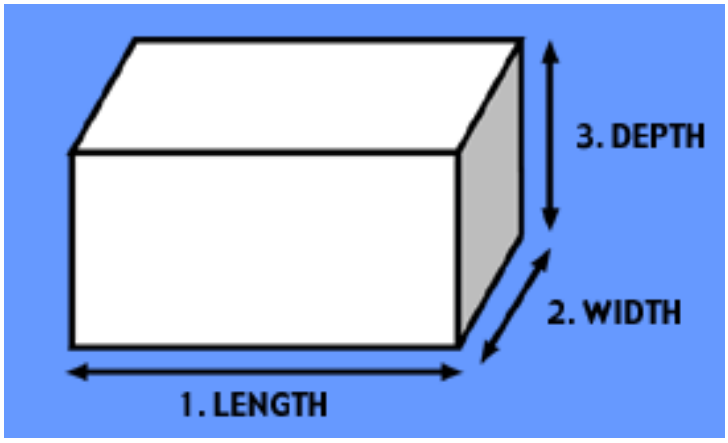
68

Corrugated Cases
- Case Design - Joining

- Glueing
  - PVA, EVA, Hot Melt
  - Single Point
  - Multi Point 2, 4, 6 +
- Stitching
  - Galvanised Steel, Copper alloy
  - Auto Stitcher
  - Flatbed Stitcher
  - Upright Stitcher

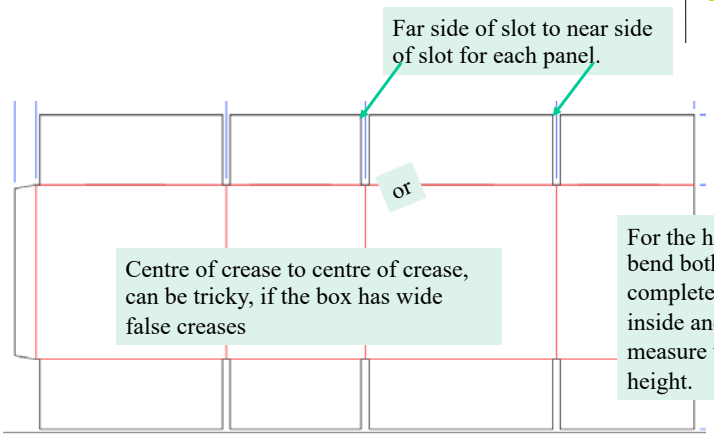
69

Corrugated Outer are specified by internal dimensions.



