TAPPI

2010 PLACE Extrusion Coating Short Course

Charleston, SC

April 24th – 26th, 2010

Challenges of

WEB HANDLING AND WINDING

by

R. Duane Smith

Product Manager
Specialty Winding
Black Clawson Converting Machinery / Davis-Standard LLC

90 Minutes of Fun Filled Adventure

60 min.- Tutorial on Challenges of

Web Handling and Winding

30 min. – Case Study Adventure applying

Web Handling and Winding

Principles in the real world!

Challenges of
WEB HANDLING AND WINDING

CHALLENGES THAT WE FACE

IN UPSTATE NEW YORK

Black Clawson Converting Machinery / Davis-Standard LLC

Located in Beautiful Fulton, NY

In the next 60 minutes- We Will Be Discussing

Lots Of Challenges

- Challenges in Web Handling
- Challenges in Web Spreading
- Challenges in Slitting
- Challenges in Winding
- Challenges in Eliminating Roll and Web Defects

Goal of this Presentation

That you will take back at least a few Gold Nuggets from the information presented and apply these to improve the Productivity & Profitability of your operation

What is the Challenge in **Web Handling?**

Answer -

Convey the Web Straight through the Process Without Wrinkles

Web Tension

In A Perfect World - Would not need

Web Tension

Float The Sheet Straight Through the Line Without Generating Wrinkles

Unfortunately

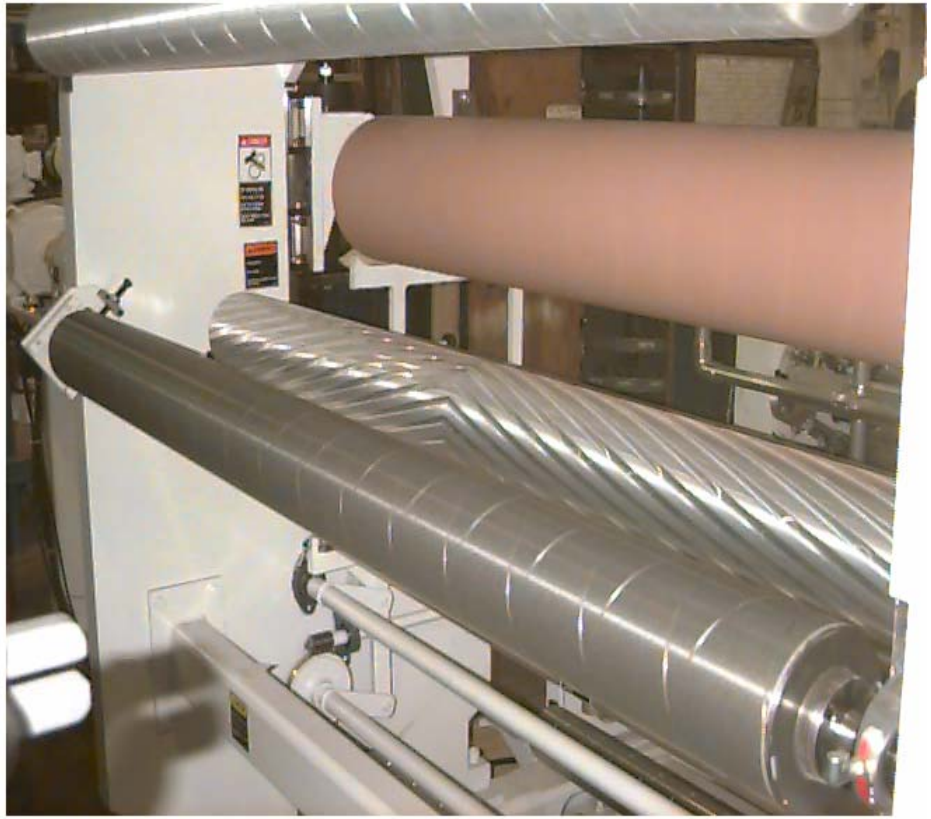
Rollers *are not Perfect*

Webs *are not Perfect*

What are the Challenges of

Web Handling Roller Design?

Web Handling Rolls
DESIGN CONSIDERATIONS



- **Having the Right Roller Material**
- **Having the Right Roller Diameter**
- **Having the Right Roller Bearings**
- **Having the Right Roller Spacing**
- **The Challenges of Air Greasing**
- **Web Handling Roller Alignment**

ROLL MATERIALS

- **Chrome Plated Steel-** ***Normally Used with Paper & Paperboard***
- **Anodized Aluminum-** ***Used for Films, Light Paper & Aluminum Foils***

The cost of Steel and Aluminum are about equal

- **Carbon Fiber Composite**

Roll Materials for Special Applications ***i.e. Thin Films & Non-wovens***

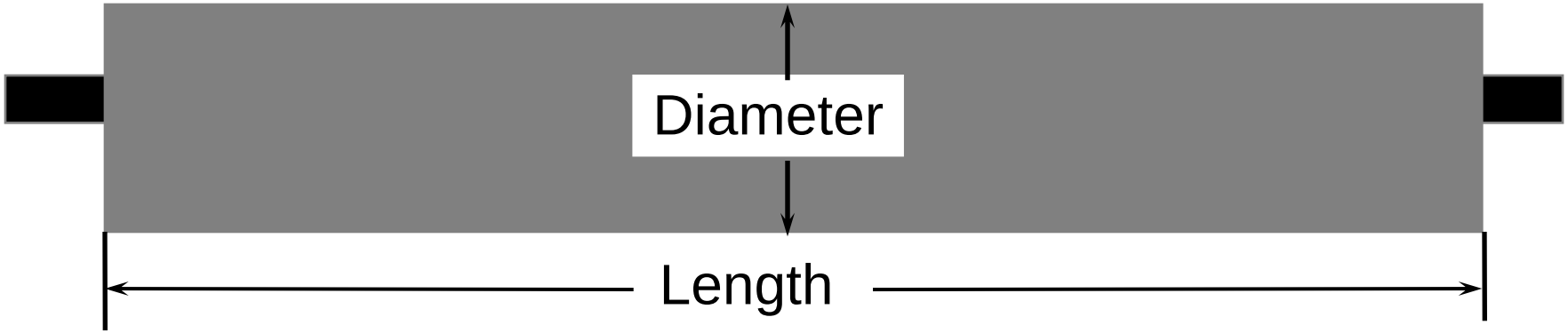
+ Less weight & inertia than Aluminum

- Less Durable than Metal

- More Difficult to Manufacture, therefore more Expensive

However Costs are Coming Down

IDLER ROLL DIAMETER



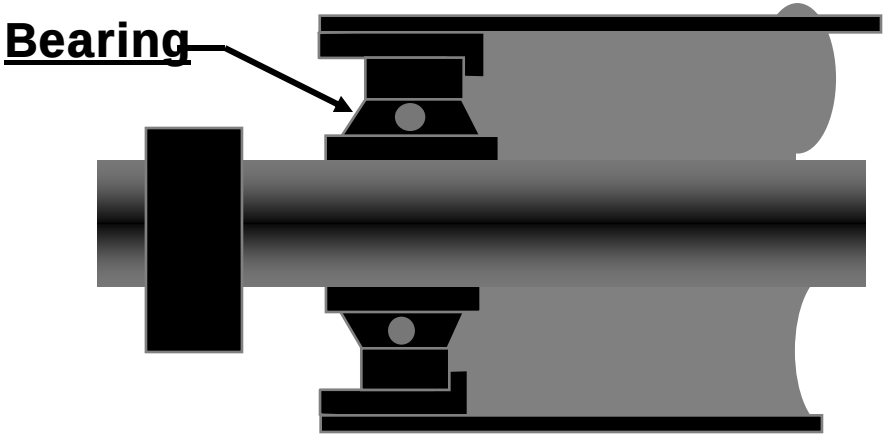
Roll Diameter

- **Generally** $\frac{\text{LENGTH}}{\text{DIAMETER}}$ = **16 or Less**, i.e. @ 64” = 4”
- **Paperboard or Stiff Material, Consider Bend Radius**
- **Roll Deflection, *Rule of Thumb*:**
  - **Generally .010” per each 100” of Roll Face**
  - **Less… If Handling Unsupported Foil**
  - **More… If Handling Extensible Web Materials**

IDLER ROLL BEARINGS

Low friction seals & Keep brg. size to Min.

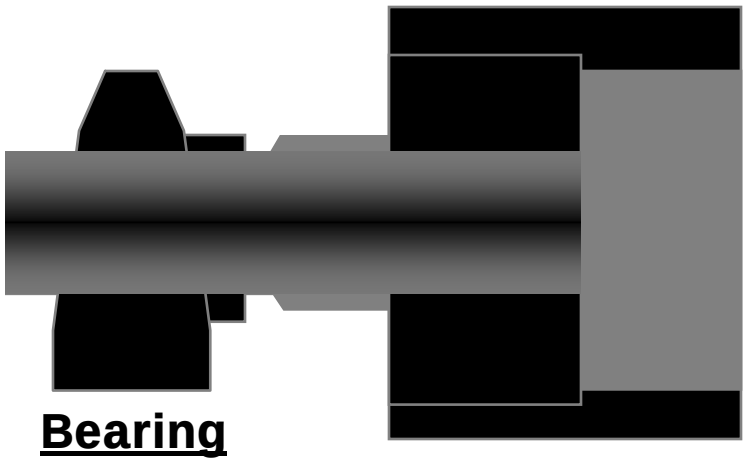
Dead Shaft Type



+ Usually Less Expensive
+ Lower Inertia

- Greater Deflection (Not for Wide, High Tension Applications)
- No Bearing Re-Lubrication
- Difficult Bearing Replacement
- Requires Larger Diameter bearings (journal sag w/ sm. dia.)

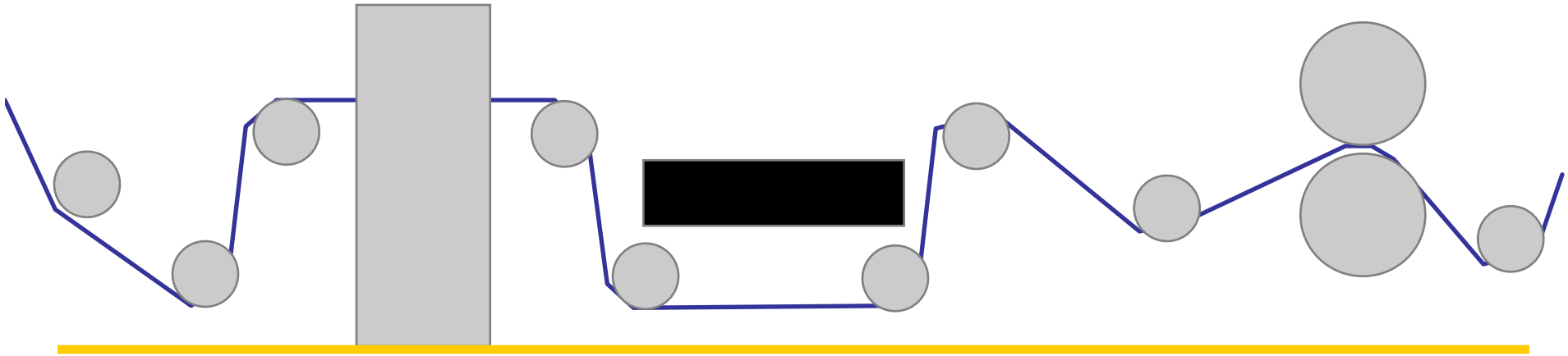
Live Shaft Type



+ Less Deflection due to Head Stiffness and Larger Journals
+ Bearings Out in the Open
+ Bearing Size Not Limited
+ Bearings Easily Lubricated

- More Expensive
- Greater Inertia

ROLL SPACING

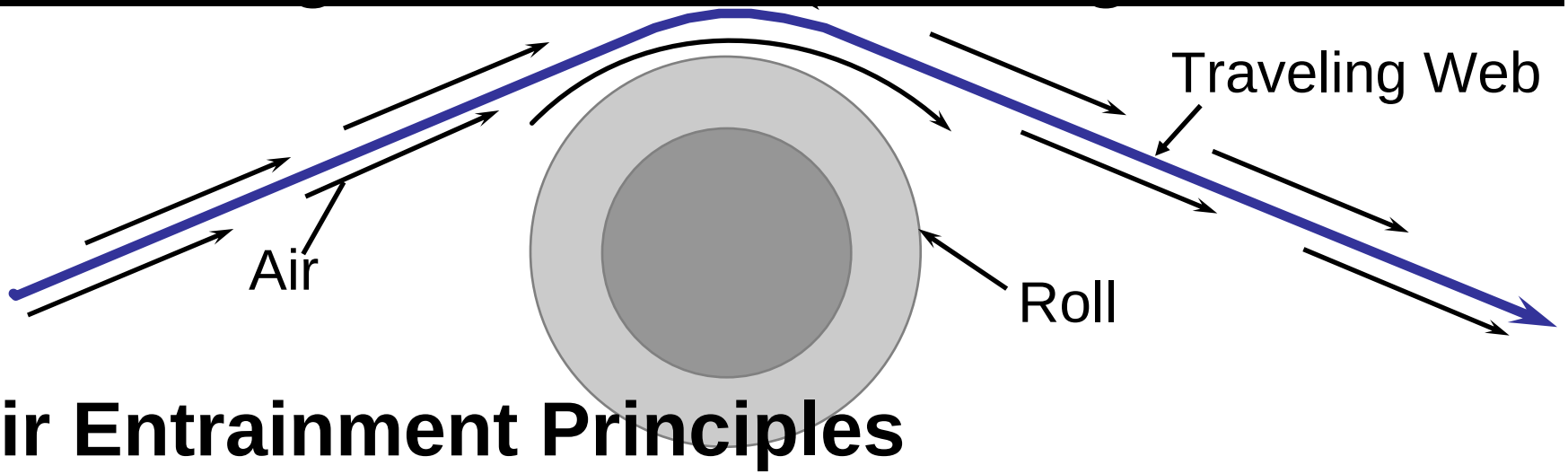


"***Rule of Thumb***"- Roll to roll spacing -2/3 Web Width

- *Thin (.0003) Aluminum Foils*, use 24" max.
  Longer spans if a Spreader roll is used after the longer span.
- Roll Spacing is Speed / Tension Influenced;
  Web Flutter - Shorter distances between rolls

AIR GREASING

Tracking & Web Scratching Problems



Air Entrainment Principles

- **Roll's and Web's Surface Do Not Affect Air Layer**
- **Larger Roll Diameters Entrap More Air**
- **<u>Smoother</u> Rolls Will Lose Traction Easier & Scratch Web**

Possible Solutions

- **Rougher Roll's Surface**
- **VentAir Groove Roll's Surface**

Web Handling
Roller Alignment

Rule of Thumb-

Rollers Should be Level & Tram within .010”/ 100” (.001”/ foot)

Greater Allowable Misalignment for Extensible Materials (stretchy films)

Less Allowable Misalignment for Non-Extensible Materials (aluminum foil)

Other Web Handling Roller Considerations:

- **Roundness (TIR)**
- **Roller Straightness**
- **Dynamic Balance**

Reference Book

"***The Mechanics Of Rollers***"

Dr. David Roisum

TAPPI Press

Challenges in Web Handling

- **Easy to Align Web Handling Rollers to 1 PART IN 10,000 (.010” / 100”)**
- **Difficult to Manufacture Webs to 1 PART IN 100 (1% Across Sheet)**

Web Producer’s Challenge

Make Web Basis Wg. Profile as Flat as Possible

Basis Wg. = f(thickness & moisture)

Web Handling Challenge

Pull Sufficient Tension to
Convey Imperfect Web Materials
Straight Through the Process
Without Wrinkles

Suggested Amounts of Web Tension

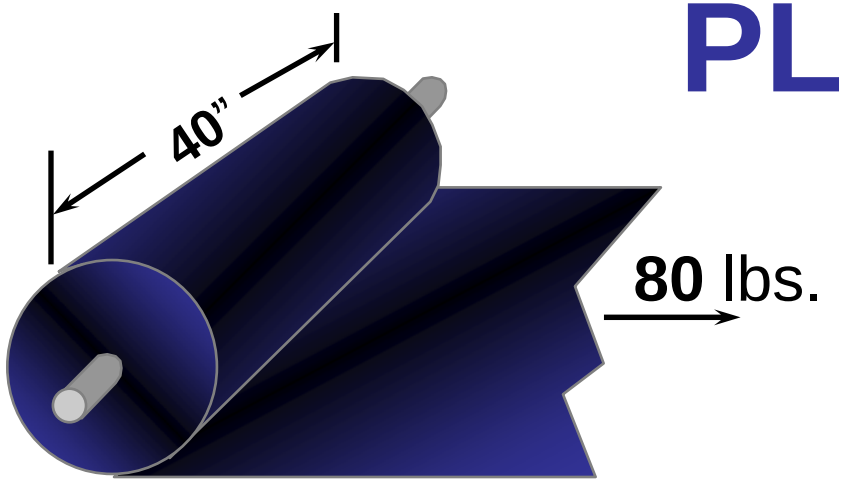
"Rule of Thumb"

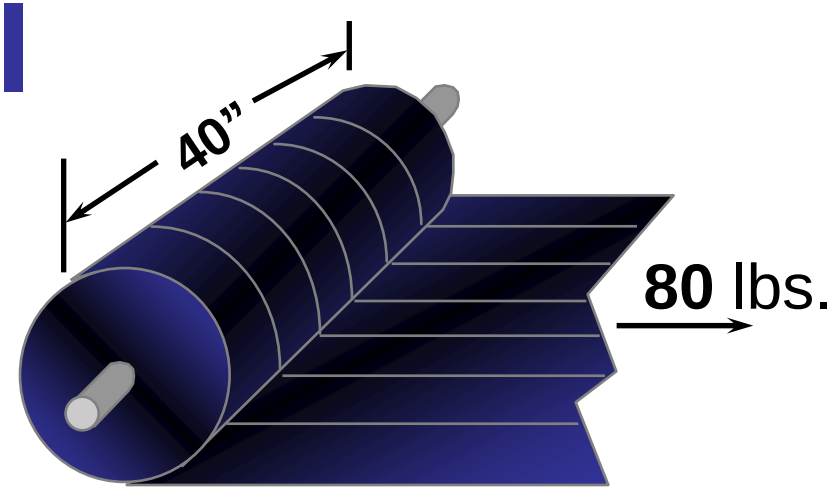
10 - 25% of Machine Direction Tensile Strength of Web Mat'l.

TENSION TERMS –

Unit Tension –Pounds / Linear Inch

PLI





Per 1” Width = $\frac{80\#}{40”}$ = 2 Pounds Per Linear Inch (PLI)

Unit Tension Conversion - 1 PLI = .571 newtons/cm

TYPICAL TENSION VALUES - Films & Foil

FILMS	TENSION LEVELS
• Polyester	0.5 to 1.5 lbs./inch/mil
• Polypropylene	0.25 to 0.5 lbs./inch/mil
• Polyethylene	0.10 to 0.25 lbs./inch/mil
• Polystyrene	0.25 to 1.0 lbs./inch/mil
• Vinyl	0.05 to 0.2 lbs./inch/mil
• Aluminum Foils	0.5 to 1.5 lbs./inch/mil
• Cellophane	0.5 to 1.0 lbs./inch/mil
• Nylon	0.10 to 0.25 lbs./inch/mil

1 lbs./inch/mil = 7.03 kg./cm/mm

TYPICAL TENSION VALUES - Paper

PAPER, Basis Wgt.	TENSION LEVELS
15 lbs./ream (3000 sq.ft.)	0.5 pli
20 lbs./ream	0.75 pli
30 lbs./ream	1.0 pli
40 lbs./ream	1.5 pli
60 lbs./ream	2.0 pli
80 lbs./ream	2.5 pli

Unwinding Tension (pli) = basis weight x 0.035

Winding Tension (pli) = paper basis weight x 0.055

.035 X 1.5 (50% greater) = Approx .055

TYPICAL TENSION VALUES - Paperboard

BOARD THICKNESS	TENSION LEVELS
8 point	3.0 pli
12 point	4.0 pli
15 point	5.0 pli
20 point	7.0 pli
25 point	9.0 pli
30 point	11.0 pli
40 point	14.0 pli
50 point	16.0 pli
60 point	18.0 pli

1 point = .001” = 25.4 microns

Tech Tip - Web Tension - Give me your card with Email

Web Tension Tech Tip

By R. Duane Smith
Product Manager – Specialty Winding
Black Clawson Converting Machinery / Davis-Standard LLC
Fulton, NY 13069

Web Handling can be a real Challenge! We need to convey a web flat and through straight through the process without generating defects such as wrinkles. To do is we need to convey this web under a certain amount of web tension. The question then becomes –How much web tension do I need to use to insure success in producing a web product without defects that will run on our Customer's process without problems and meet the expectations of our Customer's Customer for the web material that we produce.

The answer to the web conveyance question – How Much Web Tension should I use is ???- is AS LITTLE AS POSSIBLE!
In a perfect world- we would not need to use Web Tension. We would simple float the sheet straight through the process without wrinkling or bagginess defects.
Unfortunately, webs are not perfect and rollers are not perfect. Therefore, we do need to use web tension to successfully convey webs through a production line. This Tech Tip will address the suggested maximum web tension. Just remember, in almost all causes, when it comes to Web Tension – MORE is usually NOT BETTER!

