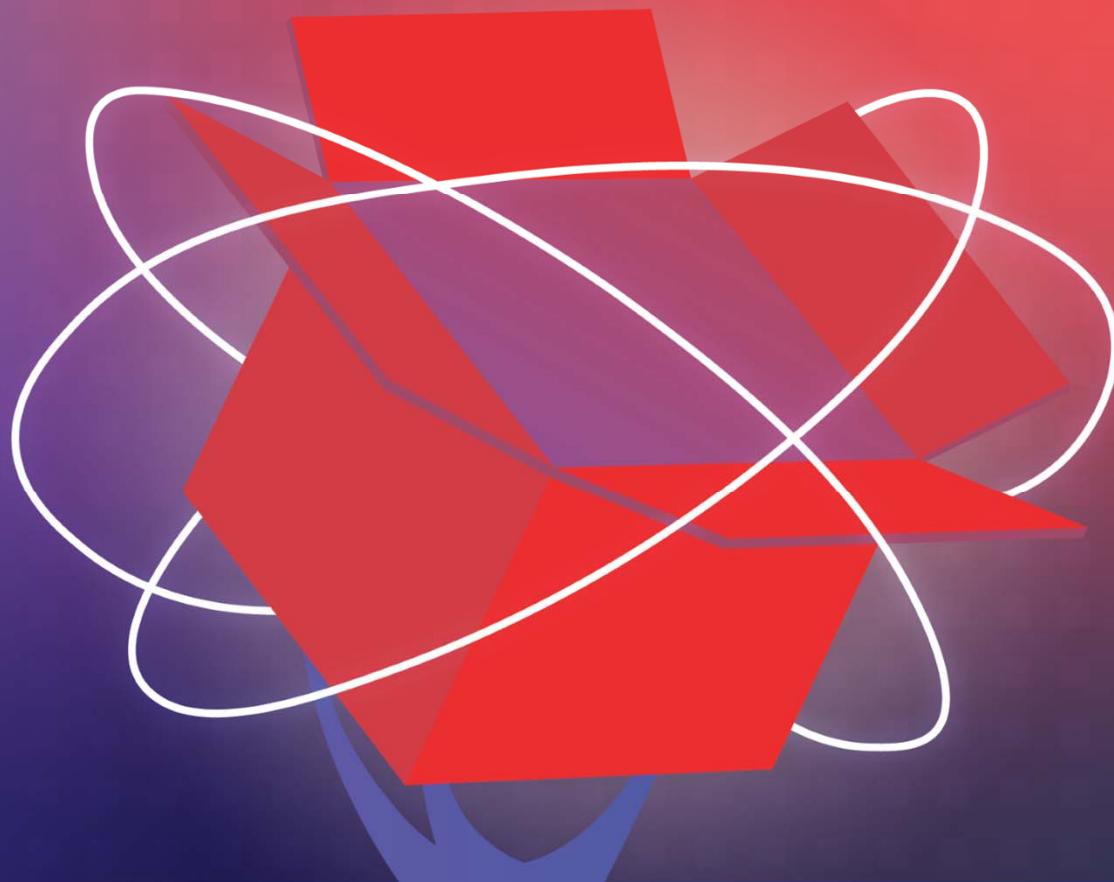




Corrugated Container Market Trends and Demands on Containerboard Producers

Charles P. Klass
Klass Associates Inc.
Land O Lakes, FL



Changes in End Use Markets

- “Plain brown boxes” are neither plain nor brown anymore!
- High quality graphics
- Big box stores
 - >60% of retail sales are in big box stores
- Retail Ready Packaging
- Shelf appeal
 - The box is the “salesperson”
- Impacts on linerboard and printing requirements

Time Tested. Future Forward.

Growth in White Top and High Graphic Quality Linerboard

- White top segment of market continues to grow
- Bleached pulp is not as strong
- Mill experiences have shown that full coverage of brown liner without mottled appearance requires ~13#/MSF bleached kraft pulp
 - 25% if 42#
 - 50% of 26#
- Addition of white pigment can help in achieving coverage at lower top ply weight but reduces strength.