70

Measuring an existing box

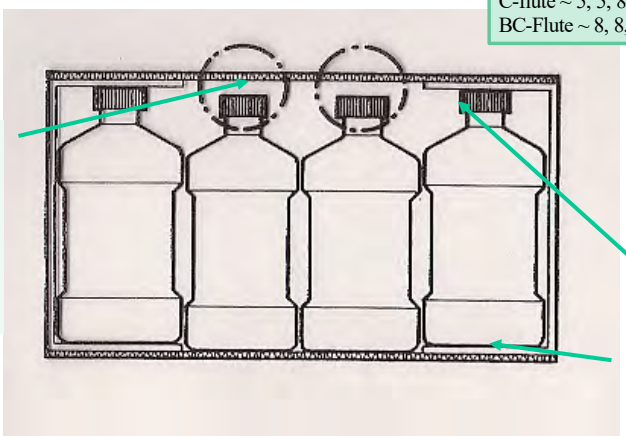


All of these methods, gives you the set size

71

Looking inside a box

Typical tolerances
B-flute ~ 3, 3, 6mm
C-flute ~ 5, 5, 8mm
BC-Flute ~ 8, 8, 14mm

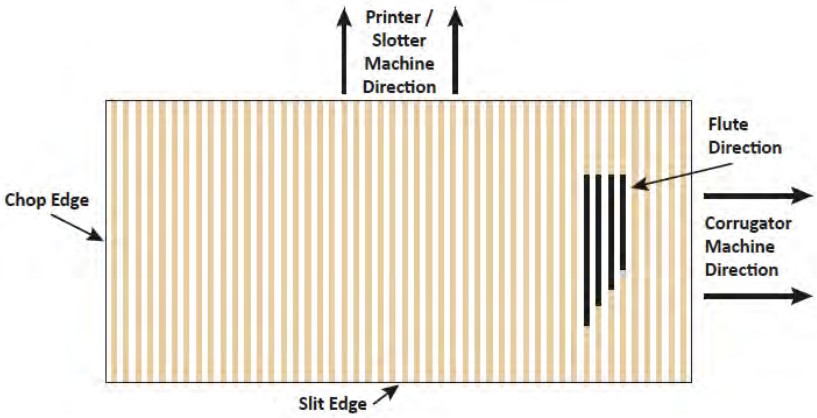


Possible product movement, may be a reason to specify an 0204

The reason box height tolerance is close to double the wall width.

72

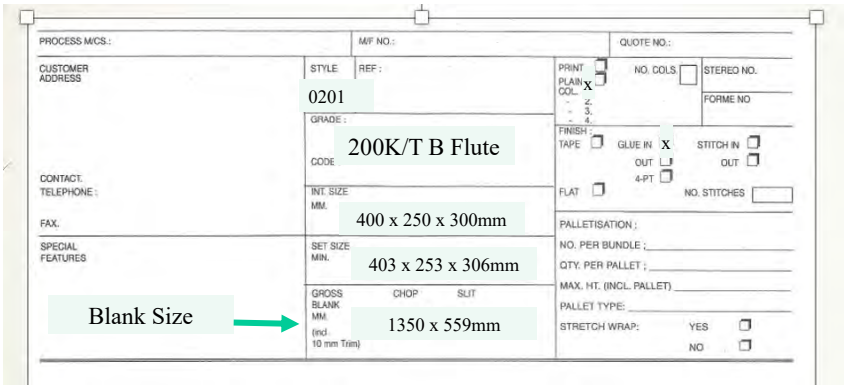
Required Board Size x Quantity = xyz thousand m2



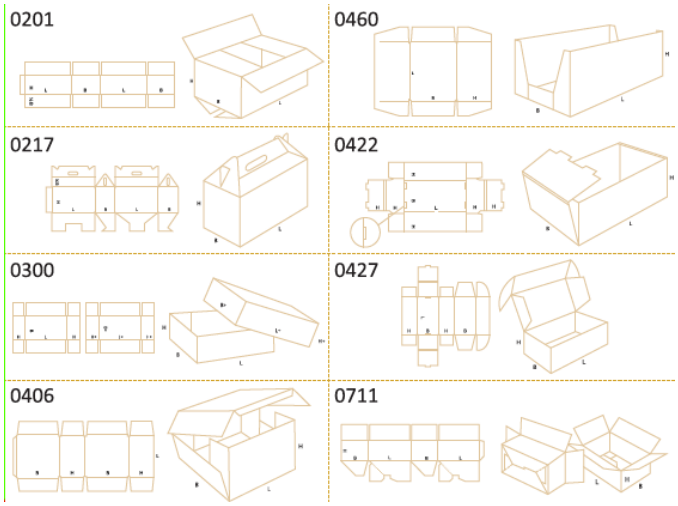
73

Corrugated Case – Slotted 0201 Spec Form

(Manual entry)



74



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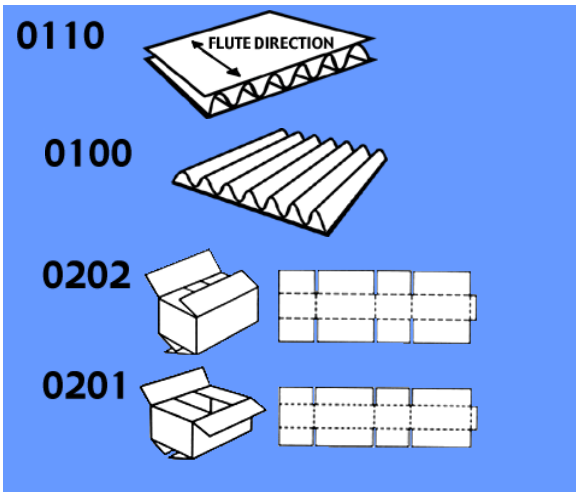