Since no web is perfectly flat, we need to convey imperfect webs. The suggested amount of web tension is typically between 10% and 25% of the web material's elastic limit (tensile strength). That means that if it takes 10 # (4.5 kg) of tension to stretch a 1" (2.54 cm) web to the point it will break or permanently deform, then you should run about 1 pli (pounds per linear inch) or .18 kg/cm of tension (10%) with a maximum tension of 2.5 pli or .45 kg/cm (25% of the elastic limit).

TYPICAL TENSION VALUES- Films & Foil

Black Clawson EGAN ER-WE-PA

FILMS	TENSION LEVELS
• Polyester	0.5 to 1.5 lbs./inch/mil
• Polypropylene	0.25 to 0.30 lbs./inch/mil
• Polyethylene	0.25 to 0.30 lbs./inch/mil
• Polystyrene	1.0 lbs./inch/mil
• Vinyl	0.05 to 0.2 lbs./inch/mil
• Aluminum Foils	0.5 to 1.5 lbs./inch/mil
• Cellophane	0.5 to 1.0 lbs./inch/mil
• Nylon	0.10 to 0.25 lbs./inch/mil

1 lbs./inch/mil = 7.03 kg./cm/mm

FIGURE #1

For the paper and paperboard industry, TAPPI suggests from their empirical studies that the maximum web tension be determined by multiplying the paper's basis weight (#/3000 square feet) by a factor of .035. Therefore a 15# paper x .035 = 0.5 pli tension, a 30# paper x .035 = 1.0 pli and a 60# paper x .035 = 1.5 pli maximum web tension. Figure #2 gives a table of the suggested maximum tensions for Papers and figure #3 gives the suggested maximum tension for paperboard.

TYPICAL TENSION VALUES- Paper

Black Clawson EGAN ER-WE-PA

PAPER, Basis Wgt.	TENSION LEVELS
15 lbs./ream (3000 sq.ft.)	0.5 pli
20 lbs./ream	0.75 pli
30 lbs./ream	1.0 pli
40 lbs./ream	1.5 pli
60 lbs./ream	2.0 pli
80 lbs./ream	2.5 pli

Unwinding Tension (pli) = basis weight x 0.035
Winding Tension (pli) = paper basis weight x 0.055

.035 X 1.5 (50% greater) = Approx .055

Conversion Factors
lbs./3000 ft^2 = grams/sq. meter x 0.615
pli = newtons/cm x .571 or *(kg/cm x 5.6)*

FIGURE #2

Cardinal Rule of

Web Handling 101

Provide Isolation Of

Unwinding Tension

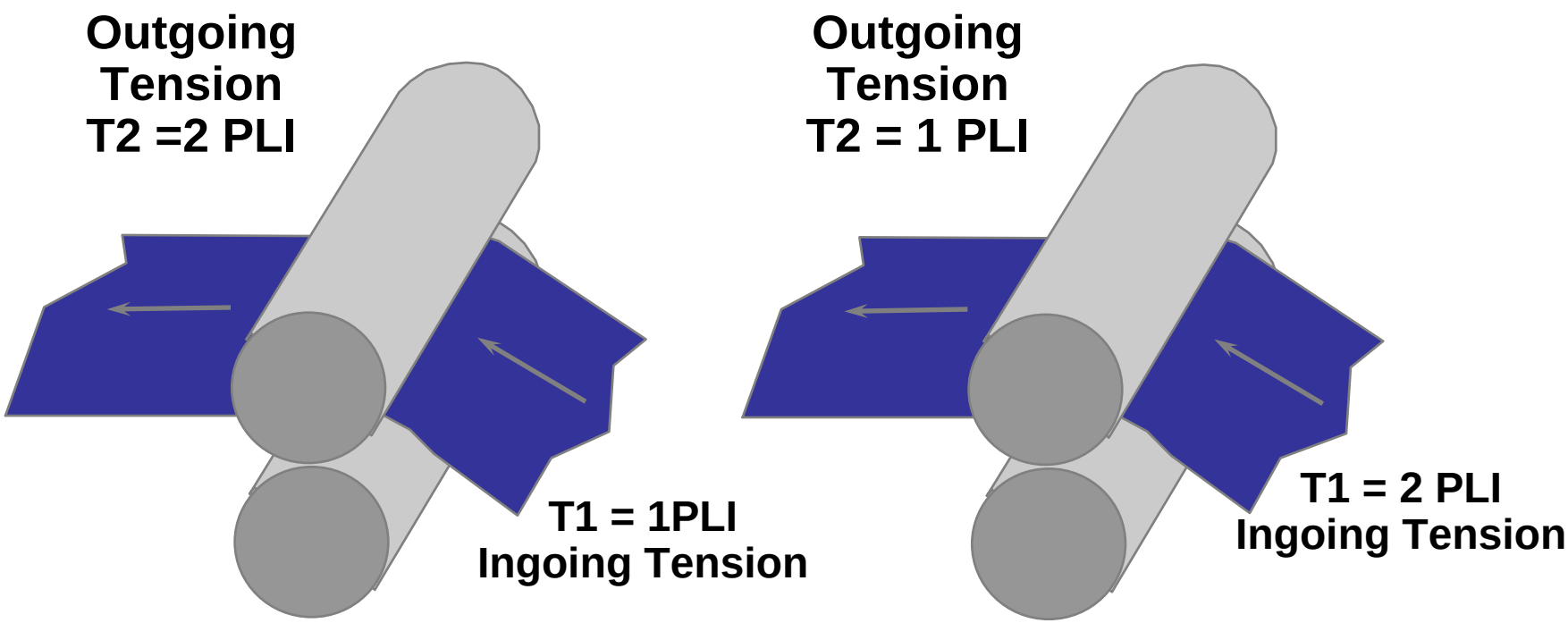
From Various Process Tensions

From Winding Tension

For Web Tension Isolation

Must Have Grip On Web!!!

Pull Roll Differential Tension

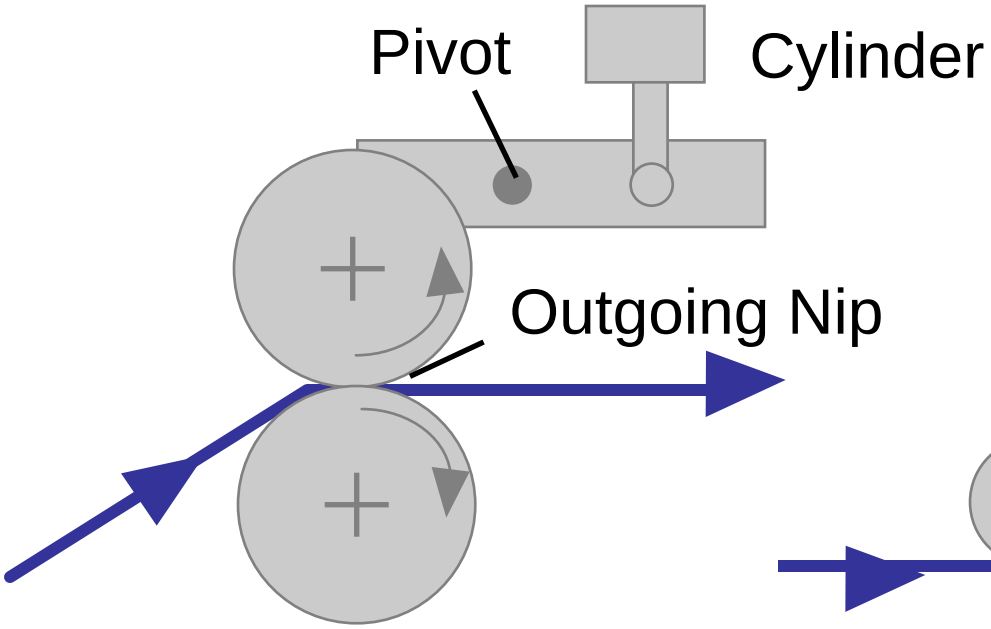


T = T1 - T2
= 1 - 2
= -1 PLI
(Regenerating)

T = T1 - T2
= 2 - 1
= +1 PLI
(Motoring)

Contact Type Pull Rolls

Nip Pull Rolls



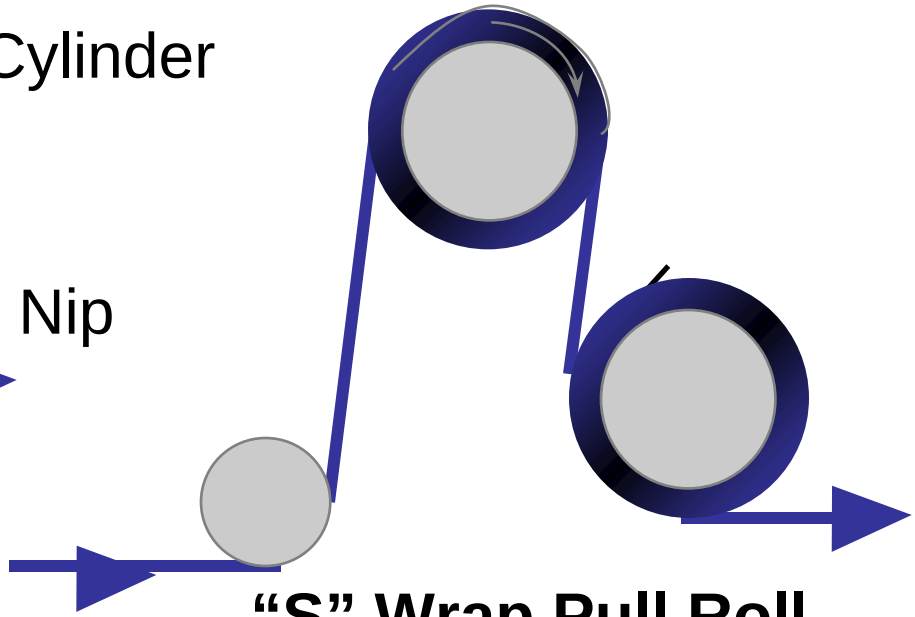
Nip Pull Roll

Suggested Nip =

3 x Tension

Check Loaded Deflection

Rubber Covered Rolls



"S" Wrap Pull Roll

T1/T2= f(wrap, coef. of friction)

"S" Wrap Will Not Isolated Tension Waves

Suction Rolls

+ Used for tension isolation when you can't nip the substrate
- Deckles for width changes
- Vacuum blower (noisy) -locate remote

TENSION CONTROL

- **Highly Extensible Webs**

  Draw Control w/ Transducer Operator Feedback

- **Normal Webs**

  - Unwinds - Dancer Control

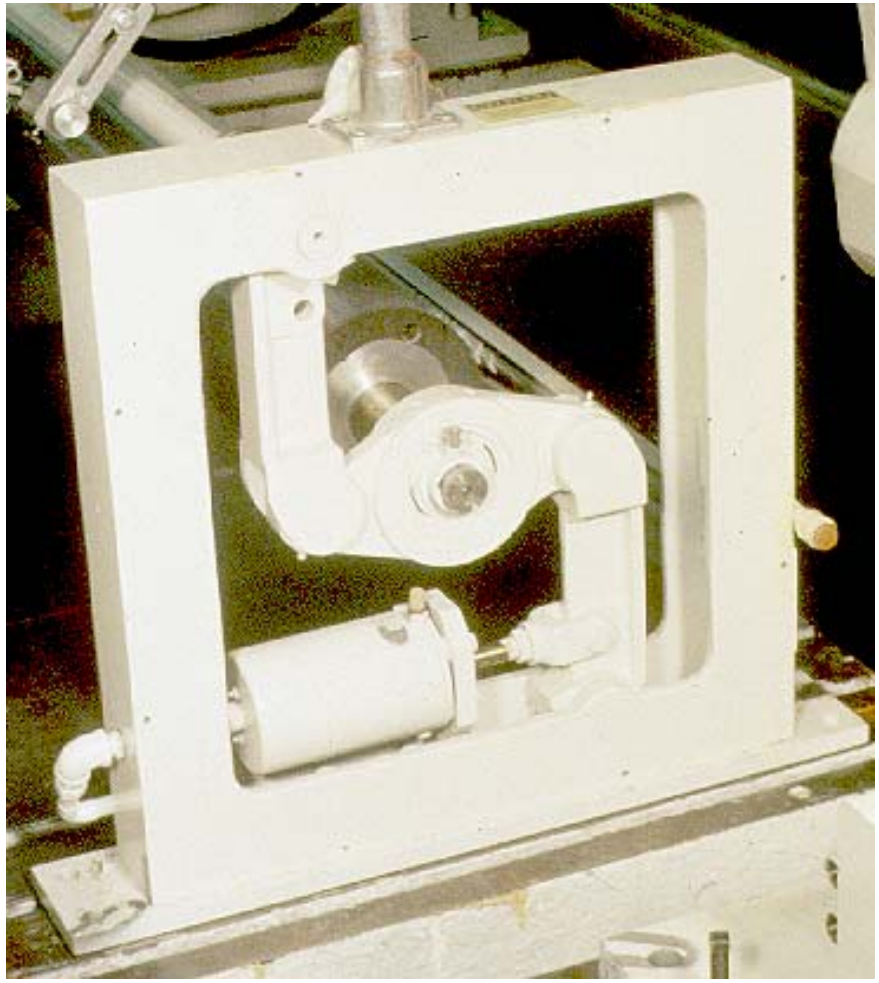
  - Processes - Transducer Control

  - Winders - Transducer Control unless Roll Changer has significant Web Length Changes. Then must use Dancer

DANCER SYSTEM MUST BE PROPERLY DESIGNED

Z-BAR DANCER

- Center Position Control System
- Low friction, pneumatic actuated/ loading
- Roll's Weight taken through pivots
- Hysteresis free
- Inertia compensated
- Best for Unwinds for Soft Tension Control



TRANSDUCER LOAD CELLS

Best for Winder tension control

+Most responsive for drive trimming

+Direct readout of tension

+Good for high speed operation

+ Precision roll balance for best accuracy

Practical Example:

A West Coast Company Was Losing $100Ks in Products due to Wrinkles.

Consultant Cost $5,000.00

You could have solved problem with the information gained by Participating in This TAPPI Short Course

Problem: 55# photographic printing – Wrinkling on one side - Just before nip of Rider Roll on Winder. Only Wrinkled on Wide Width Product!

Solution:

This 55# calendered grade had tensile strength of 37 #/inch.

10% of tensile = 3.7% pli min. suggested tension

90 psi on dancer = 210# tension / 80” web = 2.6 pli

Problem: **Not pulling sufficient tension to pull out acceptable basic wg. variation across sheet.**

Winder Spindle Drive @ 50” dia - 210#=60% FLC
(Plenty of Spindle Power to pull more tension)

Solved Problem by: Moving the dancer roll from 24” to pivot to 16” to enable **pulling 315# tension or 3.9 pli** @ 90 psi on the 80” sheet.

This enabled pulling sufficient tension to pull sheet flat before nip and eliminating Wrinkle.

The most costly defect in Web Handling is:
WRINKLING

Davis-Standard CONVERTING SYSTEMS
Black Clawson | EGAN | ER-WE-PA

TECH TIPS
Helping you get more out of your production line.

Advance | Blown Film | Cast Film | Extrusion Coating & Laminating | Liquid Coating & Laminating | Pelletizing | Process Control | Unwind & Winding

Wrinkles

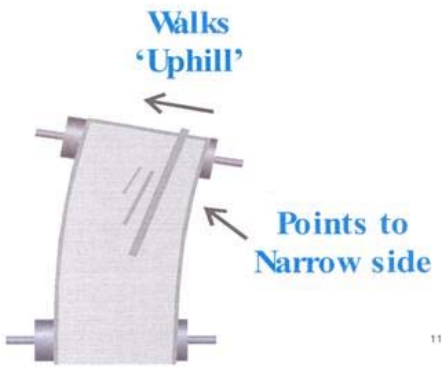
Wrinkling is the number one cause of defect waste in the web industry. This subject is so important that a complete chapter has been written on WRINKLES by Dr. David Roisum in the new TAPPI book - ***Roll and Web Defect Terminology***. Please go to this link for more information on this book-

Wrinkles can be soft (non-creased) or hard where they actually fold over and form creases. They are **M**an, **M**aterial and/or **M**achine induced. Most wrinkles are a combination of these elements.

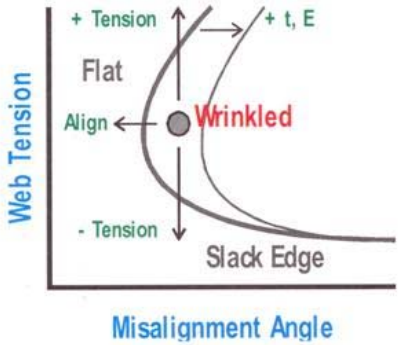
Wrinkles caused by **M**an (improper settings) can usually be attributed to improper web tension and/or winding settings. Wrinkles can form in the web in the process line by running tension settings (**M**an) that are too low or too high in combination with **M**aterial and **M**achine deficiencies. Roll wrinkle defects, such as Baggy Lanes, Buckles, Corrugation Wrinkles and Crepe Wrinkles, are caused by improper roll structure settings (improper use of the **T**ension, **N**ip, and or **T**orque roll structure tools) or the winding of non-uniform webs too tightly into a roll form.

Wrinkles caused by **M**aterial are due to non-uniform formation, conditioning, coating, drying and/or laminating in the web's process history. The root cause of many wrinkles is the non-uniformity in the cross machine direction surface of the web. Since no web is perfectly flat or uniform across its surface, our challenge as Web Processors is to handle webs with acceptable variations in consistency and to produce wrinkle free products to our customers that will run on their processes without problems.

Wrinkles caused by **M**achine deficiencies are the focus of this Tech Tip. Many times **M**aterial deficiencies, which produce soft wrinkles, can be turned into hard or creased wrinkles when the web goes over a highly wrapped idler roll or through a nipped section.
If these wrinkles are straight in the machine direction (M.D. Wrinkles), then either the web **M**aterial is trying to expand and the **M**achine won't let it, or M.D. Wrinkles are caused by excessive roller deflection or grooving. When these M.D. wrinkles show up in the wound roll, this defect is often referred to as "Tin Canning". Adding proper web spreading in the proper location or ensuring that the spreaders already provided are in proper adjustment and/or pulling less web tension will normally correct these M.D. Wrinkles. Click on this link to access a Tech Tip on Spreading on the Davis Standard Website.



Shear Wrinkles
Figure #1 (Courtesy of Dr. D.R. Roisum)



Wrinkle Window
Figure #2 (Courtesy of Dr. D.R. Roisum)

Davis Standard Converting Systems
46 N. First St., Fulton, NY, 13069 USA PHONE: 315-598-7121 FAX: 315-593-0396
Web Site www.bc-egan.com

Tech Tip on Wrinkles – Give me Email address

Challenges in

Web Spreading

Web Spreaders Purposes:

To Prevent Wrinkles

To Separate Webs

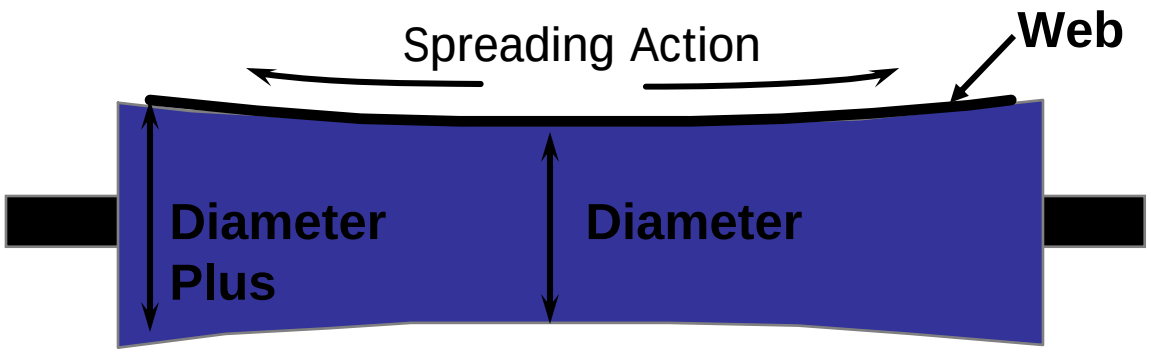
CONVERTER'S CHALLENGE

Provide the Best Spreader for the Application And Keep Spreader Properly Adjusted

COMMON TYPES OF SPREADERS:

- Reverse Crown Rollers
- FlexSpreader Rollers
- Herringbone Grooving (Al. Foil)
- Single Bowed Spreader Roll
- Dual Bowed Roll Arrangement

REVERSE CROWN SPREADERS



A roll that has a diameter at the ends slightly larger than in the center. The surface speed is greater at the ends than the center. The surface speed difference causes an ingoing web tension distribution that is shaped similar to the speed profile. The roll's spreading action is a function of its crown and roll deflection.

<u>Most Effective on Extensible Materials</u>

REVERSE CROWN SPREADERS

- **Application**

  -**Wrinkle Removal**

  -Most Effective on Extensible Materials

  -Web Wrap should be Greater Than 60 Degrees

  -Web Entry Span should be 1.5x Web Width Min.

  -Suggested Dia. Difference .3-.5% of Roll Dia.