Flexo Printing

- Most corrugated is printed via flexo
- More colors
- Finer screens
- Post print now competes with preprint
- Preprint now competes with litho-lam
- **Demands a better printing surface**

Preprint and Post Print

- Preprint
 - Linerboard is printed roll-to-roll and then corrugated
 - Preprint presses have dryers
 - High holdout surfaces can be successfully printed
- Post Print
 - Combines corrugated construction is printed – usually in a flexo-folder-gluer
 - No print dryers
 - Sheet surface must absorb aqueous vehicle
 - Gripper bars will metal mark – so surface must be non-abrasive

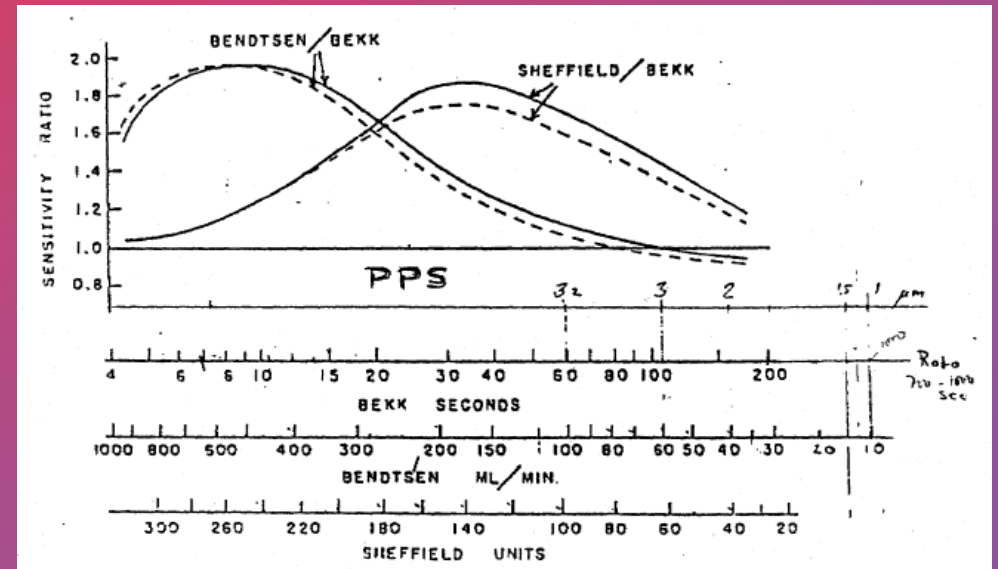
Lighter Weight Boxes

- Trend in Europe and other overseas markets
 - On average, European boxes are 20% lighter than in USA for same stacking strength
- Lower basis weights made on machines with starch surface sizing
- Most North American linerboard and medium machines can't make needed basis weight and get equivalent strength
- Where will lighter weight liner and medium come from?
- New greenfield containerboard machines designed for lightweights
- Conversion of uncoated free sheet and newsprint machines