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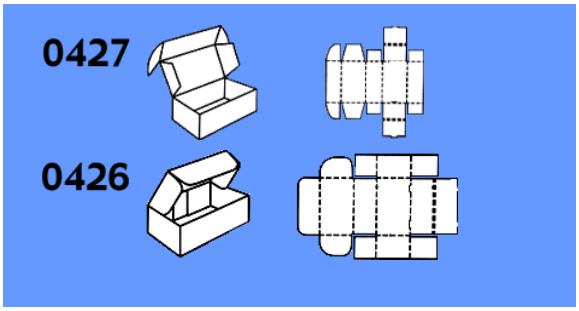

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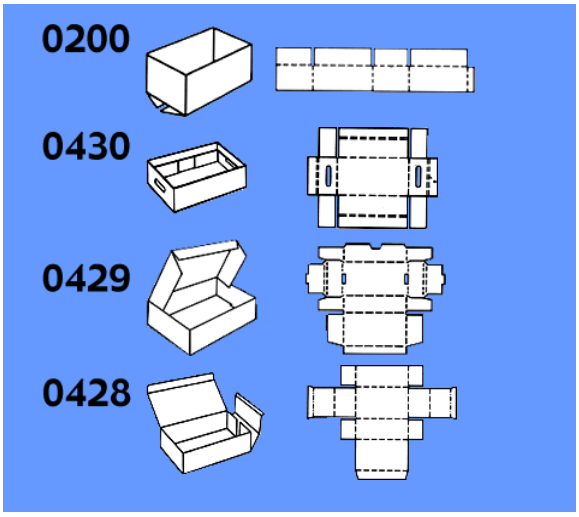


78

78

Printer Slotter / Rotary Die

79

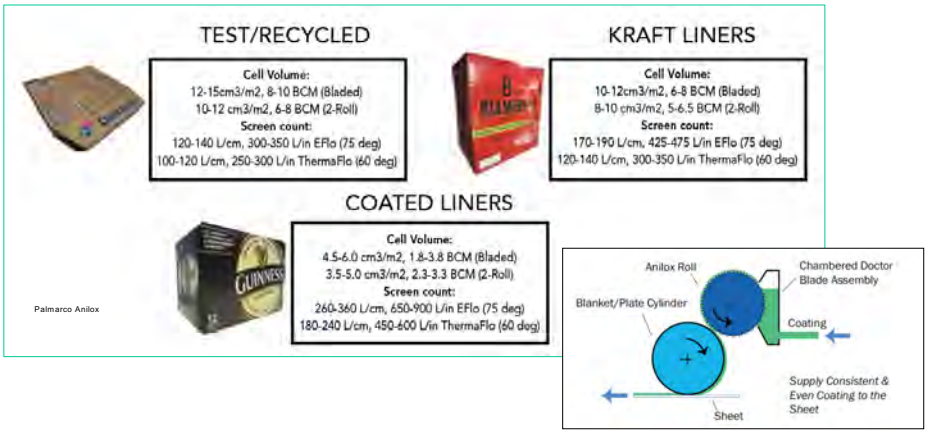
Slotting Unit (section)

80

Casemakers or Flexo Folder Gluers (FFG)

81

Machine set up to Print different quality levels.