  -Poor Man's R.C.S. is Tape on Ends of Idler Roll

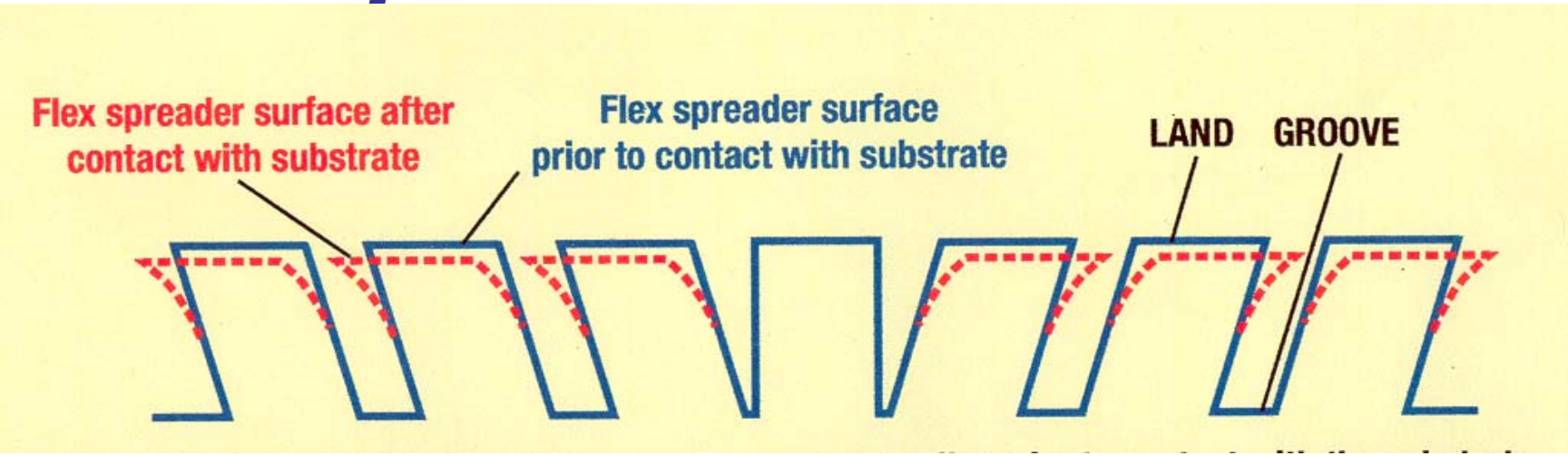
- **Pros** **- Least Expensive Type of Web Spreader**

  - Easily Retrofitted to Operation

- **Cons** **- No Running Adjustments of Spreading**

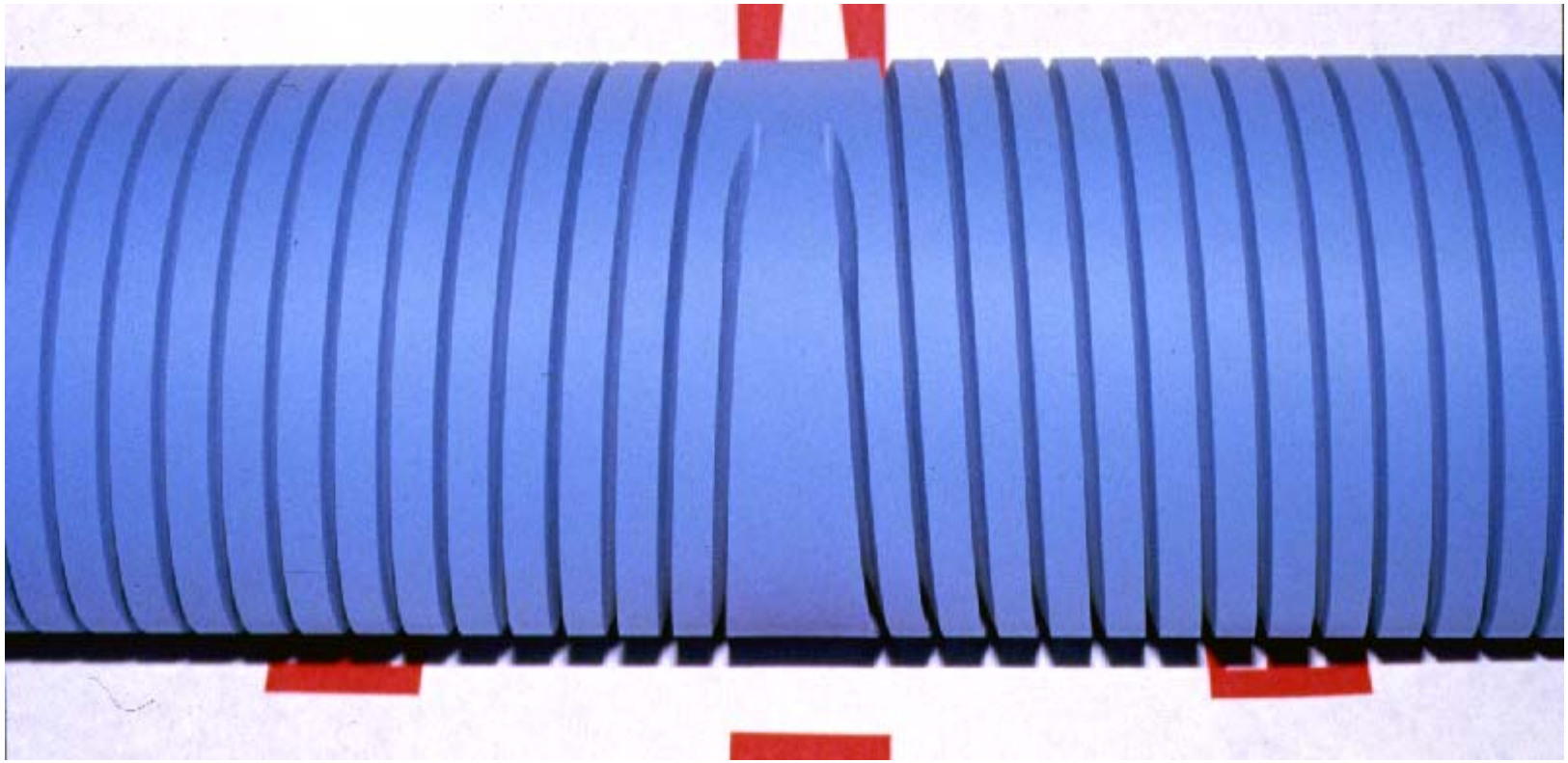
  - Spreading Action is Very Product Dependant

FlexSpreader Roll



A FlexSpreader is a roller that has a spiral grooving cut into a soft rubber covering. The grooving starts at the center & is cut at an angle so that the web tension deflects the lands outwards, carrying the web with them to provide the spreading action. The amount of spreading is a function of rubber cover hardness and Web Tension.

FLEX SPREADER DESIGN



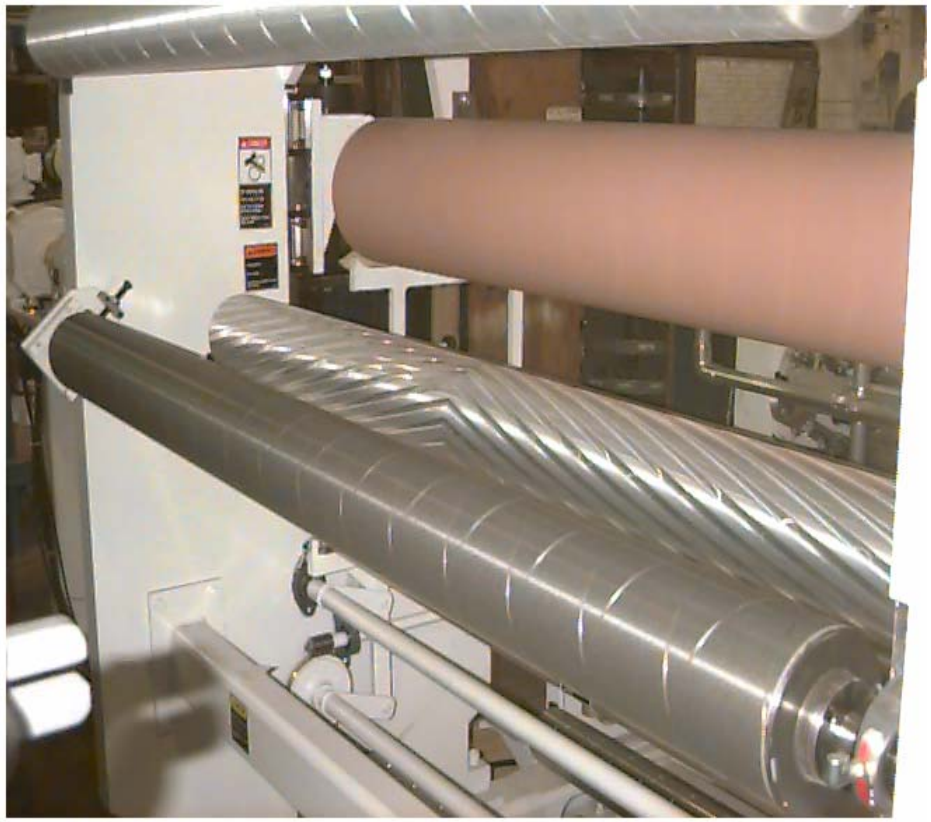
Spiral Points in Web Direction

Most Effective on Non-Extensible Materials

FlexSpreader Roll

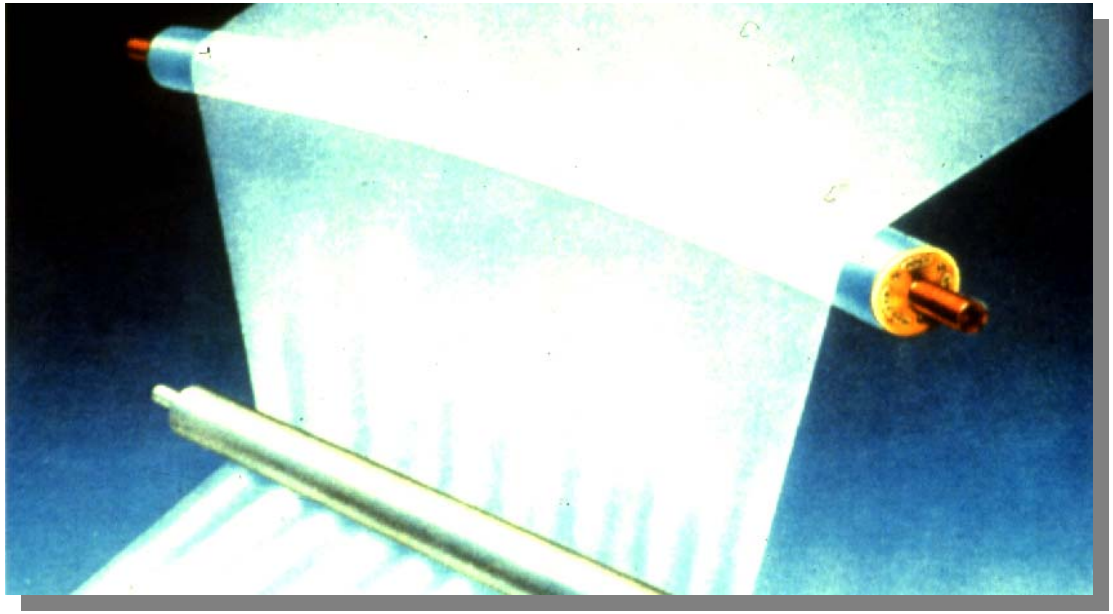
- **Application:**
  - **Wrinkle Removal**
  - **<u>Pre-wind</u> Web Spreading with <u>No</u> Slitting**
  - **<u>Pre-slit</u> Web Spreading with Slitting**
  - **Most Effective on Non-Extensible Materials**
  - **Web Wrap Should be 90 Degrees or Greater**
- **Pros** **- Relatively Low Cost, Easily Retrofitted and Operated**
  - **Self Compensates for Tight and Loose Areas Across Web for More Uniform Cross Machine Web Tension**
  - **Grooving Eliminates Slippage Due to Air Entrapment**
- **Cons** **- Needs Web Tension to Provide Spreading Action**
  - **Limited Control of Spreading Flexibility**

ALUMIUM FOIL SPREADING
HERRINGBONE ROLLS



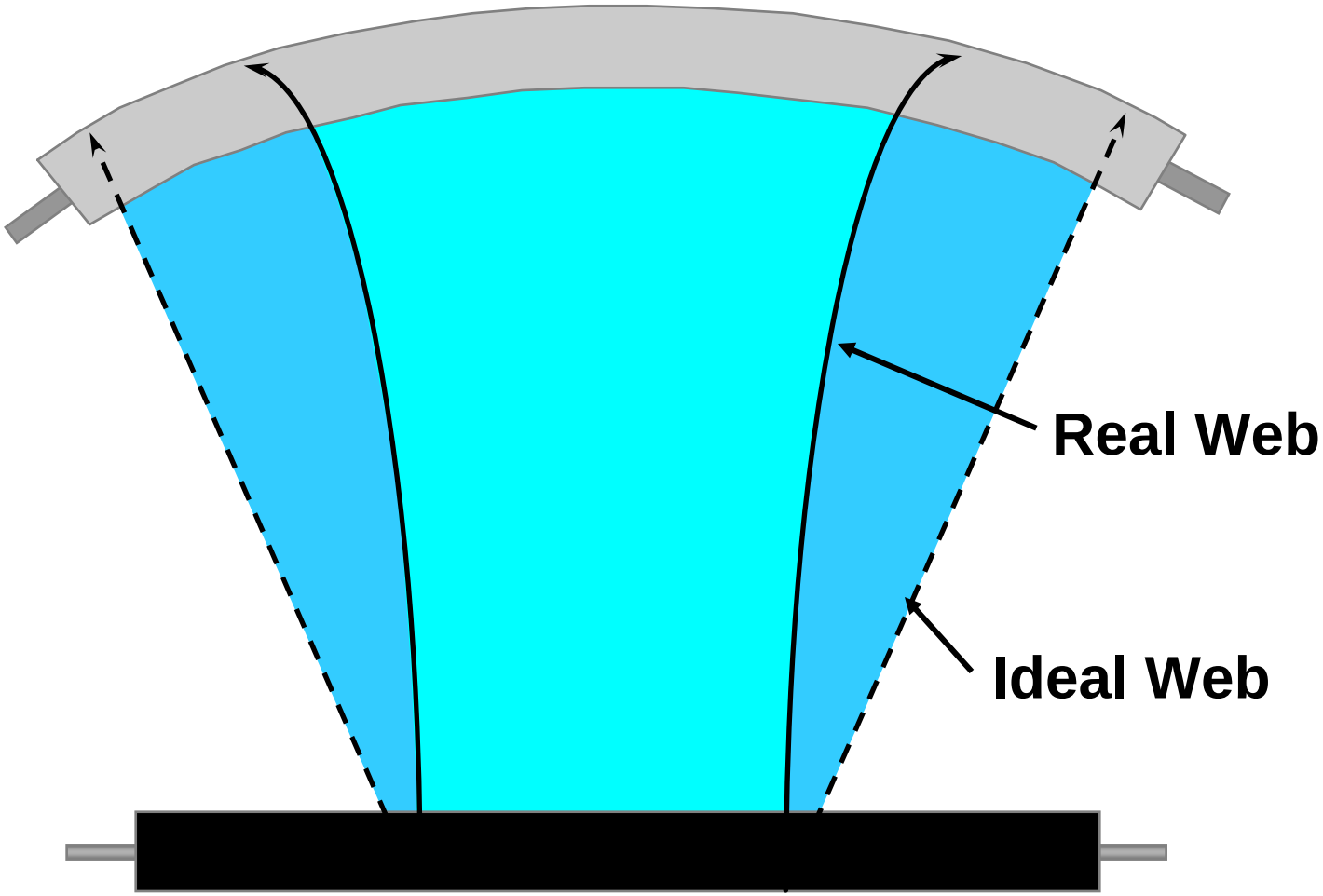
- **Outward groove machined into shell**
- **Roll is directional**
- **Works well on foil web paths**
- **Keep to less than 90 degrees wrap for foil**

BOWED SPREADER ROLL



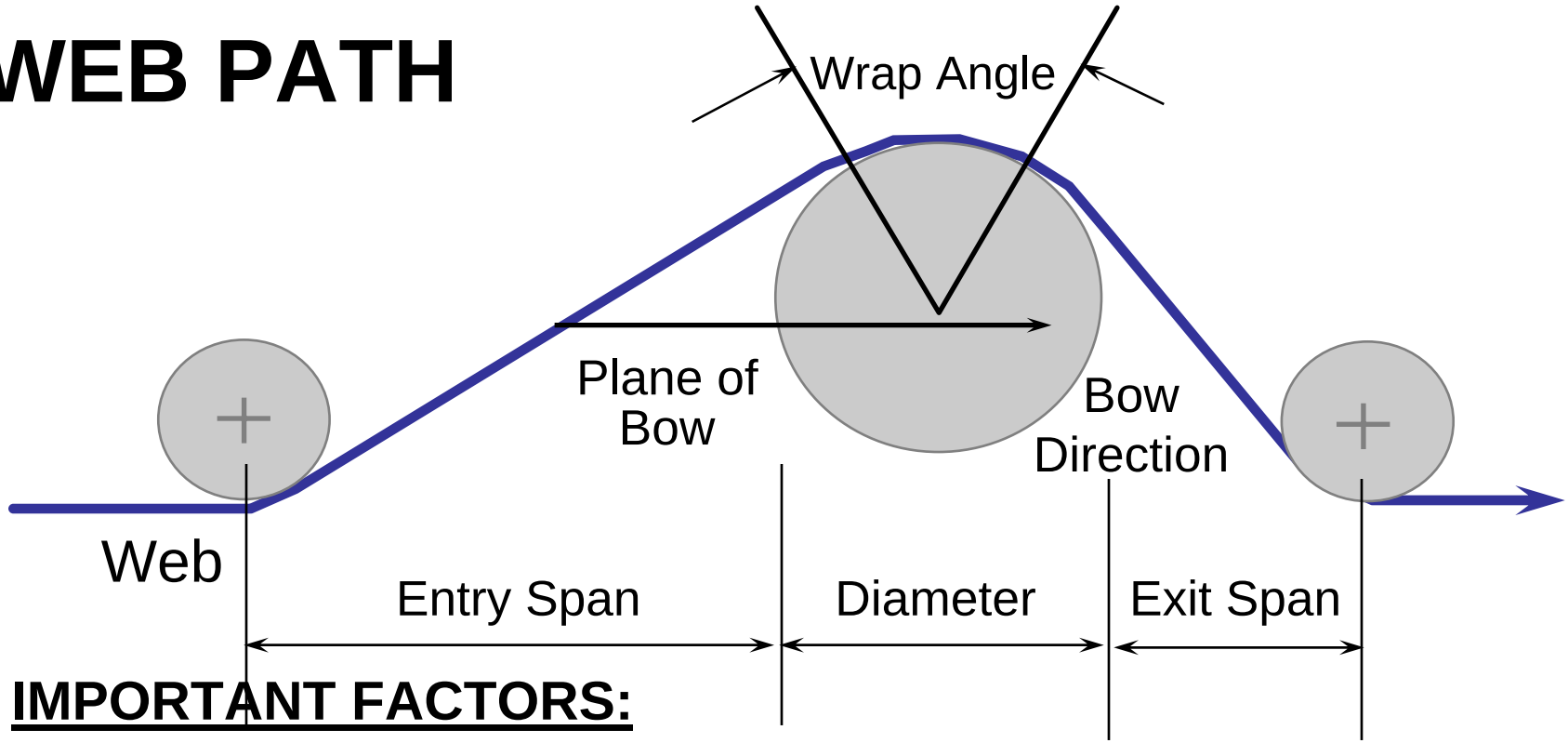
A roll with a fixed or variable curved axle supporting segmented, bearing mounted metal sleeves. Sleeves are typically covered w/ a flexible soft rubber covering. High wear applications - eliminate the cover and the metal sleeves are traction coated.