Level Sheet Surface Requirements

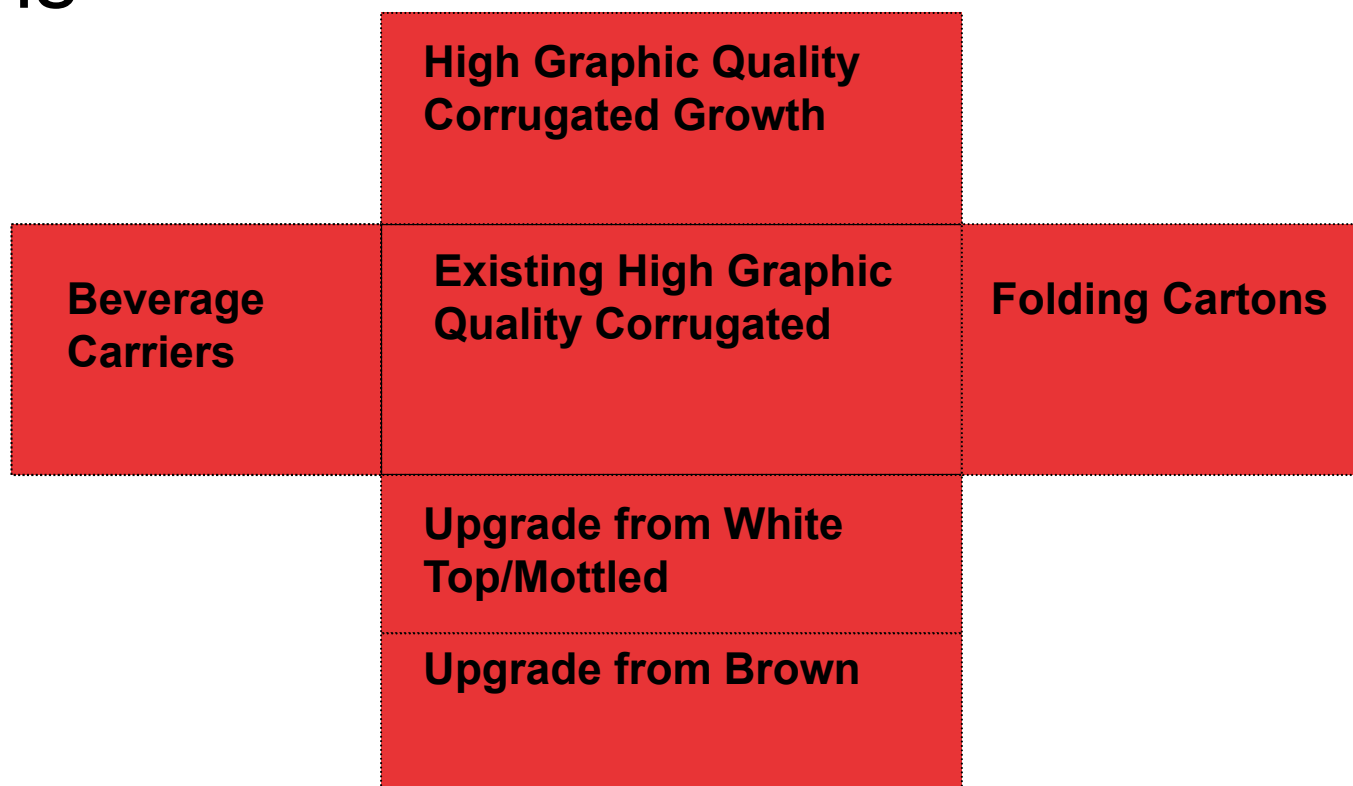
- Good “kiss fit” to flexo plate surface is essential
 - For solid print areas, caliper variation needs to be $< \pm 0.5$ point
 - For good halftone reproduction, caliper variation needs to be $< \pm 0.2$ point
- Sheet surface smoothness needs to be ≤ 200 Sheffield units
- PPS is a better test and PPS_{10} should be $\leq 3.5 \mu$

Smoothness Measurements ts Equivalence Chart



Time Tested. Future Forward.

High Graphic Quality Corrugated Growth Patterns



Microflute Corrugated

- Competes with coated multi-ply recycled paperboard
 - Lighter weight ~35 – 40%
 - Stronger
- Can be converted in regular folding carton machinery
- May require coated surface with adequate surface strength for offset printing
- Lighter weights than linerboard produced on most North American linerboard machines
- Moving ahead faster in Europe and Asia on newer machines

Digital Printing of Corrugated

- Benefits
 - Eliminates make ready, plates and waste
 - Especially valuable for short production runs
 - Facilitates customization
- High speed pigmented ink jet
 - Quality equivalent to flexo
 - Water resistant
 - UV ink jet is rapidly developing
- Surface quality requirements