Some machines have revolving anilox carousels, to speed up anilox changeover. Typically, FFG machines tend to stay in their chosen print quality range, as changes will impact on make-ready time, print quality, inks, liner choice, drying time, plate type etc. Top quality print typically requires finer Anilox, Coated Board, Thinner Plates and interdeck and end of press dryers…

82

Example of a spec changing for:

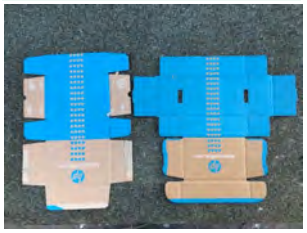
- Price

- Sustainability

- Increased Vol.

83

Hand erected or Automatic?



Print colour not quite as good.

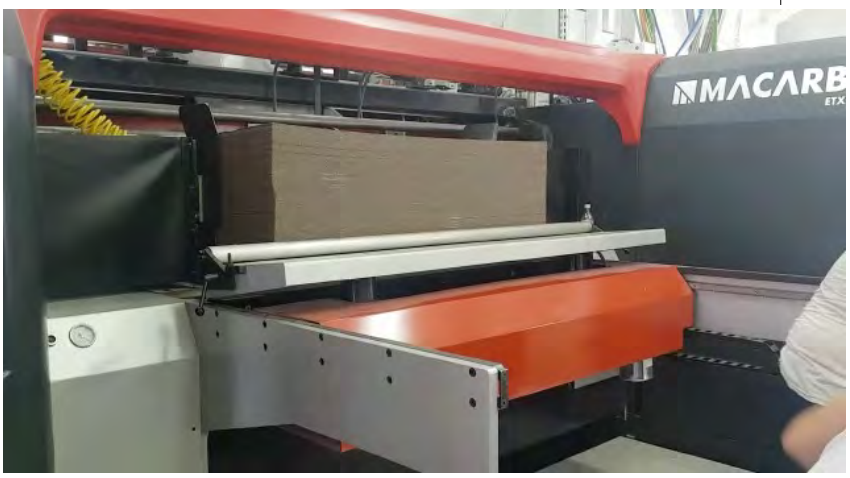
Less Board, Cheaper Board, more Sustainable…

Board grade and style changed for volume, price or sustainability / carbon footprint savings?

K/K B~flute to T/T B~flute. Plus style from 0427 to Auto pack version

Sometimes wise to suggest such changes to the Customer to support, or hold the business, and build trust.

84



85

Corrugated Cases - Selecting the correct Grade

- Each product to be packed must be evaluated in terms of
  - Weight and Volume,
  - Duration & Type of Storage & Transport needs
  - Most Cost Efficient size
- In Ireland B & C Singlewall and BC Doublewall are historically the most common flute grades, but M, R, etc. and EB Double wall are growing…
- Choice of Flute must be considered with choice of grammage

86

86

There are a number of common flute profiles or sizes

A FLUTE - 5mm - **A** - *Good stacking and protection*

B FLUTE - 3mm - **B** - *Good puncture resistance* + Most Common Grade

C FLUTE - 4mm - **C** - *Good stacking and protection* + Very Common Grade

E FLUTE - 1.5mm - **E** - *Lightweight fine flute*

F FLUTE - 1.2mm - **F** - *Extra thin*

BC FLUTE - Flute Double Wall 6mm - **BC** - *Combination of B + C flutes*

The various liners and fluting medium can be selected to produced A Board as a single wall board or double wall board.

Single Wall Board - 2 liners and single flute

Double Wall Board - 3 liners and double flutes

Triple Wall Board - 4 liners and three flutes

87

87

Common Board Grades

When choosing a board grade this may be a guide to common grades

Paper Combination:
125K/125T - B Flute - **Light Standard Grade**

150K/150T - B Flute - **Common/Medium Grade/Postal Grade**

200K/200T - B Flute - **Heavier/Durable Board**

300K/300T - B Flute - **Very Heavy/Strong Board**

To increase the cushioning or the stacking strength of the box change the 'B flute' for a 'C Flute'. For example 125K/125T - C Flute.