BOWED SPREADER ROLL-
WEB BEHAVIOR



BOWED SPREADER

WEB PATH



<u>IMPORTANT FACTORS:</u>

-Web Length of Entry Span wants to be <u>as long as possible</u> to Minimize required Bow. Length of Exit Span <u>short as possible</u>

-Wrap Angle to be 45-180 degrees to max. traction & min. bow. (Old thinking was 15-30 degrees <u>not true today!</u>)

- Bow Direction to be set at 90 degrees to Bisector of Wrap Angle in the Direction of the Web Travel

BOWED SPREADER ROLL

- **Application:**
  - **Wrinkle Removal and/or Slit Web Separation**
  - **Can be used on both extensible and non-extensible mat'ls.**
  - **VentAir grooving reduces slippage from air entrainment**
  - **Lead-in web span to be as long as possible to minimize required bow**
- **PROS**
  - **Can be used on processes having a wide range of mat'ls.**
  - **Can be adjusted to tighten center or ends of web**
  - **Readout of amount of bow available**
- **CONS**
  - **More complex and costly than other spreaders**
  - **Needs to be driven on light tension applications**
  - **Bow position and amount of bow on variable bow rollers may be misadjusted by operators**
  - **Bearings are not able to be relubricated and difficult to replace**

Web slitting applications usually limited to 4 rolls or less

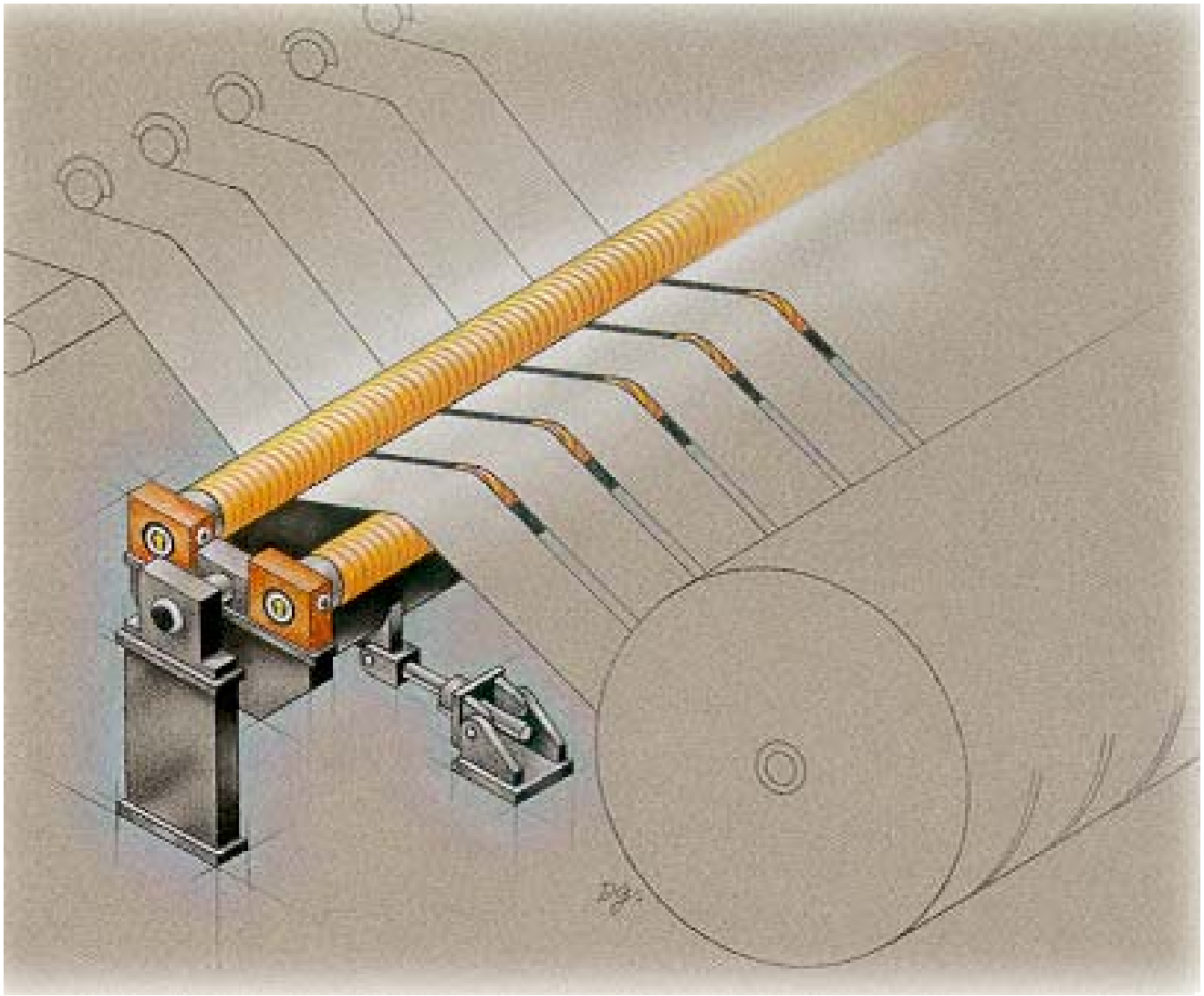
BOWED SPREADER ROLL

Amount of Spreading

Function Of :

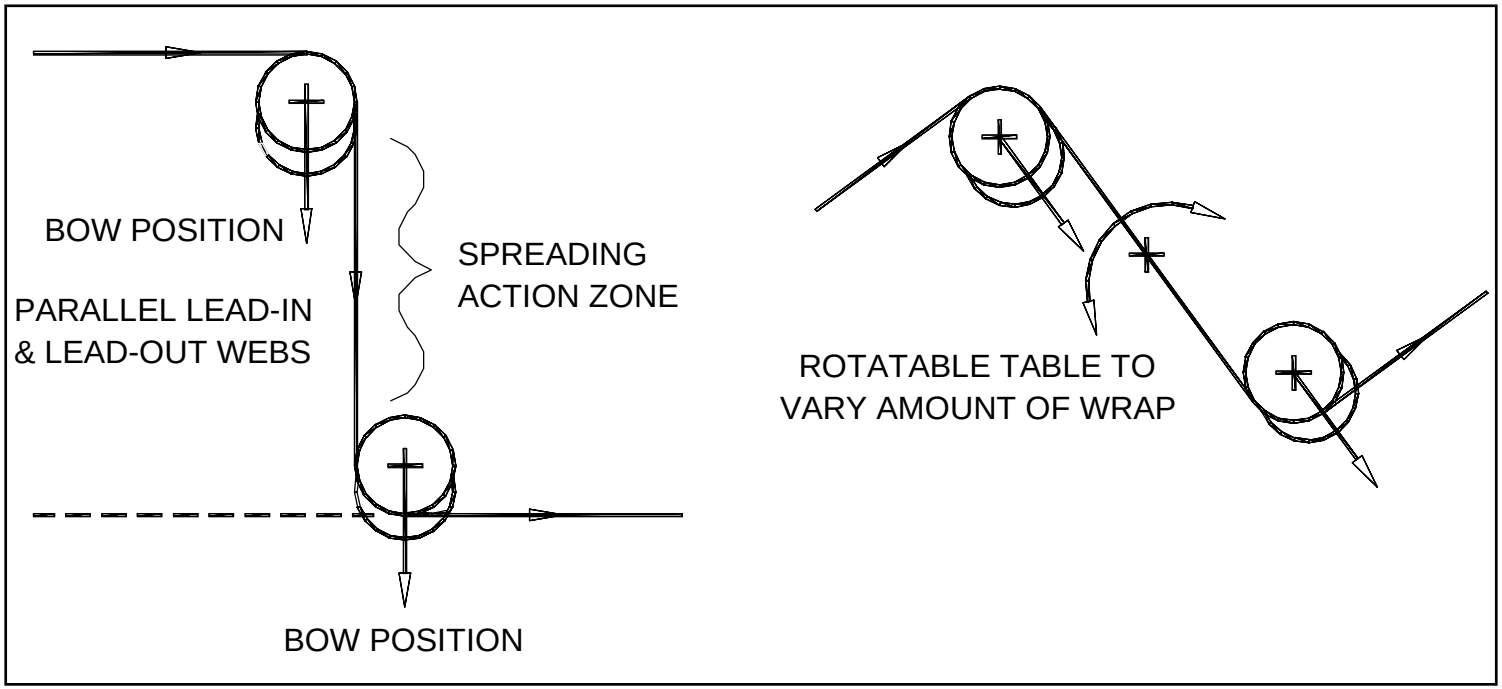
- **Amount of Bow**
- **Amount of Wrap**
- **Amount of Web Tension**

DUAL BOWED ROLL SPREADING



Schematic Courtesy of Spencer Johnston

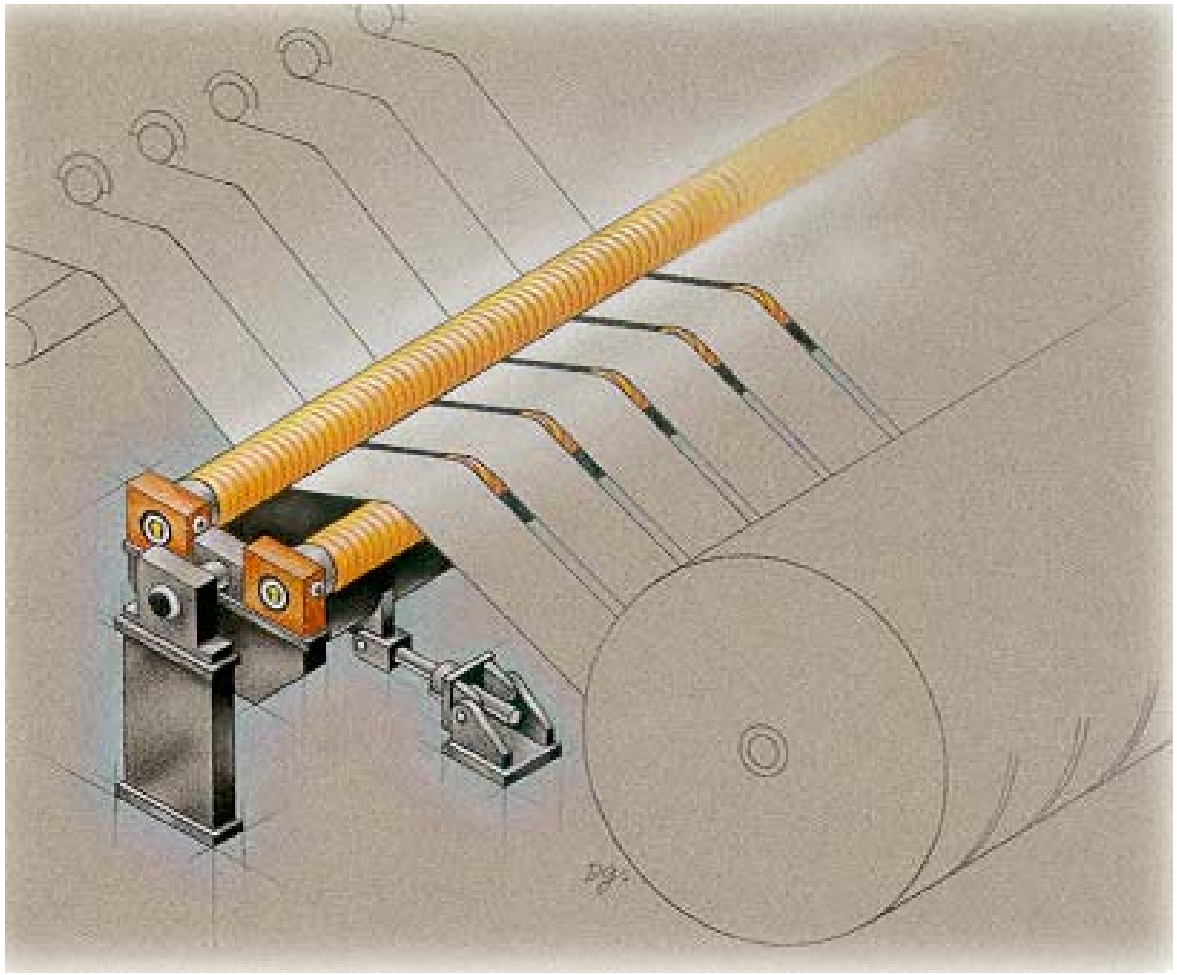
DUAL BOWED ROLL SPREADING



Bows are parallel with the bows pointing 90 degrees to the lead-in and lead-out web paths as shown. The spreading action takes place between the two bowed rolls with no spreading effect upstream or downstream. Additional spreading flexibility can be provided by a rotatable table to vary the amount of wrap on the rolls.

DUAL BOWED ROLL SPREADING

Rotatable Spreader Table



Schematic Courtesy of Spencer Johnston

DUAL BOWED SPREADER ROLL

- **Application:** **Slit web separation for slitting and spreading multiple rolls (usually 5 or more)**
  - **Can be used for a wide range of material and slitting variations**
  - **Parallel lead-in and lead-out web leads and sufficient distance between rollers for web separation are critical.**
  - **1st and 2nd rolls will most likely have different amounts of bow due to deflection from tension vector.**
  - **Spreading action function of amount of wrap, bow and web tension**

Spreading Applications Tech Tip –Email Address

Davis-Standard CONVERTING SYSTEMS | Black Clawson Converting Machinery | EGAN | ER-WE-PA

TECH TIPS

Helping you get more out of your production line.

Advance | Blown Film | Cast Film | Extrusion Coating & Laminating | Liquid Coating & Laminating | Pelletizing | Process Control | Unwind & Winding

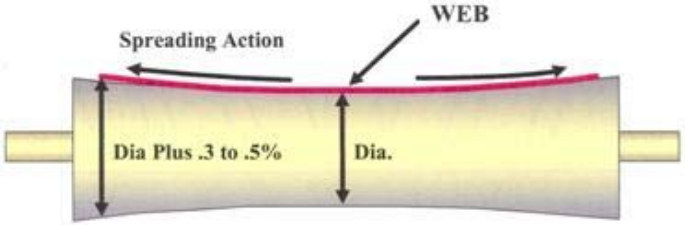
How To Get The Most From Your Web Spreader

By R. Duane Smith
Product Manager – Specialty Winding
Black Clawson Converting Machinery / Davis-Standard LLC
Fulton, NY 13069

Almost all web processing systems require web spreading before critical components to remove wrinkles or for slit web separations. Unfortunately, many of the spreading devices are misapplied or not properly adjusted. This results in not getting the web spreading action desired.

This Tech Tip will discuss the various types of spreaders commonly used in the web converting industries, gives a description of the spreading mechanism, application information and lists the Pros and Cons for using this type of spreading device. We hope that you will find this information helpful in overcoming your web spreading challenges.

Reverse Crown Spreader



Practical Example-

When Spreader Doesn't Spread!

Problem: **To get web separation you have to rotate the bow of the bowed spreader roll directly into the web. This produces high tension in the center of web and possibly baggy edges of the end slit webs.**

Solution: **There is slippage between web and roll. The rotating spreader has become more like a stationary type spreader device. Most likely one or more of the bearings have failed. Check to ensure that the cover turns freely. If it does then the covering needs to be roughed-up or vent-air grooved to restore traction.**

Challenges in

Web Slitting

Selecting the Best Type of Slitting to Consistently Obtain Clean Cuts

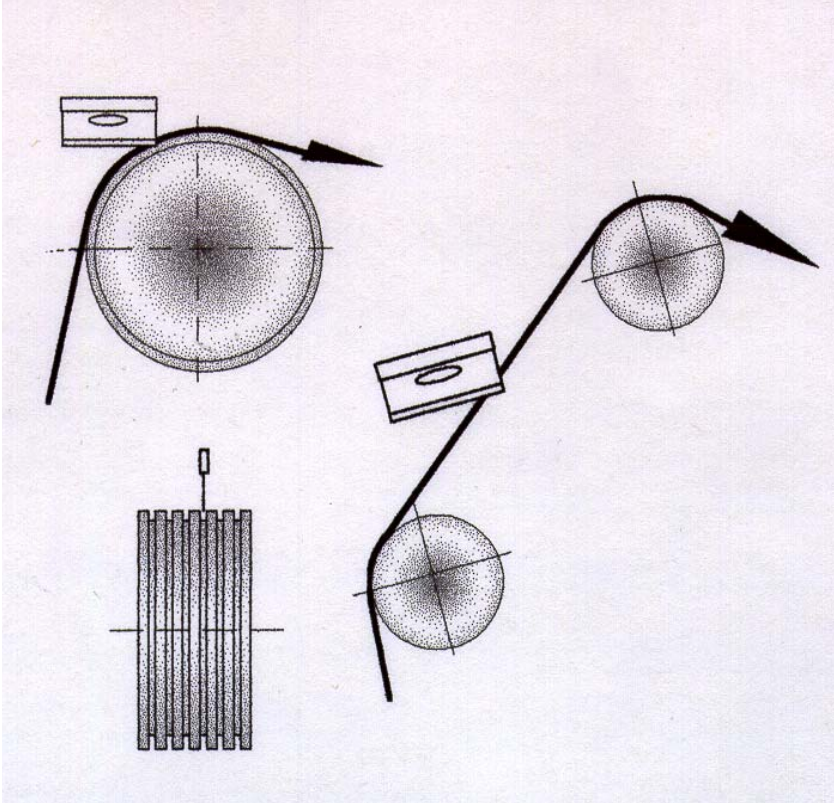
While Optimizing Ease and Safety of the Slitting Operation

Most Common Types of Slitters Used in the Web Converting Industry

- **Razor Slitting**
- **Score (Crush Cut) Slitting**
- **Shear Slitting**

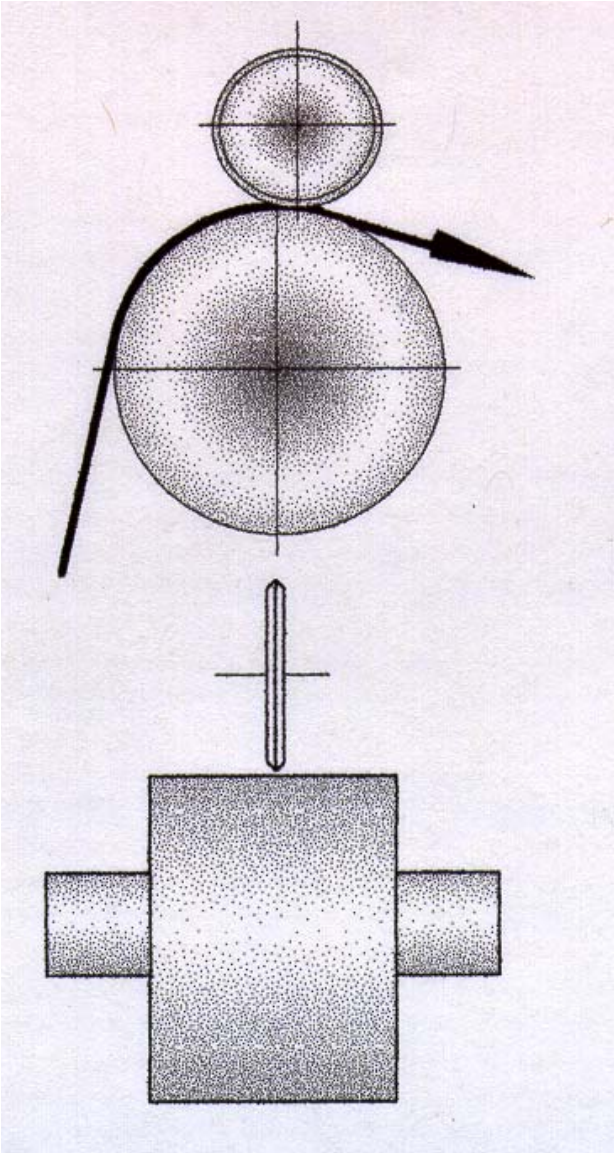
Razor Slitting

- **Cutting or Slicing Action From Web Being Pulled Thru a Stationary Knife**
- **Simplest & Cheapest Method of Web Slitting**
- **Can be Easily Adapted to Fit Almost Any Location**
- **For Appropriate Materials, Cleanest Type of Slitting**
- **Light Film Applications Require Web Support**