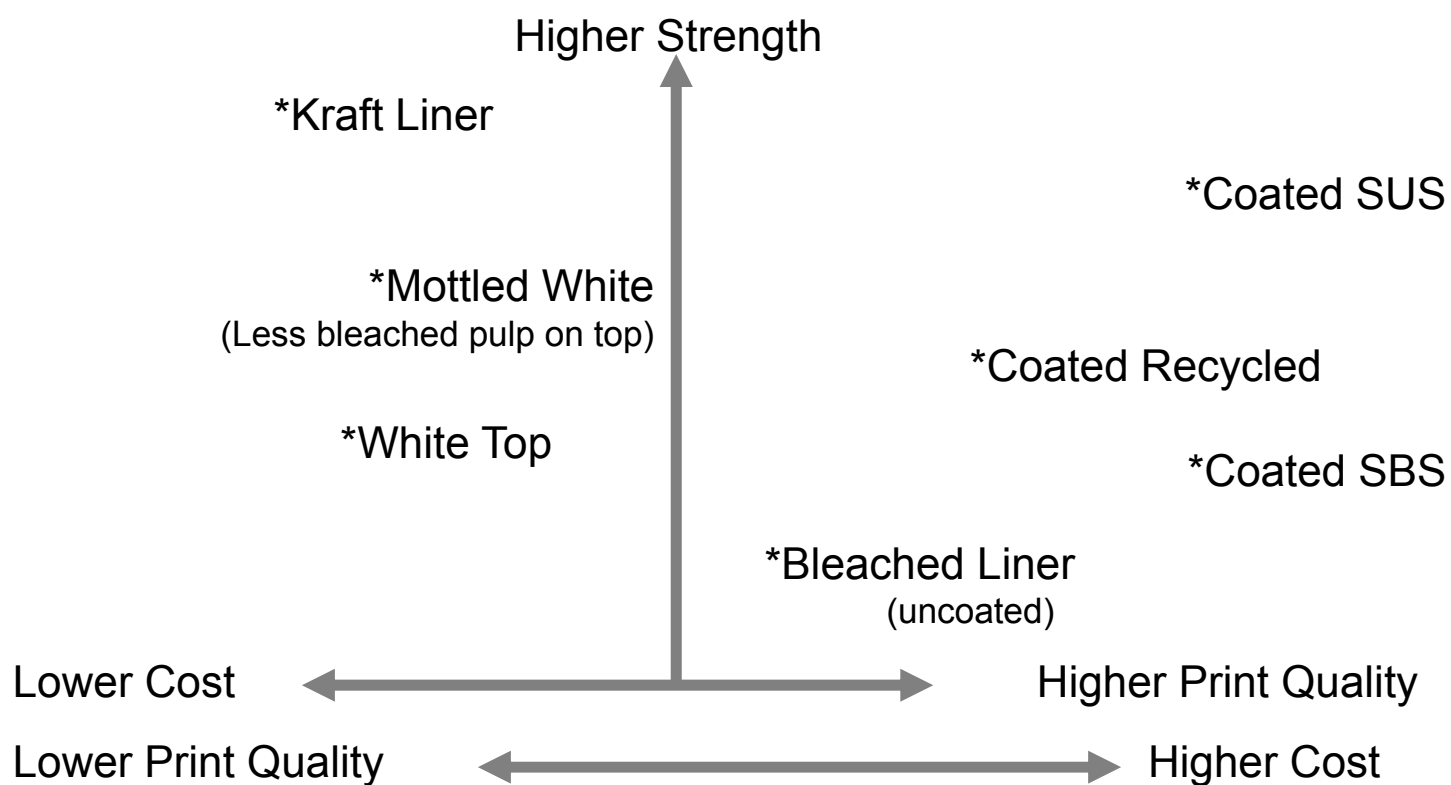
Digital Printing of Corrugated Surface Quality Requirements

- Smoothness equivalent to flexo
 - Flatter micro contour improves image
- Ink receptivity and absorbency
 - Cationic functionality at surface
 - Improves fidelity
 - Breaks anionic dispersion of pigment particles
 - Reacts with anionic dye inks
 - Sizing level should allow absorption of aqueous ink vehicle
 - Rapid drying and no smudge