If you really want to beef up the packaging specification then change the single flute either 'B' or 'C' for a much stronger double wall (double fluted) board.

Example:
200K/200T/B Flute = is close to equal to 125K/125T Double Wall

88

88

Corrugated Cases
- Case Design - DieCut

- For Cases that cannot be manufactured through a conventional Printer Slotter a cutting forme (Die) must be made.
- 2 Principal Die Cutting Processes
  - Rotary
  - Flat Bed
    - Clamshell
    - Pillar Press – Flat Bed
    - Reciprocal

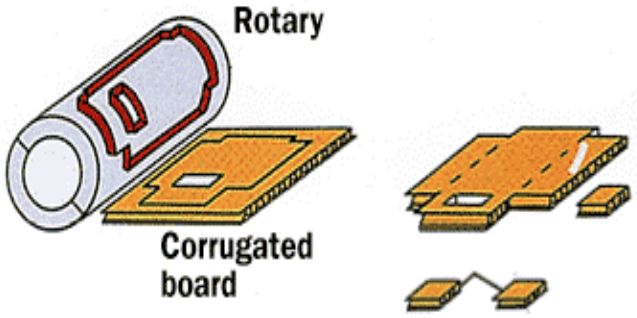
CAD Table

89

Corrugated Cases
- Case Design - DieCut

- The Cutting Forme
  - Steel Cutting, Creasing and Perforation Rule
  - Rubber / Foam to push cut case off forme and to prevent damage to case
  - Suckers and/or ejectors / Die Board to aid auto delivery
- Flat bed Die Cut - lower tolerance ie. more accurate
- Rotary Die Cuts - higher tolerance +/- = less accurate
- Diecut cases show greater consistency case to case than slotting
- Ideal for machine erected cases and necessary for odd shapes.

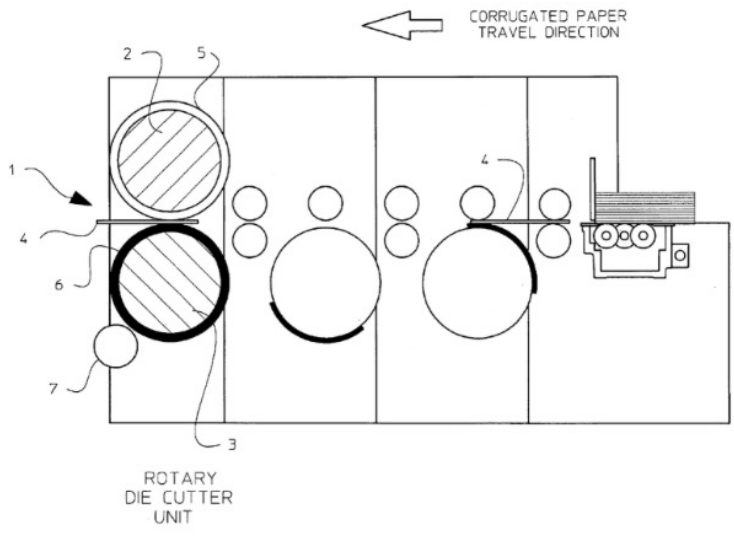
90



91

91

Printer Rotary Die



92

Rotary Die (one half)