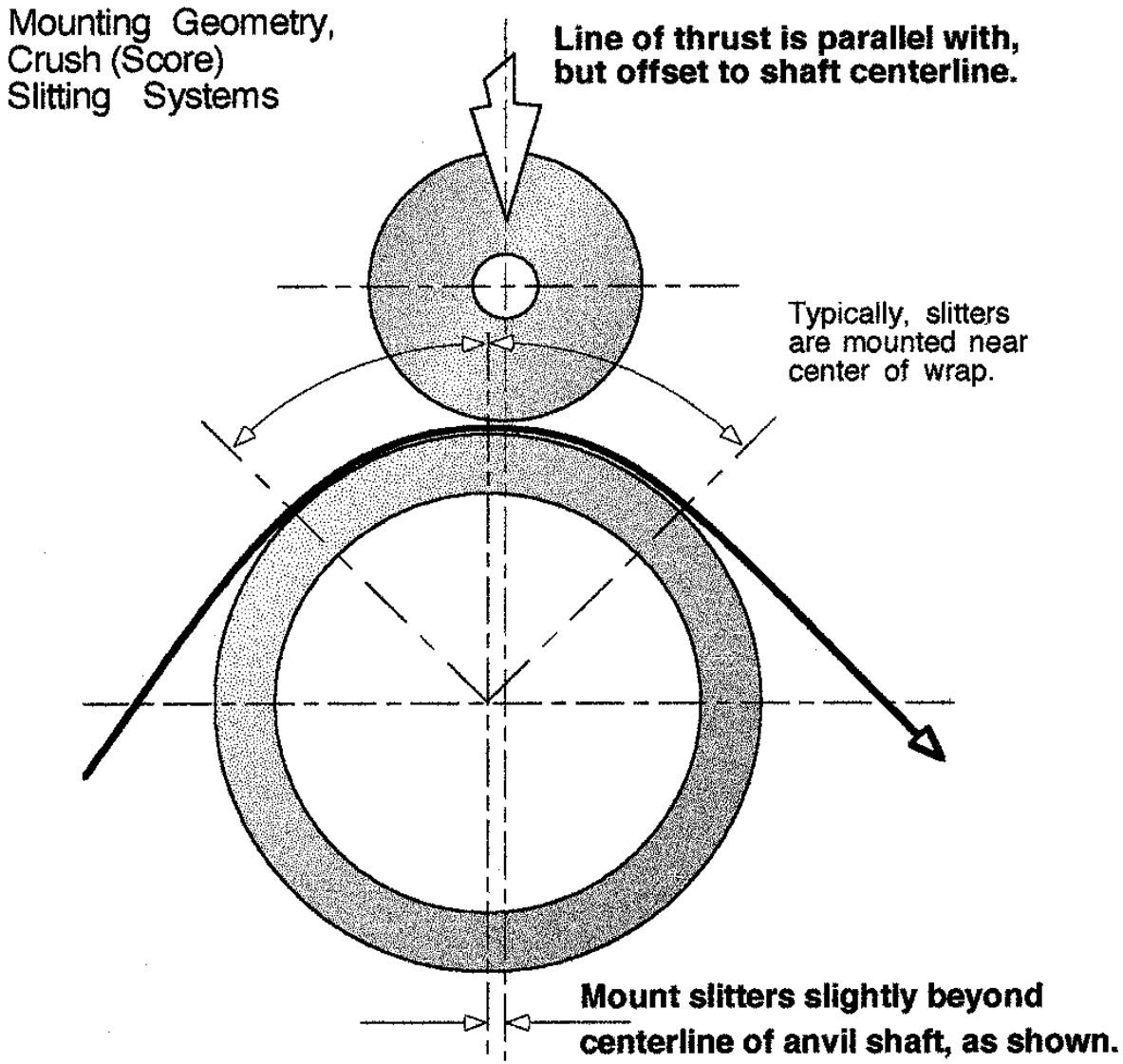


Score (Crush Cut) Slitting

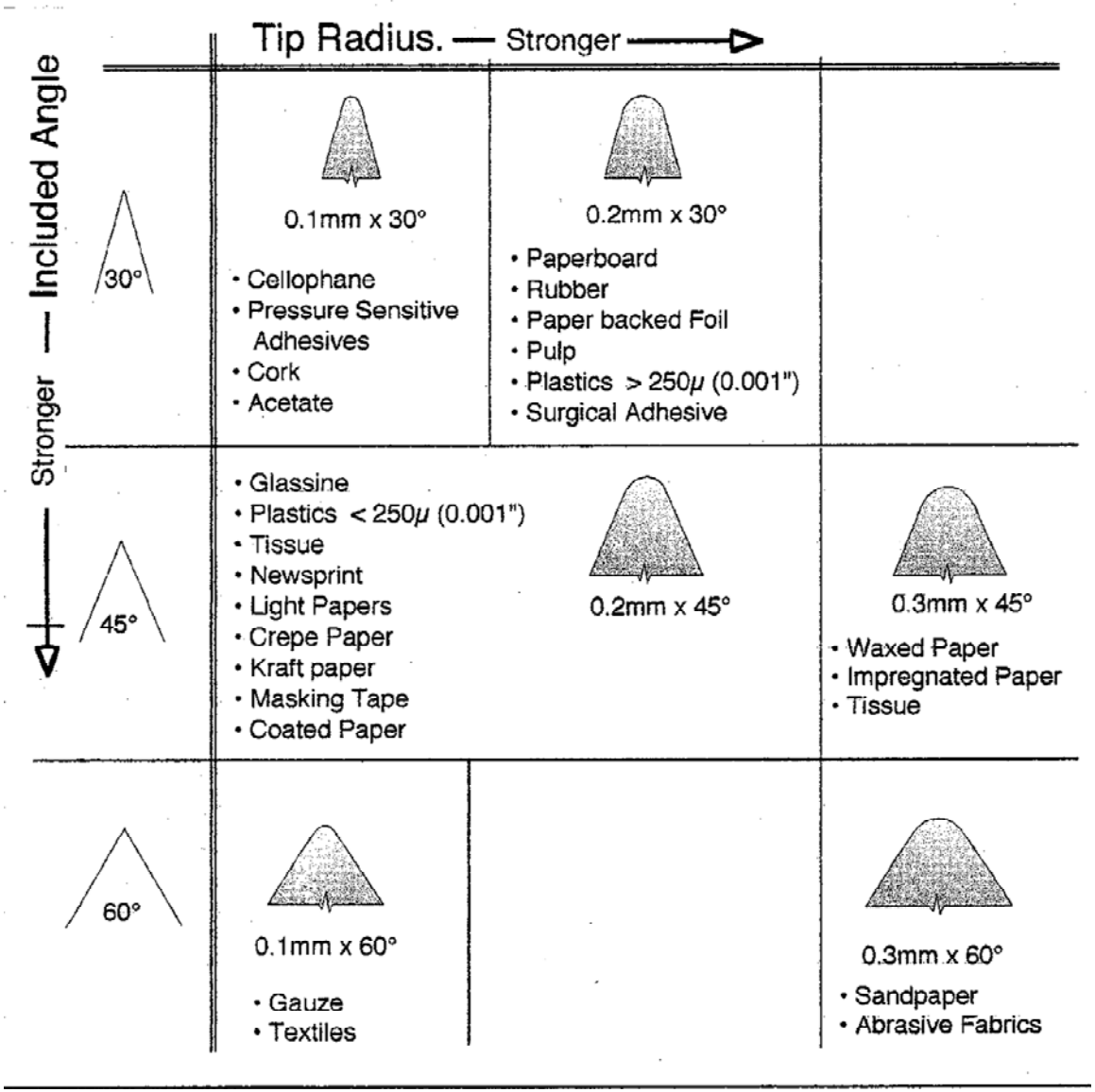
- **Slitting is Crushing Action in Nip Between Slitter Blade and Anvil Roll**
- **Easy to Use and Adjust**
- **Can be Dusty and Produce Poor Edge Quality**
- **Thick and/or Dense Mat'ls. Require High Nip Loads**
- **Ability of Blade to Absorb High Cycle Stresses Limits Speed.**
- **Blade Design for Web Material Critical for Success**



Score (Crush) Slitter Geometry

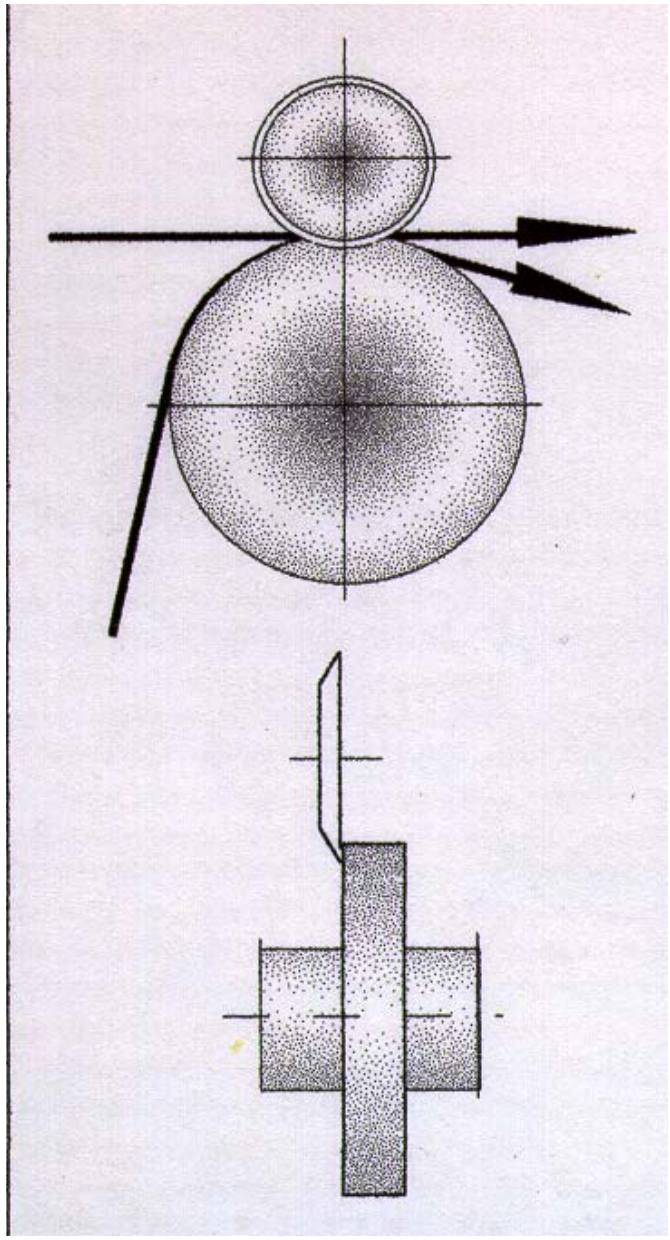


Score (Crush) Slitter Blade Profiles



Shear Slitting

- **True Shear Action Between Two Rotating Nips**
- **Most Versatile Slitting Method**
- **Properly Configured, Highest Quality Slit Edges**
- **Highest Initial Costs**
- **Most Difficult to Adjust Slit Widths**
- **Blade Life Function of Overspeed, Shear Angle, Depth of Overlap and Side Pressure**

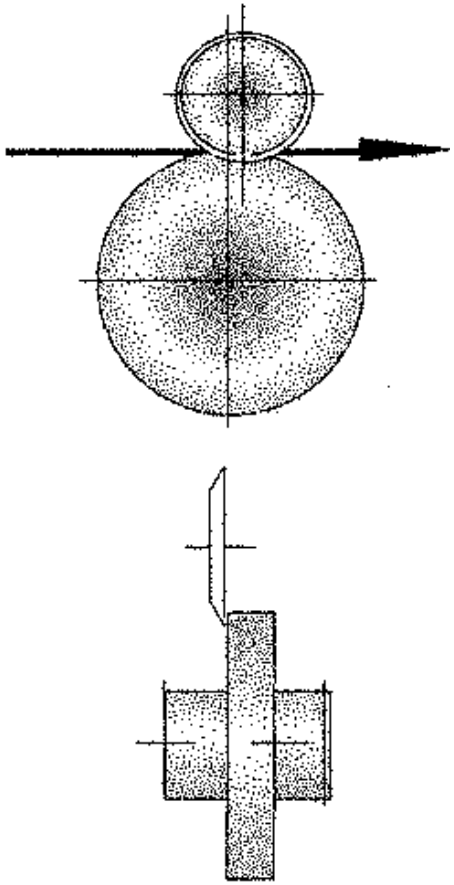


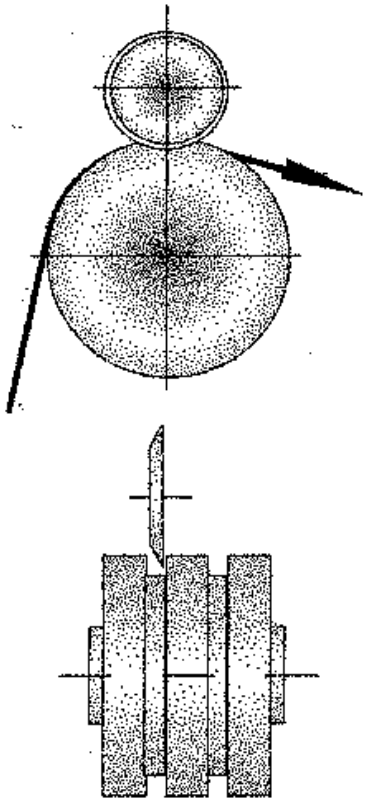
Shear Slitting Systems

Performance Considerations

- **Top and Bottom Blade Diameters**
- **Top and Bottom Blade Overlap**
- **Top and Bottom Blade Materials**
- **Bottom Blade Overspeed**
- **Sideload Pressure of Top and Bottom Blades**
- **Profile of Top Shear Slitter Blade**
- **Shear Angle of Top Slitter Blade**
- **Rigidity of Top and Bottom Blade Holders**

Shear Slitter Configuration





Tangential Shear

OFFSET IN DIRECTION Of WEB

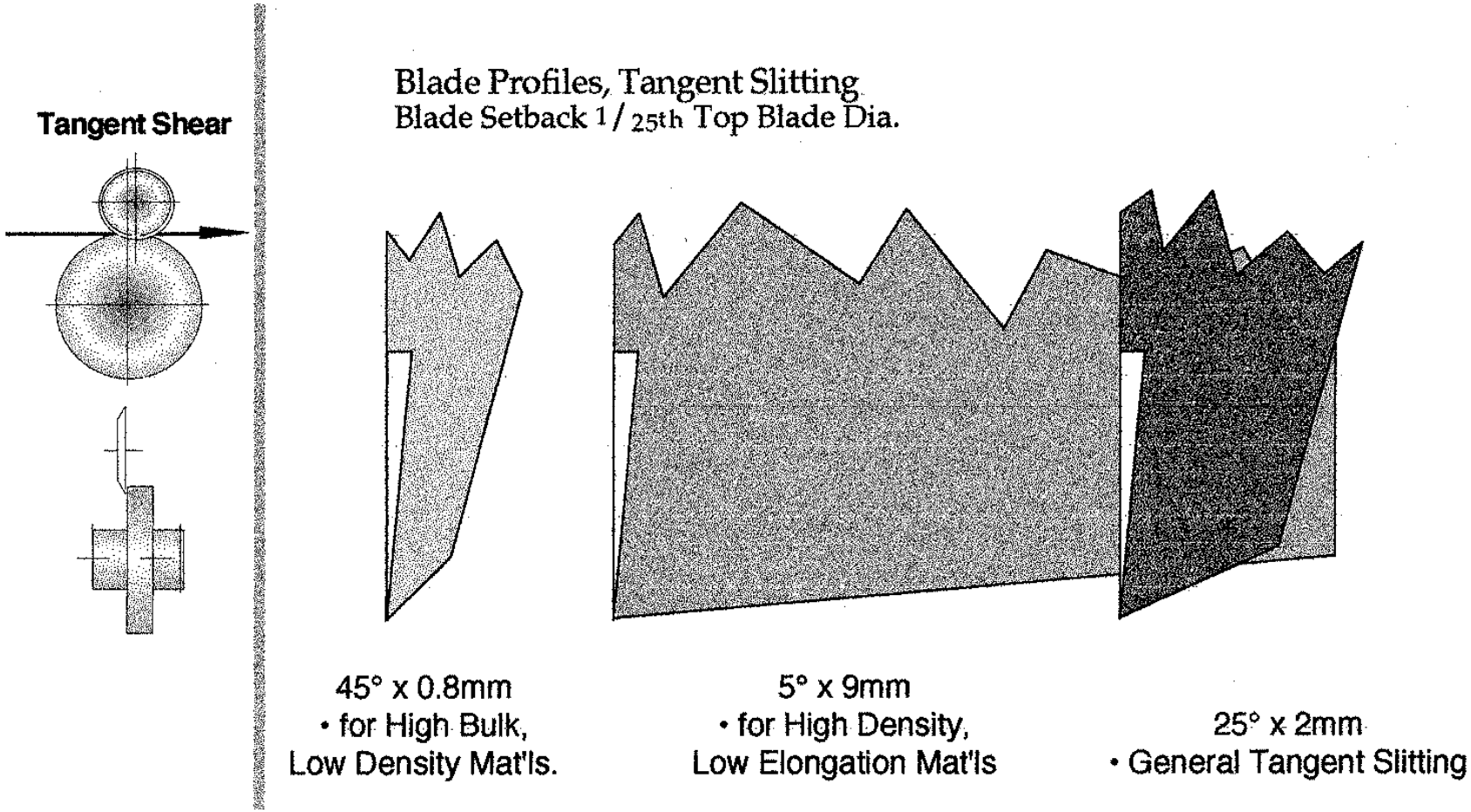
1/25th Of Top Blade Dia.

Wrap Shear

NO OFFSET REQUIRED

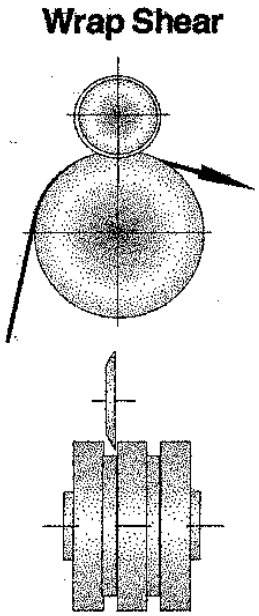
(Blades on Common Centerline)

Shear Slitter Blade Profiles

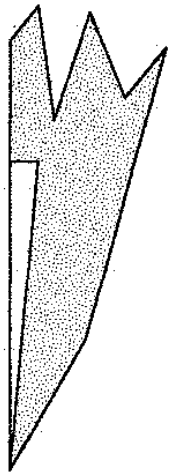


TANGENTIAL SHEAR BLADES

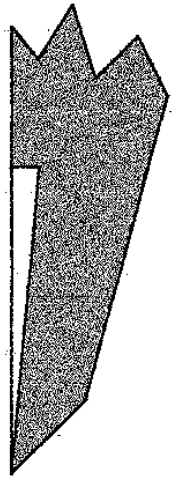
Shear Slitter Blade Profiles



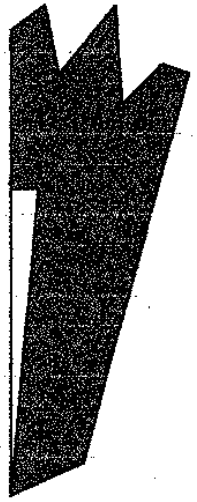
Blade Profiles; Wrap Slitting & Sheeters
Blade Setback: None. (Blades on common centerline)



60° x 0.8mm
• Precision Sheeters (Multi-Web)



45° x 0.8mm
• General Wrap Slitting
• Folio Sheeters (Single-Web)



25° x 0.8mm
• Folio Sheeters (Single-Web)
• Not recommended for critical wrap applications

WRAP SHEAR AND SHEETER BLADES

Converter's Challenge

Match Material Characteristics With Best Slitting Method

Identify The Dominant Material Properties

- **Caliper -** ***Is the Web thick or thin?***
- **Density -** ***Is the Web bulky or highly compressed?***
- **Elongation -** ***Is the Web stretchy under tension?***
- **Stiffness -** ***Does the Web easily bend?***
- **Tensile -** ***Does the Web break easily?***
- **Abrasiveness -** ***Will the Web be abrasive to the slitter blade?***
- **Compressibility -** ***Will the Web recover from compression of the slitting nip?***

Challenges in Web Slitting

Selecting the Best Type of Slitting Summary

Method of slitting:

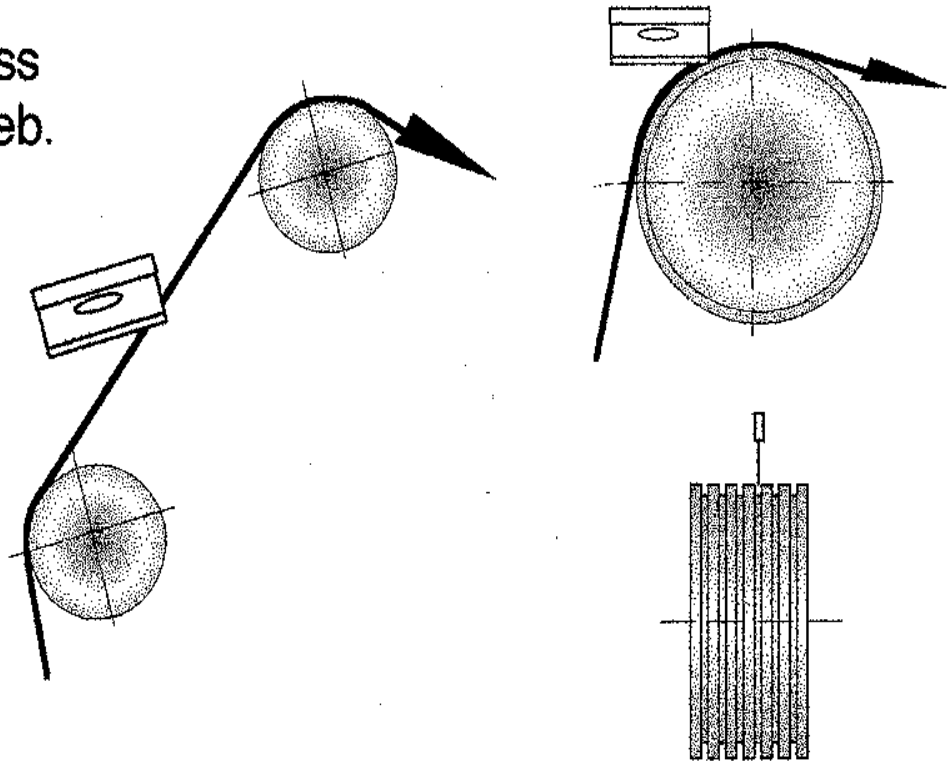
Creates lateral tensile stress at blade tip, "slicing" the web.

At issue:

- Blade Life
- Slit edge Quality
- Safety

Suitable Materials:

- Low caliper
- Low elongation
- Low tensile
- Low abrasiveness



RAZOR SLITTING

Challenges in Web Slitting

Selecting the Best Type of Slitting Summary

Method of slitting:

- Creates compressive stress between the slitter disk and anvil roll.