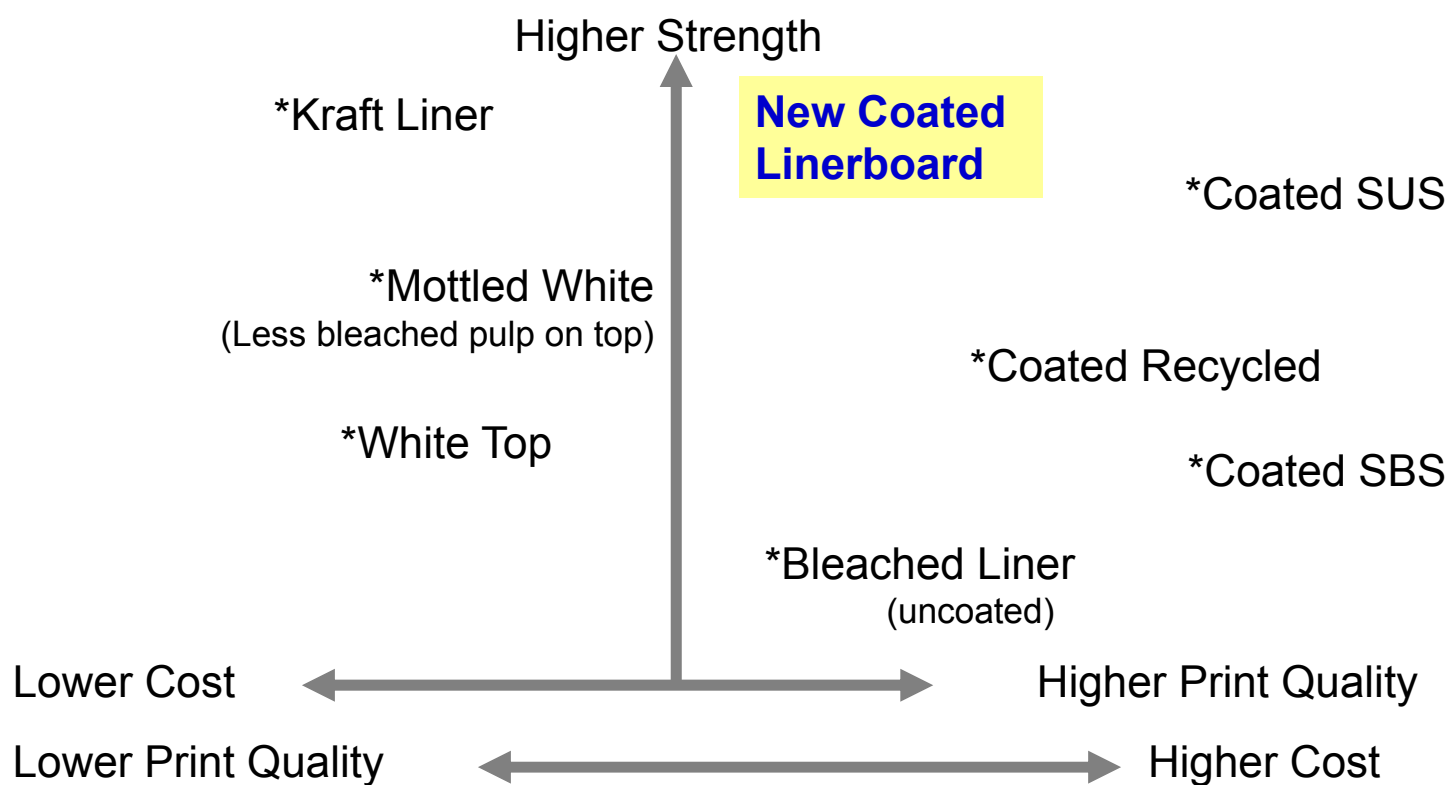
Linerboard for Digital Printing

- White top
 - Include calcium carbonate filler in top ply
 - Include cation donor in top ply
 - Low molecular weight cationic polymer
 - Salt with multivalent cation
- Coated linerboard and coated white top
 - High aspect ratio pigment in cationic dispersion

Graphic Quality Linerboard Grade Spectrum



Graphic Quality Linerboard Grade Spectrum



New Coated Linerboard Grades

- White coated over brown and coated over white (bleached kraft top ply) or grey (recycled white fiber) being done in Europe, Asia, Australia but not in North America
- Some North American corrugators use inline rod coaters to paint brown board white using preformulated coatings

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Thank you for your attention
Questions?

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