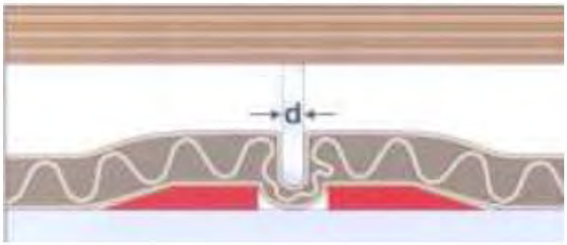
93

Flat Bed Die cutting

94

Die-cutting

- Cutting and creasing rule is sized relative to the material being converted

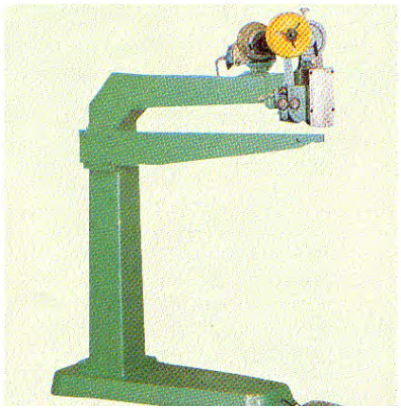


Creasing rule

95

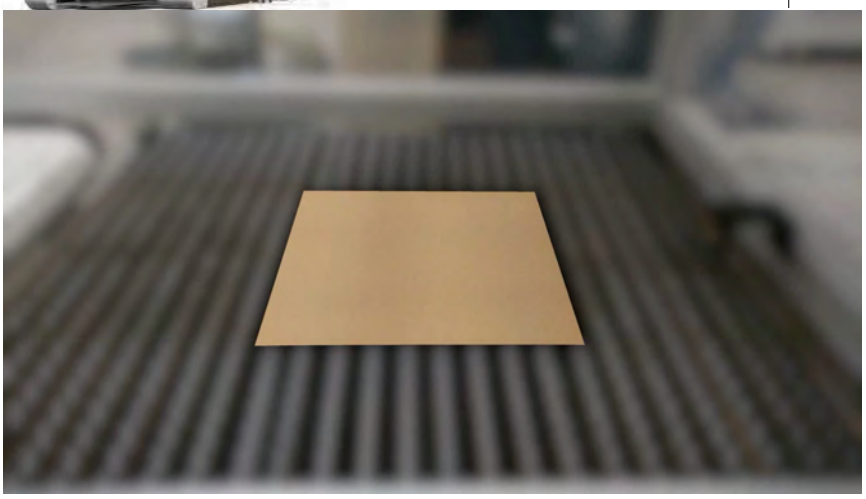
Stitching

Conversion machinery - stitching



96

Laser Cutting & ‘creasing’



97

Corrugated Cases - Case Design - Printing

- Post Print
- Pre Print
- Litho Laminated
- Letterpress
- Screenprinting

98

98

Corrugated Cases
- Case Design - Printing - Post Print

Post Print - after Board is made - **Flexographic Process**

- Doctor Blade or Wipe Roll system metering ink to the Anilox roll which transfers an exact amount of ink to the Print Plate (Stereo) which prints directly to the board
- Typically water based, fast drying liquid inks
- Kraft liners interfere with ability to match true colours
- Typically board is printed then slotted or DieCut on the one machine
- Low Tooling costs

99

99

Corrugated Cases
- Case Design - Printing - Pre Print

Pre Print - before Board is made - **Flexographic Process**

- Print Process & Inks same as Post Print - though thinner Print plates to increase plate stability and ensure accurate register
- Close tolerance Multicolour printing
- High Volume
- Liner presented to Corrugator for corrugating to Single face or corrugated board
- High Origination costs. Long runs

100

100

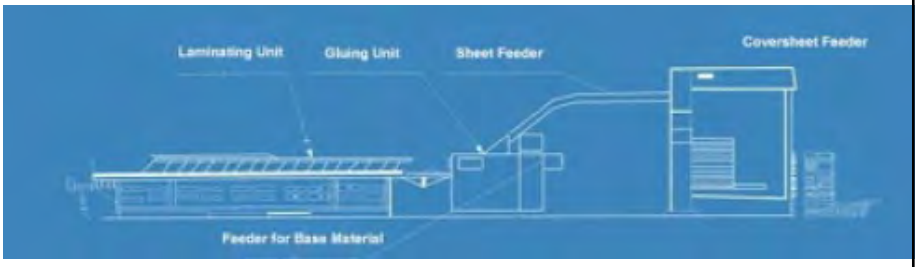
Corrugated Cases - Case Design - Printing - Litho Laminated