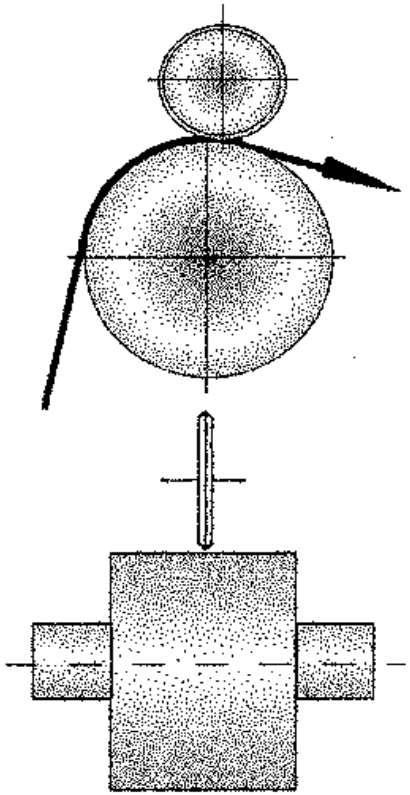
At issue:

- Blade life
- Slit Quality
- Slitting speed

Suitable materials:

- Low Caliper
- Low density
- Low stiffness
- Low tensile
- High elongation
- High abrasiveness
- High compressibility

Crush (score)



SCORE (CRUSH) SLITTING

Challenges in Web Slitting
Selecting the Best Type of Slitting Summary

Method of Slitting:

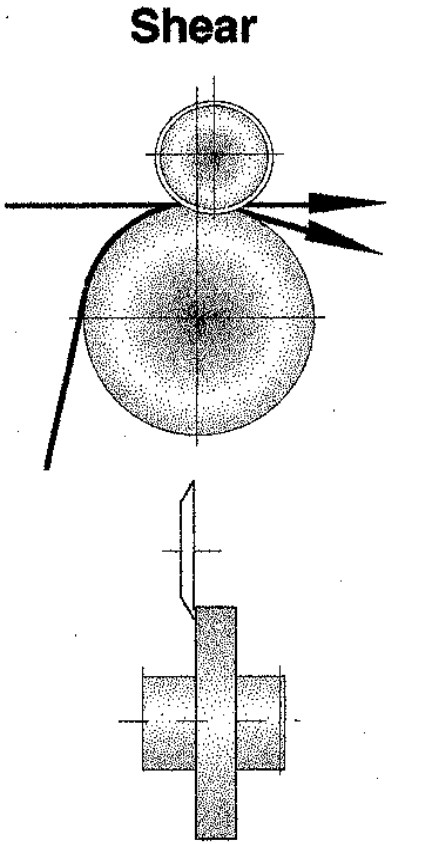
Creates a true shear stress (vertical displacement) within the material.

At issue:

- Complexity of slit width changes
- Nip precision, including:
  - Blade diameter and profile
  - Blade overlap
  - Shear angle
  - Installation geometry
  - Slitter overspeed
- Blade wear

Suitable materials:

Almost any "Flexible web"



SHEAR SLITTING

Shear Slitting Tech Tip

Davis-Standard®
CONVERTING SYSTEMS
Black Clawson Converting Machinery | EGAN | ER-WE-PA

TECH TIPS
Helping you get more out of your production line.

Advance | Blown Film | Cast Film | Extrusion Coating & Laminating | Liquid Coating & Laminating | Palletizing | Process Control | Unwind & Winding

TIP SHEET *For Shear Slitters*

1. **Grind Primary Bevel** of top Slitter Knives to the Attached Chart. Grind Bottom Knife Bands at a 3 degree grind angle.
2. **Reduce** the amount of **web deflection** by adding a 15° degree off vertical secondary bevel starting after .04" horizontally from tip of primary bevel. See Attached Chart.
3. Have top slitter knives **honed** to 8 RMS. Minimum surface finish to be 12 RMS.
4. After Sharpening, **check** blades for small nicks with a Q-Tip around sharp edge.
5. After Sharpening, **inspect** both top slitters and bottom bands to insure **axial** run out is within .002" total and bottom bands for .004" total **radial** run out after grinding.
6. Knives should be **dipped in plastic** to protect the edges from damage and for handling safety.
7. **Always** thoroughly **clean** mounting surfaces with Clean Cloth when mounting slitter knives.
8. After installing, **check** both top slitters and bottom bands to insure **axial** run out is within .004" total and bottom bands for .008" total **radial** run out.
9. After installing, **check** blades for small nicks with a Q-Tip around sharp edge.
10. Set proper penetration of top knife = .03" plus web thickness. Use **overlap template** to insure consistent top slitter overlap to bottom knife.
11. When slitter jump occurs, **always inspect bottom** knife for damage, and change out the top

Practical Example

When More Isn't Better

Problem: **High amount of slitter dust and short blade life of top shear slitter blades. Product 35#, .003" thick printing paper.**

Solution: ***Too Much*** **Penetration of top blade into bottom knife (.03"+web thickness) and/or** ***Too Much*** **bottom knife overspeed (3 to 5% max.) and/or** ***Too Much*** **shear angle (1/2 degrees suggested) and/or** ***Too Much*** **side load pressure (should be able to easily spin top blade when loaded against bottom knife).**

Use only enough penetration to prevent blade jump, and overspeed, shear angle and sideload pressure to obtain clean dust free edges of slit rolls. More Isn't Better !!!

Challenges in **Winding**

If all webs were Perfect –

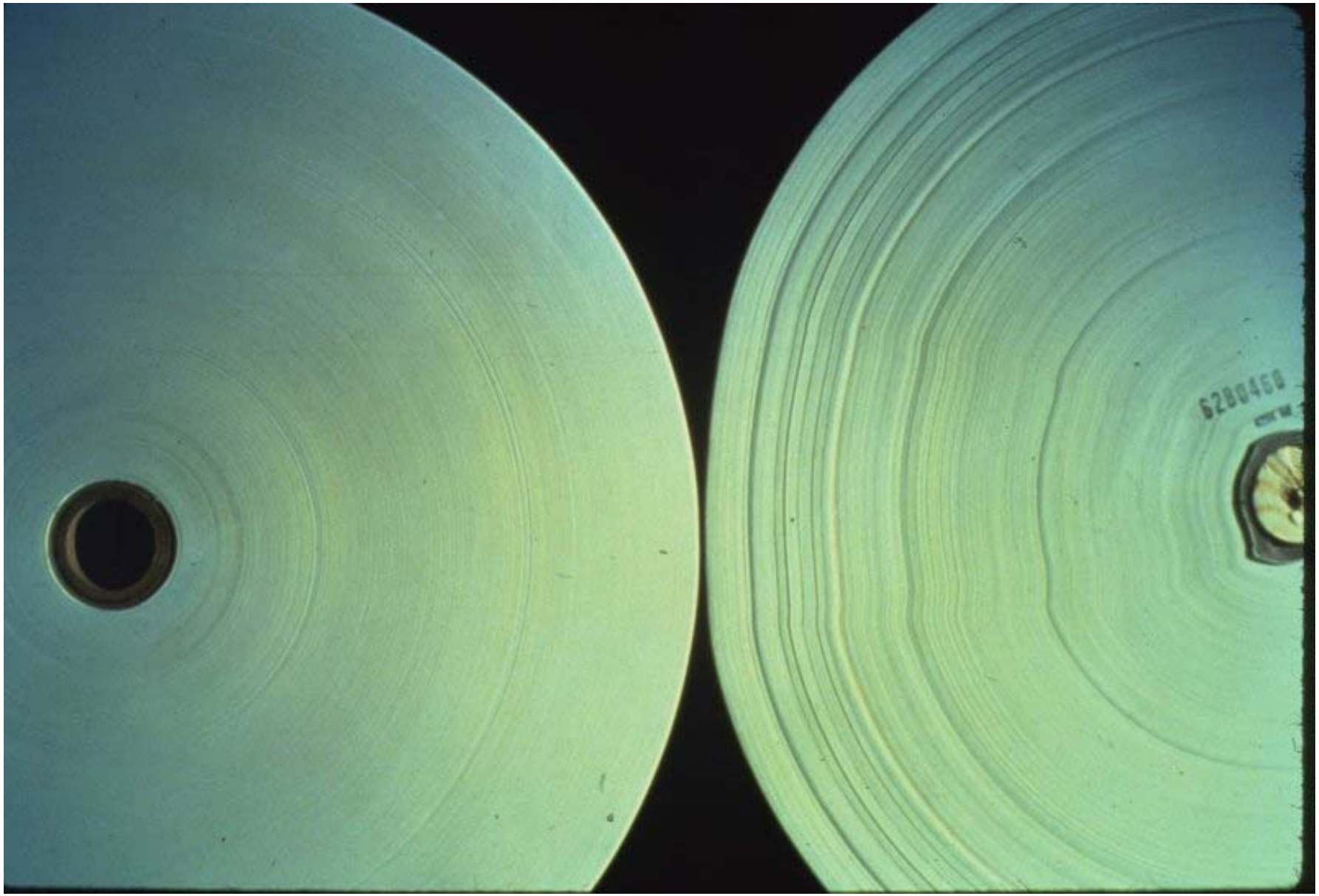
Winding would not be Challenging

Perfect Web- No Such Animal !!

<u>Winding operations challenge :</u>

To wind webs with Slight Imperfections and produce *<u>Quality Rolls</u>* that will run on Customer's processes without problems that will produce *<u>High Quality Products</u>* for their Customers

WHAT IS A GOOD Quality ROLL?


6280460

WHAT IS A Quality ROLL?

Yours Rolls of Paper, Film or Nonwovens

MUST BE:

- ***RIGHT SHAPE* - ROUND AND PROPER WIDTH**
- ***RIGHT SIZE* - RIGHT DIAMETER OR LENGTH**
- ***RIGHT CONSISTANCY* - NOT TOO HARD - NOT TOO SOFT**
- ***LOOK GOOD* - NO BLEMISHES OR VISUAL DEFECTS**
- ***AROMA?* - WIND *POOR QUALITY* ROLLS - SOMEONE WILL RAISE A <u>STINK!!!</u>**

Roll Hardness

The Critical Factor In Determining the Difference Between A Good Roll & A Bad Roll

ROLL DEFECTS DUE TO ROLL HARDNESS

- ***OUT-OF-ROUND ROLLS***
- ***ROLL BLOCKING***
- ***RIDGES***
- ***BAGGY AREAS***
- ***CORRUGATIONS OR ROPE MARKS IN WOUND ROLLS***

"Art of Winding" Article

Paper Film & Foil Converting

Full Article available on www.bc-egan.com

Give me a Email and I will send you hyperlink.

HOW TO ACHIEVE & MEASURE ROLL HARDNESS

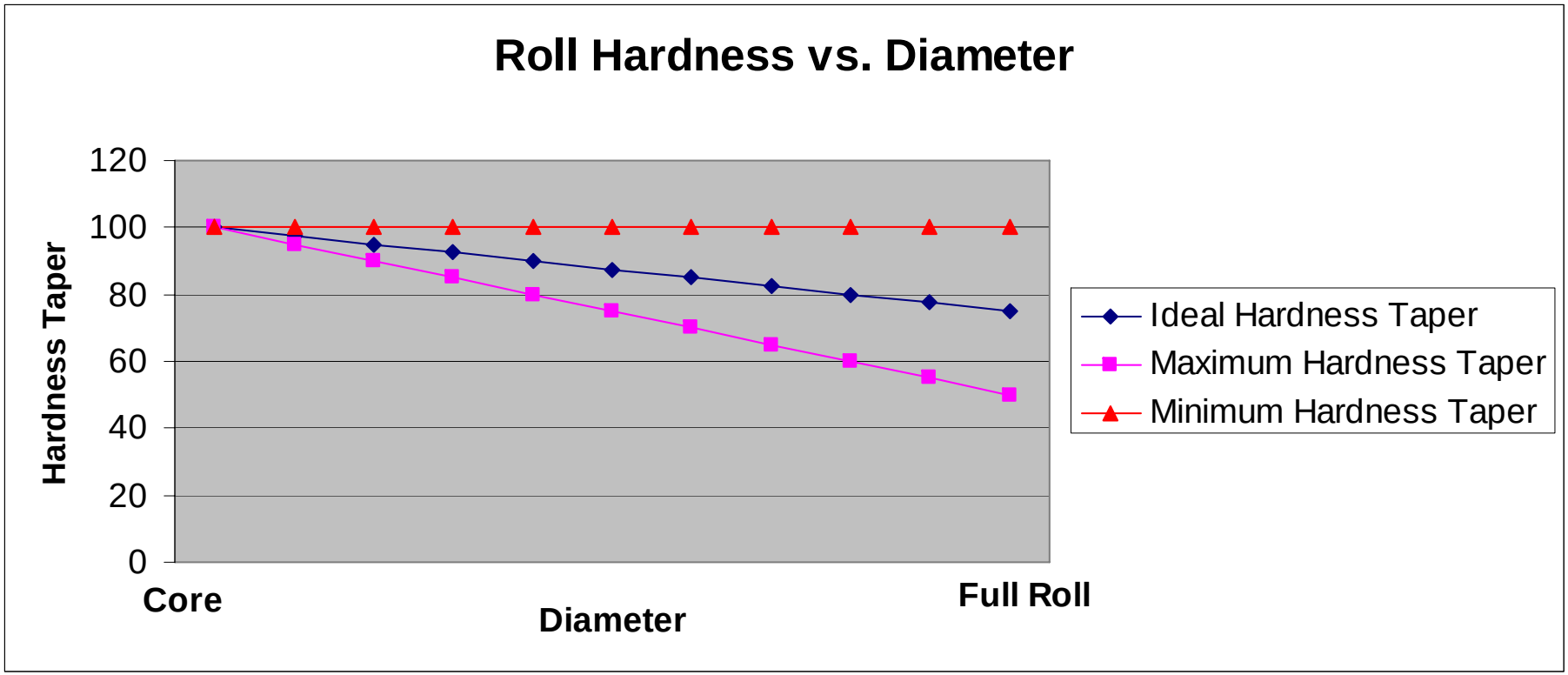
AS ROLL WINDS - INWOUND TENSION OR RESIDUAL STRESSES BUILD UP INSIDE THE ROLL

IF STRESSES BECOME GREATER AS ROLL WINDS LARGER - <u>INNER WRAPS</u> TOWARDS THE CORE <u>WILL LOOSEN AND GO INTO COMPRESSION</u>

THIS CAUSES ROLLS TO CONTAIN DEFECTS SUCH AS TELESCOPING, BUCKLING &/or STARRING

ROLL HARDNESS MUST BE PROFILED TO PREVENT THIS!

ROLL HARDNESS PROFILES



From Chapter #21 of TAPPI Film Ext. Manual – 2nd edition, 2005

Winding Process

Three Winding Principles for Roll Hardness Control

TNT Winding Principles :

Tension **- The WINDING WEB Tension**

Nip **- The NIP of the Pressure Roll or Drum**

Torque **- The TORQUE from the Center Drive or Torque Drum**

Tension Principle of TNT Winding

Elastic Webs - Web Tension is Dominant Principle of Winding in order to Control Roll Hardness

The more that you stretch the web before winding - the harder the wound rolls will be.

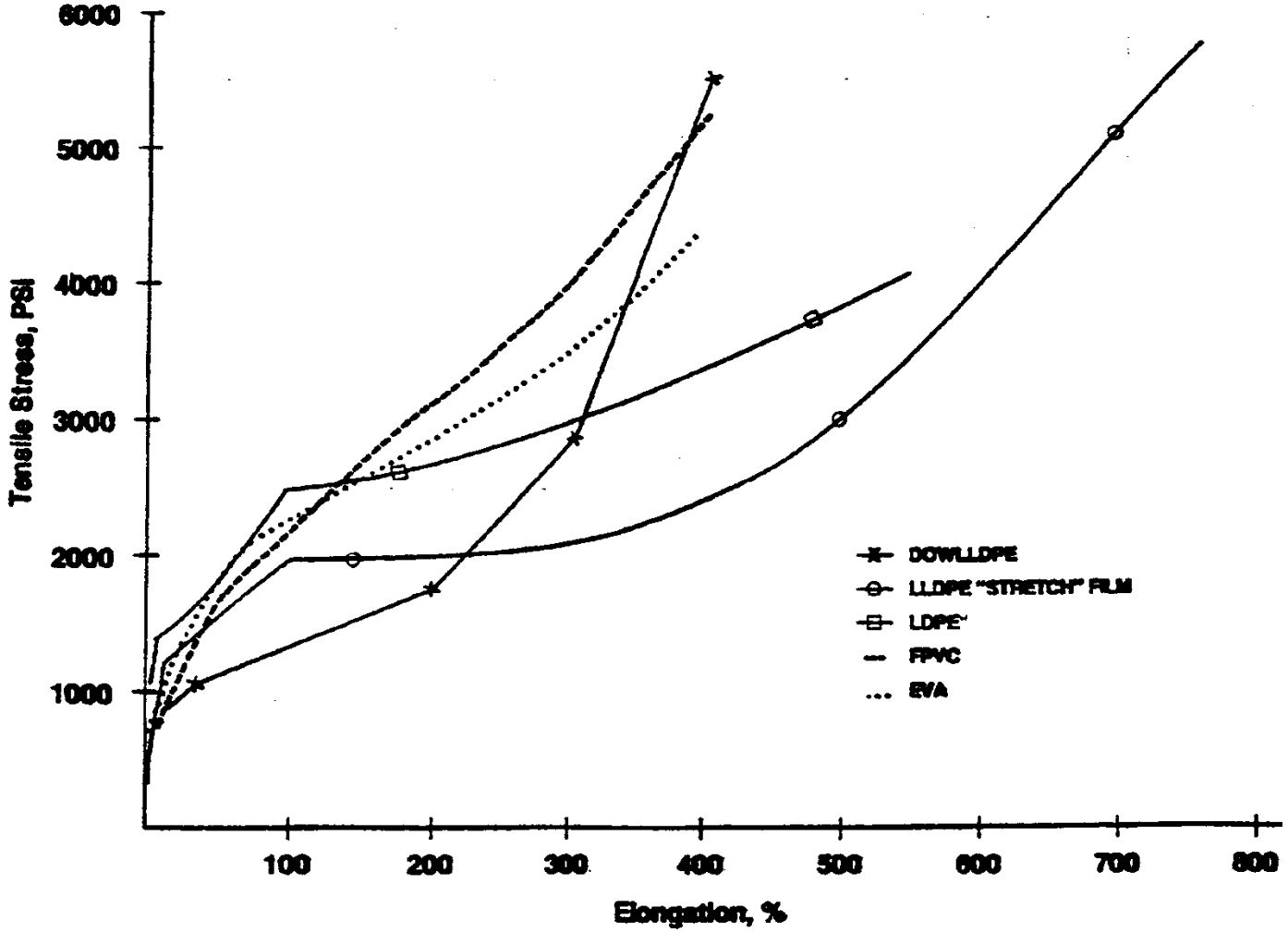
Tension Principle of Winding

How Do Determine the Maximum amount of Tension to Wind Film Webs at ????

Maximum Allowable Tension

- Empirical data has shown that a tensile stress of 1.5% of the elastic modulus, or Modulus of Elasticity, can be applied without inducing significant permanent stresses in film webs.
- The Modulus of Elasticity shows a stress vs. strain relationship

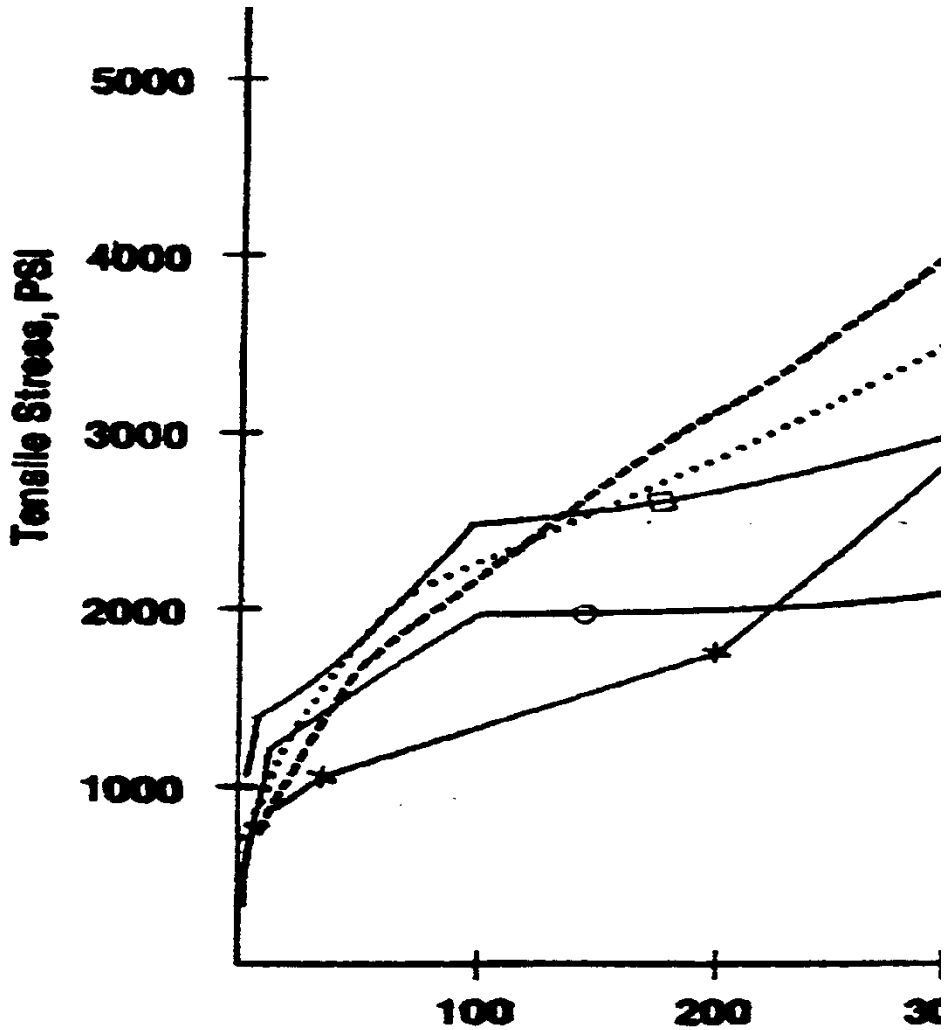
Stress/Strain Curves for Film



How to Determine the Modulus of Elasticity of Plastics?