- Litho Laminated
- Paper or Cartonboard Litho-printed in sheet format
- Typically Oil based paste inks
- For full colour, high POS Impact requirement
- Sheet laminated using PVA Glue to single face or corrugated sheets
- High Value

101

LithoLam

https://youtu.be/Vob8oYfJOsw

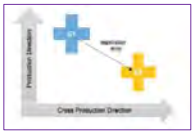


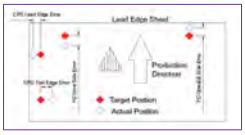
Digital Printing

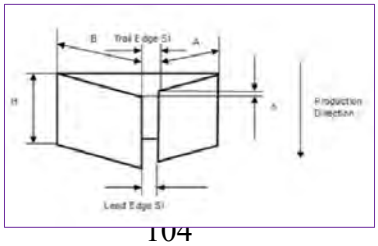
103

Quality Assurance

- Board Grade
- Dimensional checks ID to OD and tolerances
- Through Machine Vs Cross Machine
- Creasing and Cutting
- Print Quality & Tailoring
- Gap Tolerances, Fishtailing - max. tolerance
- Stitching alignment
- Glueing - Adhesion
- Pallet Presentation
- BCT & DST tests



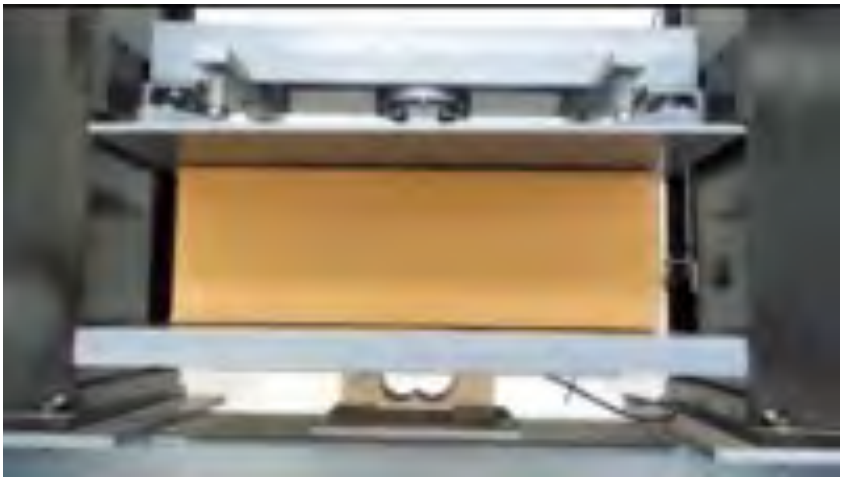




104

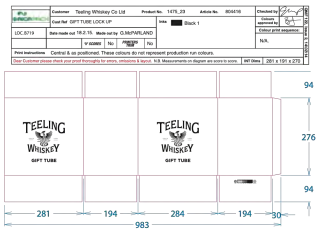
104

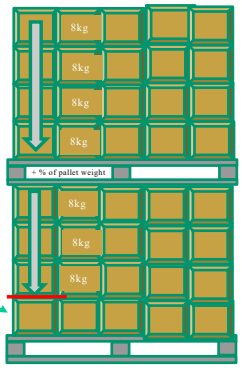
BCT test machine



105

Example Pallet Layout and Outer BCT impact





Weight on bottom box 8-1= 7 boxes x 8kg each + 2kg (pallet) = 58kg x 3.5 safety factor = 203kg

Bottom box needs to withstand at least 203KG.

A BCT of 217kg is good.

Case size: 281 x 191 x 270mm
Outer Configuration: 20 per row 5 x 4
Rows per pallet: 4 rows
Stacked: 2 pallets high (max)

Board: 175KWL / 150HS / 125DS B flute
BCT: 217kg (ISO 12048)
(ECT: 6.42 KN/M ISO 3037)

Example BCT test machine by Rycobel
https://youtu.be/PD5RwNxaqbg

106

Thanks for your time…

- Any Questions?