A secant modulus of 1 or 2 % strain, can be used to determine a useable Elastic Modulus by extrapolating it linearly to 100%

Stress/Strain Curves for Film



Tension Principle of Winding

Modulus of Elasticity

Some typical secant moduli are:

- Flexible PVC 350- 560 kg/cm2 (5-8 kpsi)
- LDPE 1,000-1,800 kg/cm2 (15-25 kpsi)
- LLDPE 2,000-2,800 kg/cm2 (29-40 kpsi)
- HDPE 5,600- 9,100 kg/cm2 (80-130 kpsi)
- BOPP 7,700- 24,000 kg/cm2 (110-350 kpsi)
- PET 14,000- 38,000 kg/cm2 (200-550 kpsi)

Maximum Allowable Tension

Example:

– **Maximum Tension of 2 mil LDPE**

- **Assume a modulus of 20,000 (LDPE)**

-1.5% of 20,000 is .015 x 20,000 or 300 psi

- **Assume a 60 in. wide x .002 in. thick web**

-60” x .002” x 300 psi = 36 lbs. Max. Tension.

<u>Try to keep web at or below this tension during processing</u>

Tension Principles of Winding

Taper Tension

- Reduce the tension smoothly as the roll diameter increases
  - 0 - 50% taper, 25% common
- Taper Tension reduces roll defects such as - Telescoping, Buckling and Starring

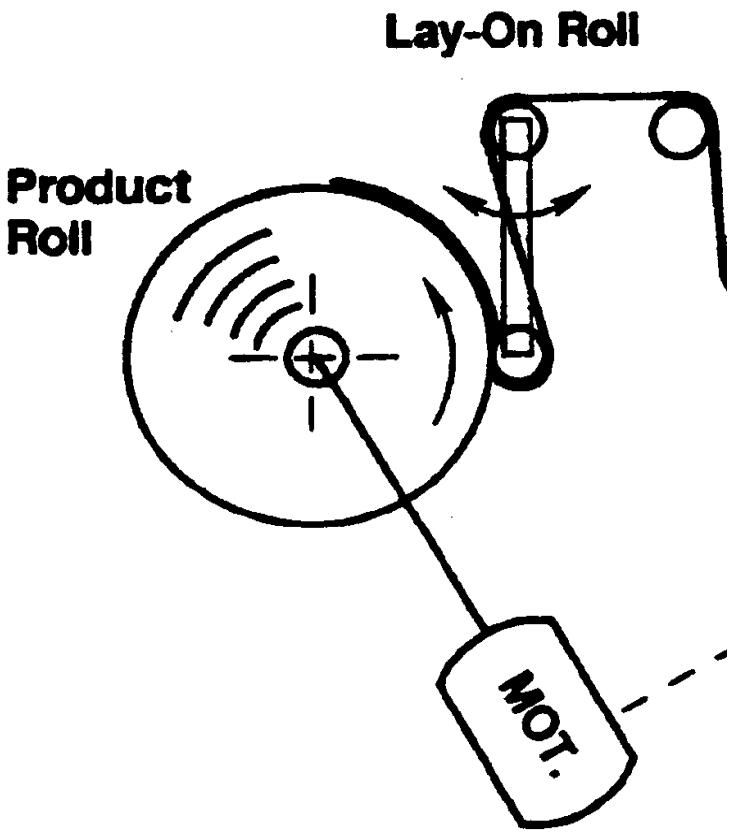
NIP Principle of TNT Winding

Nip of Winding Rolls :

- Removes the boundary layer of air following the Web.
- Adds Inwound Tension - The higher the nip, the harder the rolls.

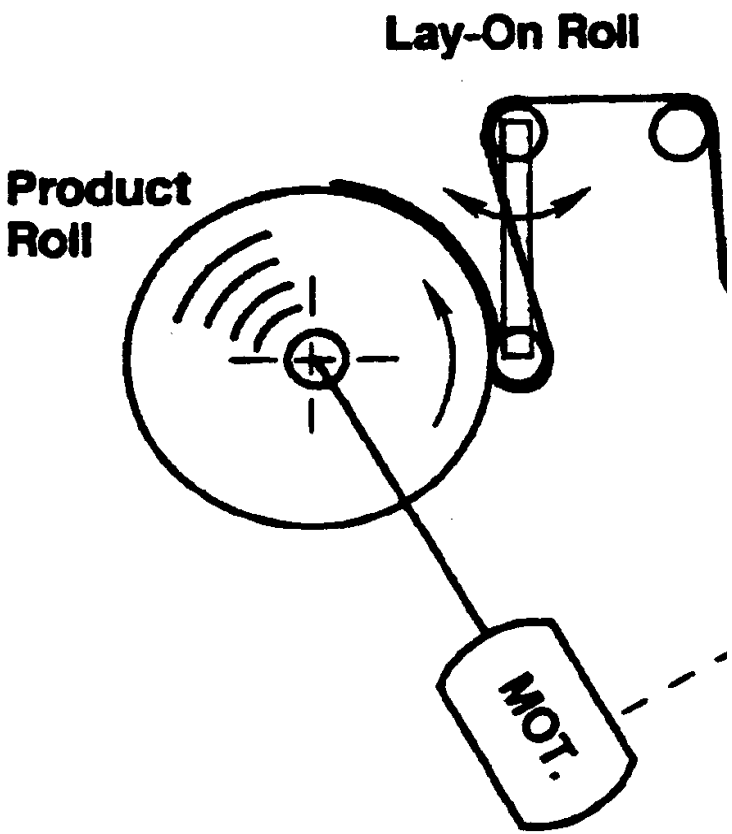
Challenge is to have sufficient nip to Wind hard & straight rolls without winding in too much inwound tension to prevent blocking and deforming the web over caliper bands.

NIP Principle of TNT Winding



- Nip must be applied where web enters the winding roll.
- The winding roll's & lay-on roll's weight and web tension should not affect the Nip loading.

NIP Principle of TNT Winding



- Nip Load should be tapered as roll winds to prevent starring and telescoping.
- However, larger winding roll's dia. drags more air and produces a Nip Taper Loading with a constant loading pressure.

Gap Winding

Air sometimes wants to be wound into the winding roll of material to:

- **Prevent blocking problems**
- **Prevent deforming the web that is wound too tightly over gauge bands**

Lay-on Roll should follow the Winding Roll's Surface with a Small Controlled Gap

Winding Process

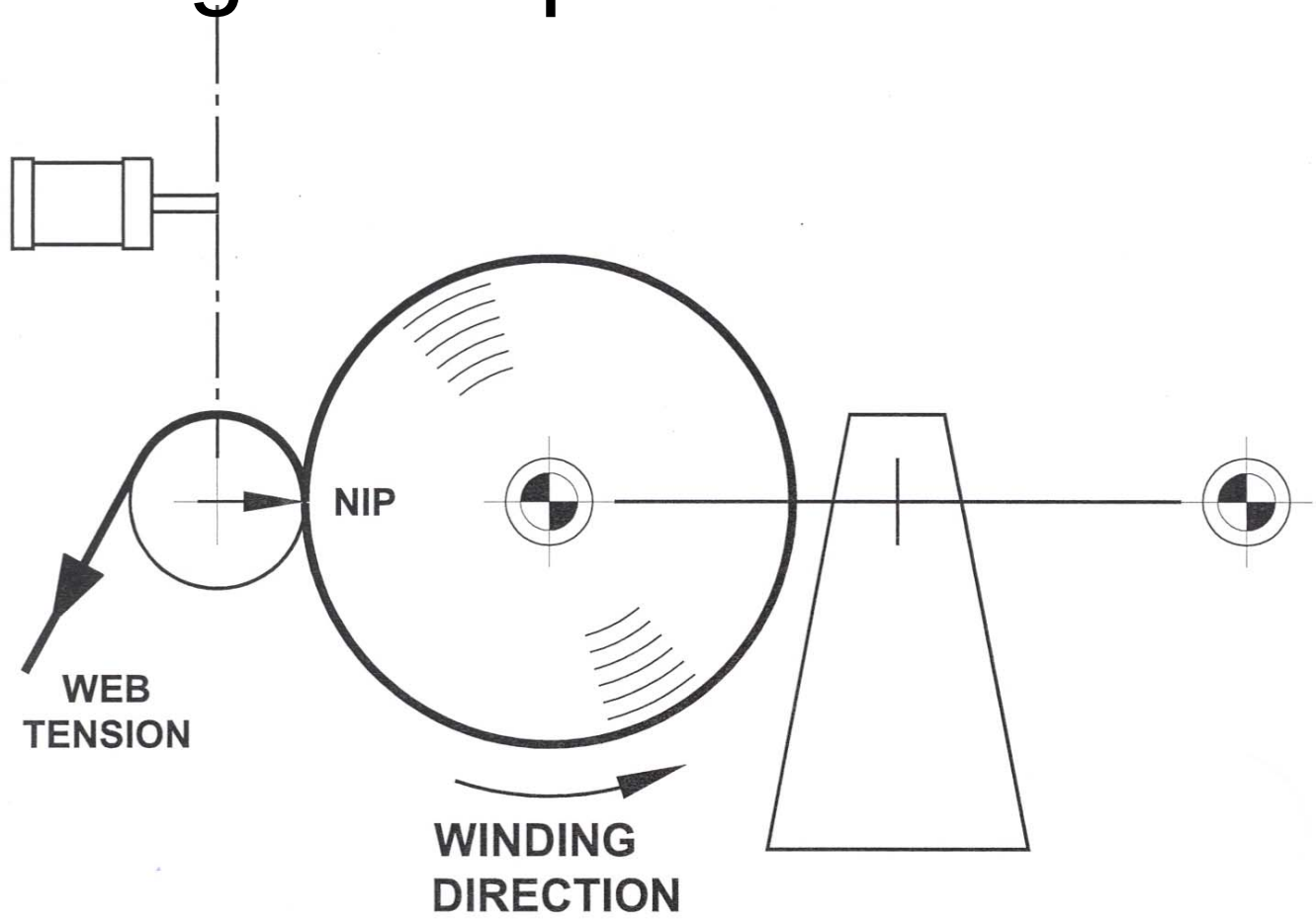
Basic types Winding Processes

- **Center Winding**
- **Surface Winding**
- **Combination Center/Surface Winding**

EACH TYPE USES ONE OR MORE OF THE T.N.T. PRINCIPLES TO BUILD ROLL HARDNESS

CENTER TYPE WINDER

Tension & Nip are Dominant Winding Principles



Turret Center Winders

Gap Winding - Use web Tension only.

(Web tension provided by spindle torque)

Contact Winding - Use web Tension and Nip To control roll hardness

Advantages - Can build softer rolls.

Quick indexing, fast cycle times.

Disadvantages - Limited maximum roll dia. due to torque applied thru layers.

Higher probability of scrap during roll changes.

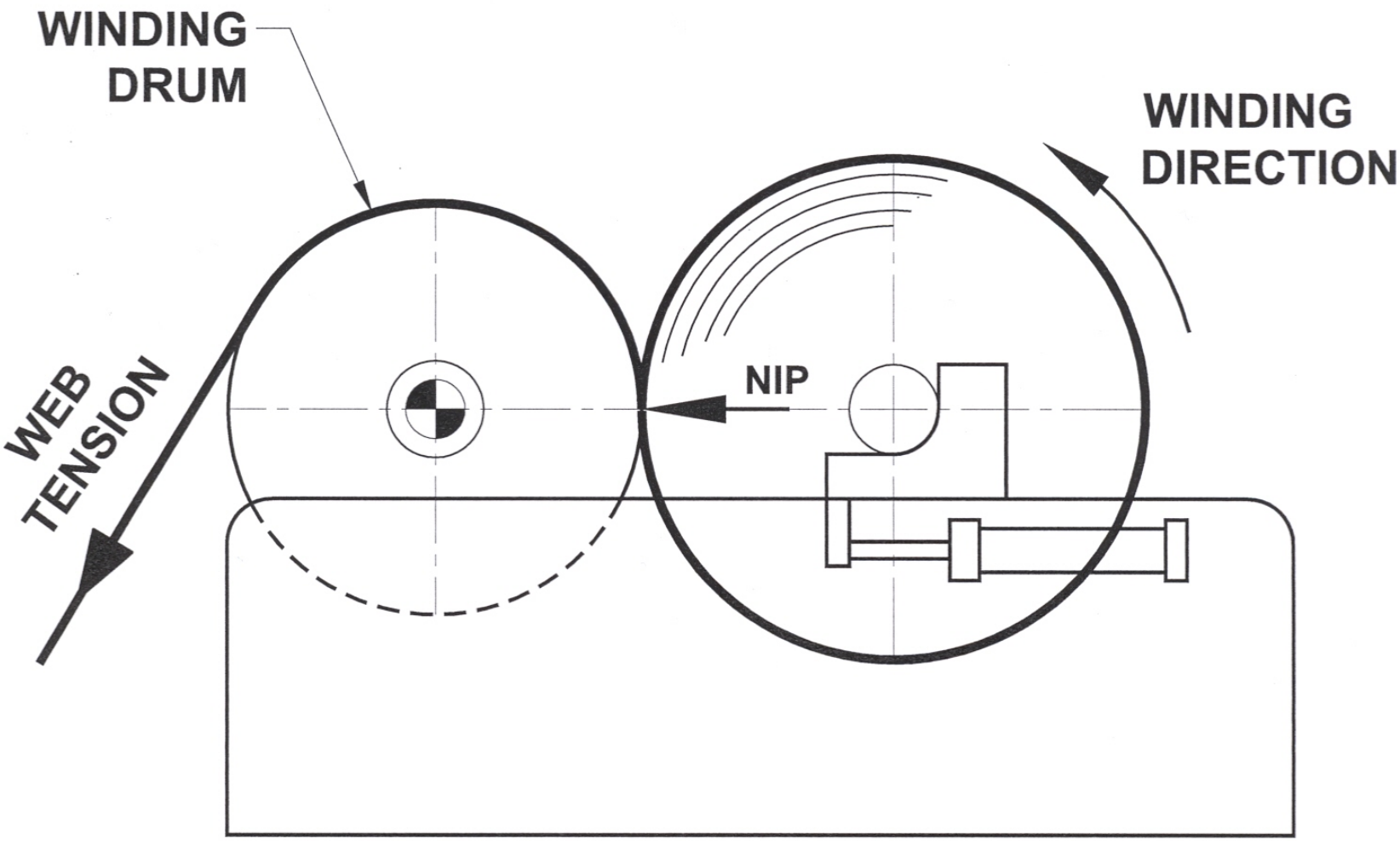
Turret Center Winders

- **Best for Winding Small Diameter Rolls**
- **Best for Winding Soft Rolls**

  i.e. Films with Gauge Bands
- **Better Control of Inwound Tension**
- **Easily Provides Dual Direction Winding**
- **Can Provide Adhesiveless Transfers**

Turret Center Winders

Drum Surface Winders



Drum Surface Winders

Winding Elastic Materials -

Web Tension is dominant winding principle.

Winding Inelastic Materials -

Nip is dominant winding principle.

Advantage **-** Web Tension is not supplied from torque applied thru the roll.

Disadvantage **-** Can not wind air into roll to minimize gauge bands and roll blocking.

Drum Surface Winders

- **Best for Winding Very Large Dia. Rolls**
- **Best for Winding Hard Rolls**

  i.e.. Protective Films
- **Best Utilization of Space and Horsepower**
- **Minimum Waste During Transfers**
- **Less Expensive**
  - **Less Equipment**
  - **Single and Smaller Winding Drive**

Drum Surface Winders

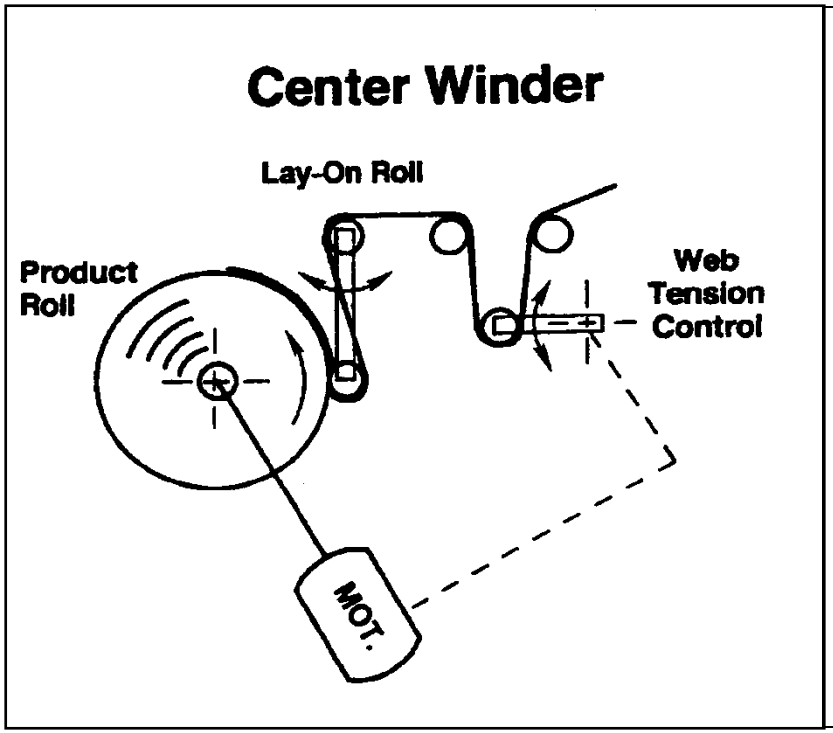
+ **In-line slitting with little waste**
+ **Thread up is simple and accessible**
+ **Winding of Large Dia. Rolls of Non Extensible Webs**

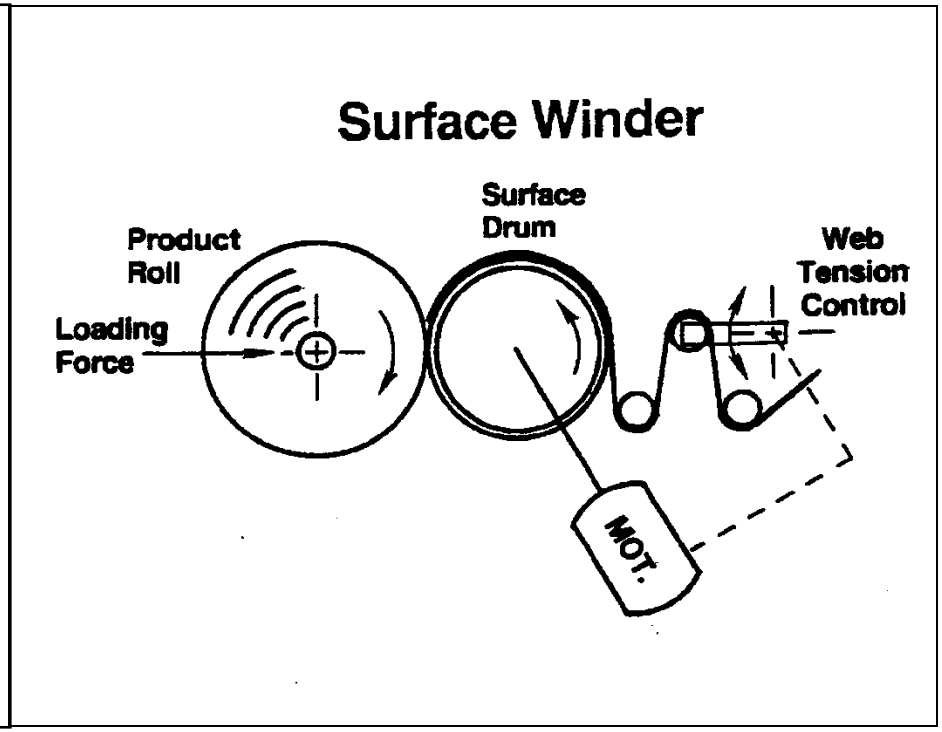
- **Tension is not controlled through the wound layers-** tension is only known prior to the drum
- **Single direction winding only**
- **Requires tape or glue on core for auto. transfers**
- **No gap winding available**

Drum Surface Winders

Center/Surface Winders

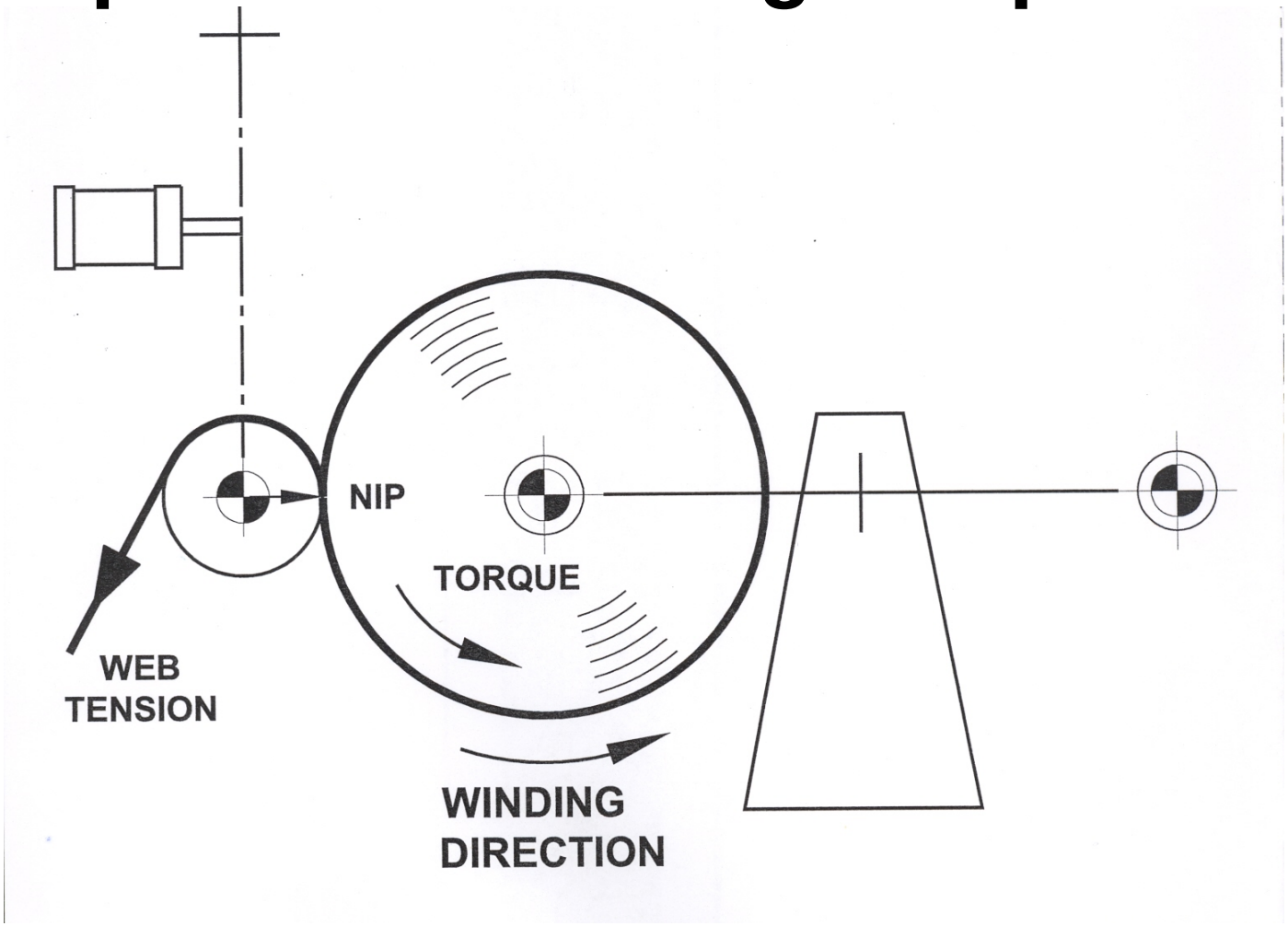
Use Both Winding Methods





CENTER/SURFACE TYPE WINDER

Web Tension is Independent Winding Principle from Winding Torque



Center/Surface Winders

Can use all three **TNT** principles -

- **T**ension, which is used for slitting and spreading, controlled by Surface Drive.
- **N**ip is controlled by the lay-on roll loading.
- **T**orque from spindle drive controls roll hardness independent from web Tension.

Advantages - **Can build larger rolls of slippery materials and can taper inwound tension without effecting neck-in of web width. Also can supply web tension w/o stretching web over gauge bands.**

Disadvantages- **More costly and complex.**

Tech Tip- When to Use Center/Surface Winders

Davis-Standard
CONVERTING SYSTEMS
Black Clawson Converting Machinery | EGAN | ER·WE·PA

TECH TIPS
Helping you get more out of your production line.

Advance | Blown Film | Cast Film | Extrusion Coating & Laminating | Liquid Coating & Laminating | Pelletizing | Process Control | Unwind & Winding

When to Use CENTER/SURFACE WINDING

Center/Surface type winders are used when winding slippery materials, when inline slitting, and for turret winders which require pulling high web tensions. On this type of winder, the web tension is pulled by the surface roll's drive and the roll hardness is developed independently from the web tension by the profiled nip from the surface roll and the profile torque from the center drive. Thus, the name "**Center/Surface Winder.**"

When winding slippery materials, the Center/Surface Winder helps to prevent internal web slippage called "cinching" and roll "dishing" during the winding operation. These slippery materials often do not have the required layer-to-layer coefficient of friction to transmit the torque required to pull the web tension at larger roll diameters without web slippage.

Center/Surface Winders are also required when center drives are used for inline slitting applications. The spreading action is a function of the amount of wrap on the bowed rolls, the amount of bow and the web tension. With a center drive, the web tension is developed from the center torque. For proper roll structure, this torque must be profiled for decrease hardness as the roll winds. (See Figure #1). This decreased tension as the roll builds results in a decrease in the amount of spreading as

Art of Winding

SETTING AND PROGRAMMING OF TENSION, NIP & TORQUE

WILL VARY DEPENDING ON:

- ***Type & Design of Winder***
- ***Type of Web Material***
- ***Width of Rolls Being Wound***
- ***Speed of Winding Operation***

Different Web Products and Different Applications Dictate Desired Roll Hardness

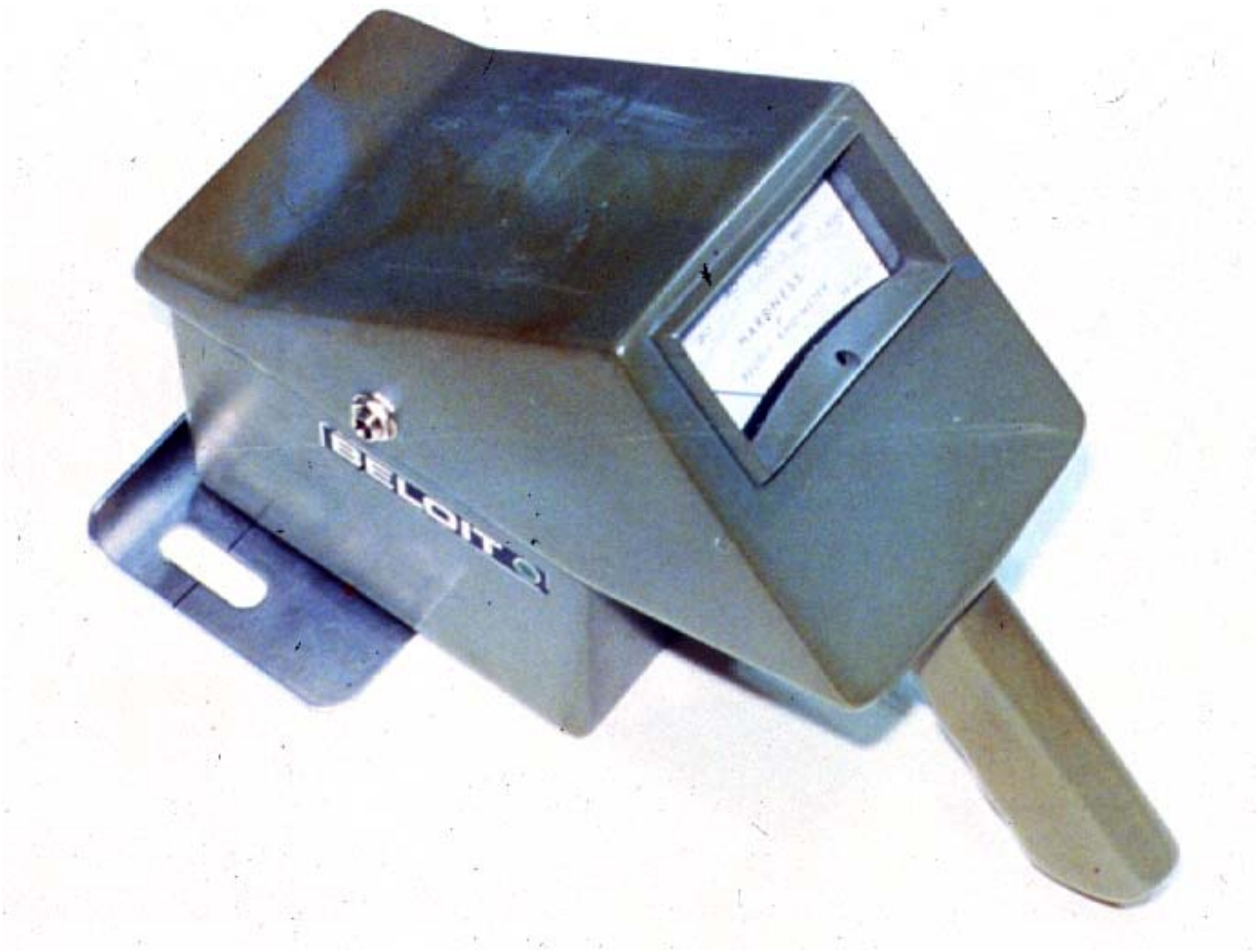
HARDNESS PROFILE MUST BE REPRODUCED CONSISTENTLY

MEASURING ROLL HARDNESS

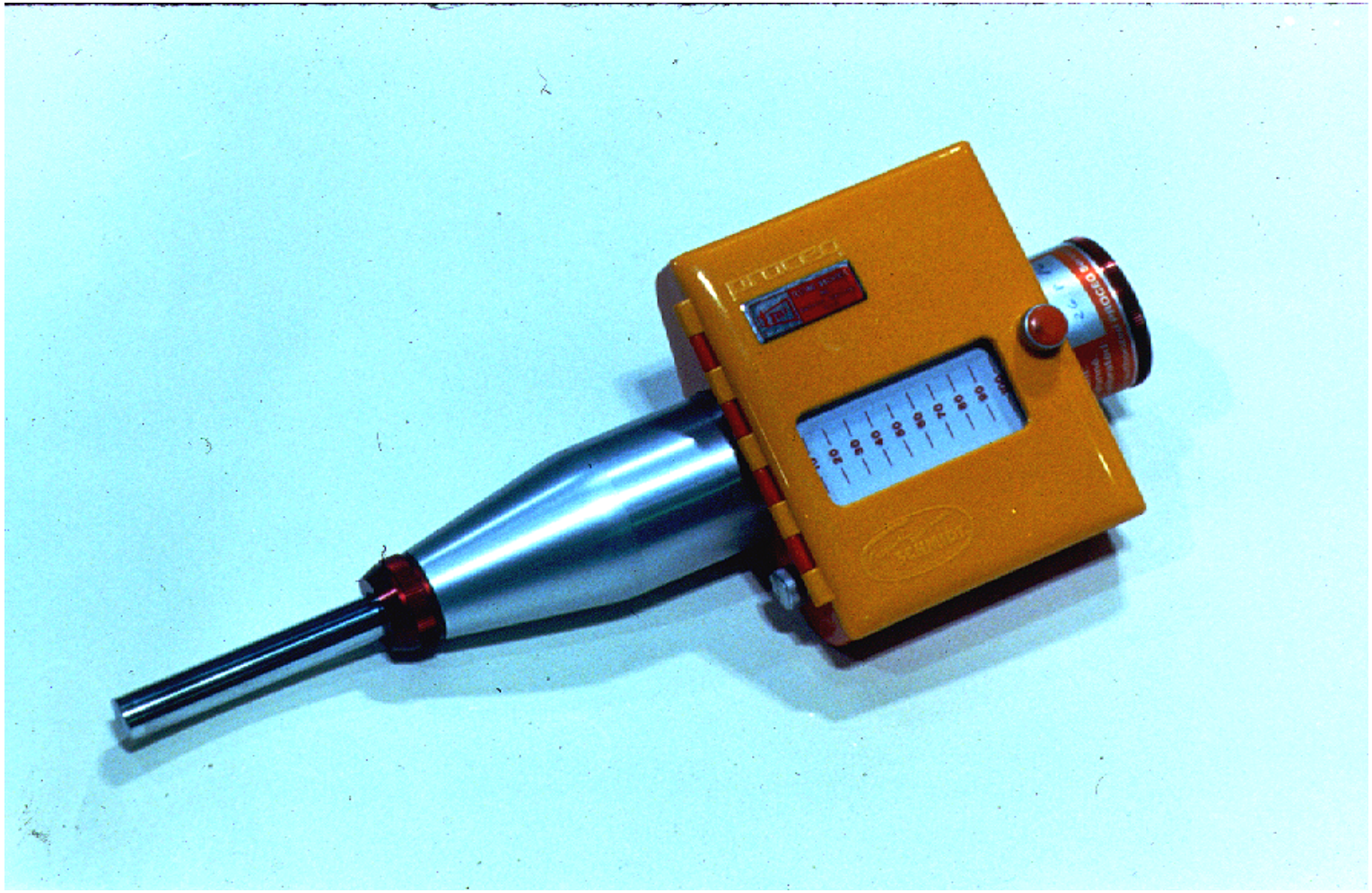
ROLL HARDNESS MEASURING DEVICES NEED TO BE AVAILABLE TO WINDER OPERATORS

- ***RHOMETER -*** Measures Hardness Across Outer Surface
- ***SCHMIDT HAMMER & PAROtester-*** Measures Hardness Across Outer Surface
- ***SMITH NEEDLE -*** Measures Hardness from Core to Full Roll
- ***RDF Curve (Microprocessor Control System) -***Measures Roll Density During Winding

RHOMETER



SCHMIDT HAMMER



PAROtester

PAROtester


aBell Engineering
104 Yates Hill Road, Hadley, NY 12835, USA
PAROtester 2
MADE IN SWITZERLAND
Rollenprüfer
Roll Tester
Min: 308
Max: 534
R : 226
498
25
R:483
ON
OFF
START
MENU
CLEAR
END
PROCEQ Testing Instruments
proceq
Switzerland

SMITH NEEDLE

AccuWind ROLL DENSITY CURVES

For Contact Information on these ROLL HARDNESS MEASURING DEVICES:

- ***RHOMETER***
- ***SCHMIDT HAMMER***
- ***PAROtester***
- ***SMITH NEEDLE***

Please Email me at

smithd@bc-egan.com

Winding Oscillation

Webs that contain severe caliper or gauge bands can not be wound without forming ridges and deforming the web as it winds over these ridges.

The Winder and the Slitters must be moved back and forth, or Oscillated, to randomize these bands in the roll.

Challenge of Oscillation Speed

Has to be Fast Enough to

Randomize Bands Yet -

Slow Enough not to

Strain or Wrinkle Web

Rule of Thumb -

Max. Oscillation Speed =

1” per minute per 500 fpm Winding Speed

For Best Results

Vary Oscillation Speed Proportional to Line Speed

Practical Example

Can’t Wind Straight Sided Rolls

<u>Problem:</u> When winding double sided silicone release PET film, the rolls dish on the winder.

<u>Solution:</u> When trying to wind slippery grades to diameters over 3 to 4 times core OD, you need to be able to *<u>center/surface</u>* wind.

Then start winding with very high torque and taper torque to almost nothing by 4 times the core OD. Roll hardness profile is built using nip control of pressure roll on winding roll(s). Web tension is pulled by pressure roll speed control.

ROLL DEFECTS DUE TO ROLL HARDNESS

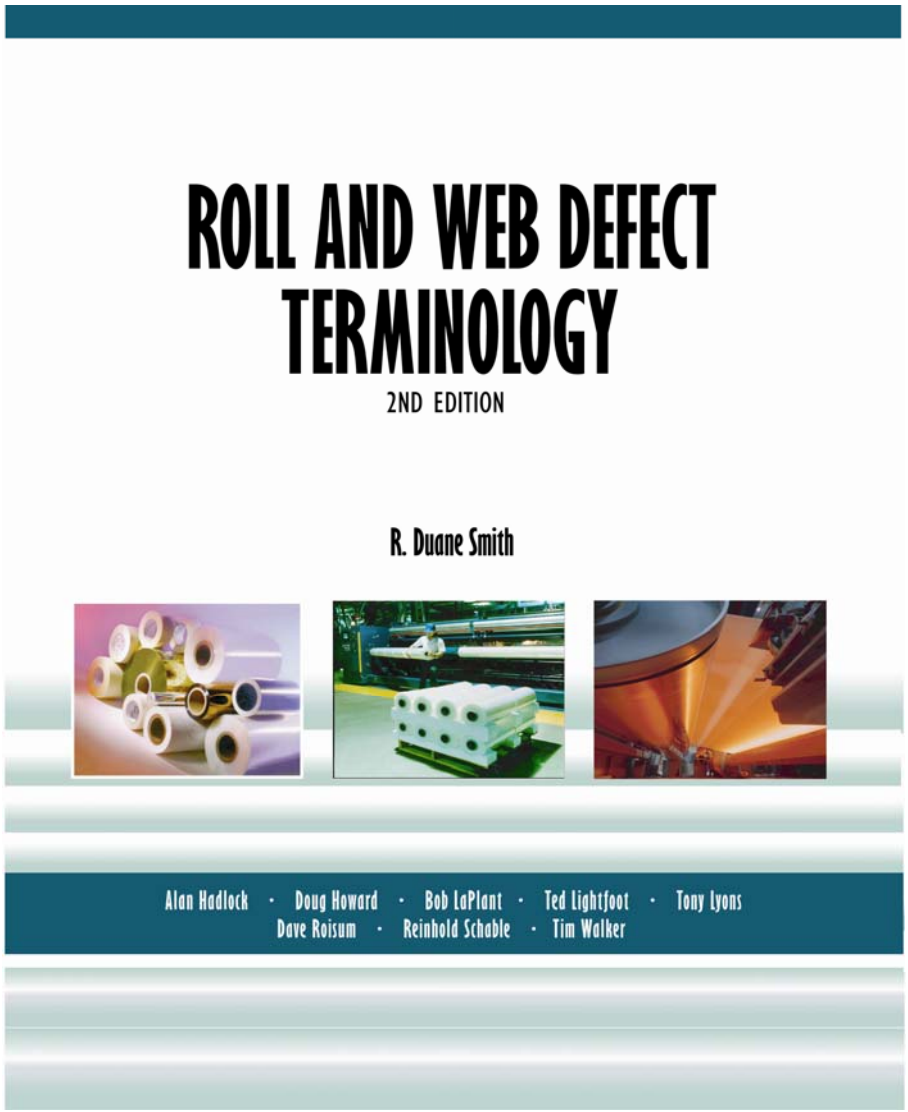
- ***OUT-OF-ROUND ROLLS***
- ***INTERNAL WEB BURSTS***
- ***RIDGES***
- ***BAGGY PAPER***
- ***CORRUGATIONS OR ROPE MARKS***

OTHER VISUAL DEFECTS TO AVOID FOR CONSISTENTLY WINDING Quality ROLLS

- **Poor Starts**
- **Core Offsets**
- **Splices**
- **Offsets and Interweaving**
- **Dished or Telescoped Rolls**
- **Starred Rolls**
- **Trim Wound in Rolls**
- **Slitter Rings**
- **Other Slitter Defects Such as:**
  - **Excessive Slitter Dust**
  - **Nicked Edges**
  - **Scalloped Edges**
  - **High Edges**

Tappi Press Newest Book

Roll and Web Defect Terminology



Roll and Web Defect Terminology - 2nd Edition

- Written and Edited by 22 Industry Experts
- Over 500 years of experience
- 16 additional Contributing Editors
- The Most Comprehensive Reference Guide available to assist in the identification and elimination of Roll and Web Defects

Roll and Web Defect Terminology

Chapters

- Roll Defects –General
- Roll Defects –Web Profile
- Roll Defects –Edge
- Roll and Web Defects - Wrinkling
- Web Defects – Papermaking
- Web Defects – Calendering
- Web Defects – Aqueous Coating
- Defects - Film Extrusion and Lamination
- Defects - Web Handling Defects
- Defects - Slitting Defects

Each of 224 defects
Concise information on:

- **A description of the defect**
- **An illustration of the defect**
- **Lists the synonyms or "Also Known As" terms commonly used**
- **Cross references these synonyms in index**
- **Lists common causes of the defect**
- **Lists the common remedies of the defect**
- **Lists other sources of information published on the defect**

Roll and Web Defect Terminology

ROLL EDGE - SLITTER RINGS

SYNONYMS

ALSO KNOWN AS: SLITTER RINGS, ANNULAR RINGS, BULLS-EYE ROLL, TARGET RINGS.

DEFECT DESCRIPTION

Slitter Rings: Appear as concentric annular ring patterns on the edges of the roll that give the roll edge the appearance of a target. This defect is very common on winders with mandrel-mounted bottom knives after the mandrel has been reground one or more times. Note: this defect is caused by the slitter, but shows up as a roll edge defect. It is also listed as a slitter defect.

CAUSES OF SLITTER RINGS

Slitter rings are formed by wobbling lower knife rings which form a cambered-edge (SD-1) slit line in the form of a sine wave. As successive layers of the cambered slit edges are wound into the roll, diameters are reached which correspond to a mathematical relationship between the roll circumference and the length of the slit edge sine wave. At these diameters, the characteristic "slitter rings"will form.

Typical causes of slitter rings include:

1. Excessive slitter runout due to non-concentric grinding of bottom knives. Normal maximum is 0.05-0.1 mm (0.002-.004 inches).
2. Wobble of bottom knife rings due to poor fit on mandrel or hub.
3. Bent lower slitter shaft or slitter mounting spindle.
4. Extremely narrow lower ring "tilts"on mandrel.

TAPPI - ROLL AND WEB DEFECT TERMINOLOGY

CLASSIFICATION:
- SLITTER DEFECTS - ROLL EDGE
- REF. NUMBER RD-50

ROLL EDGE - SLITTER RINGS

When bottom slitter knife wobble is not present and a common pattern is found on all rolls, other non-slitting related causes, such as tension variables, bowed roll (spreader) influences, machine alignment, or machine harmonics may be indicated.

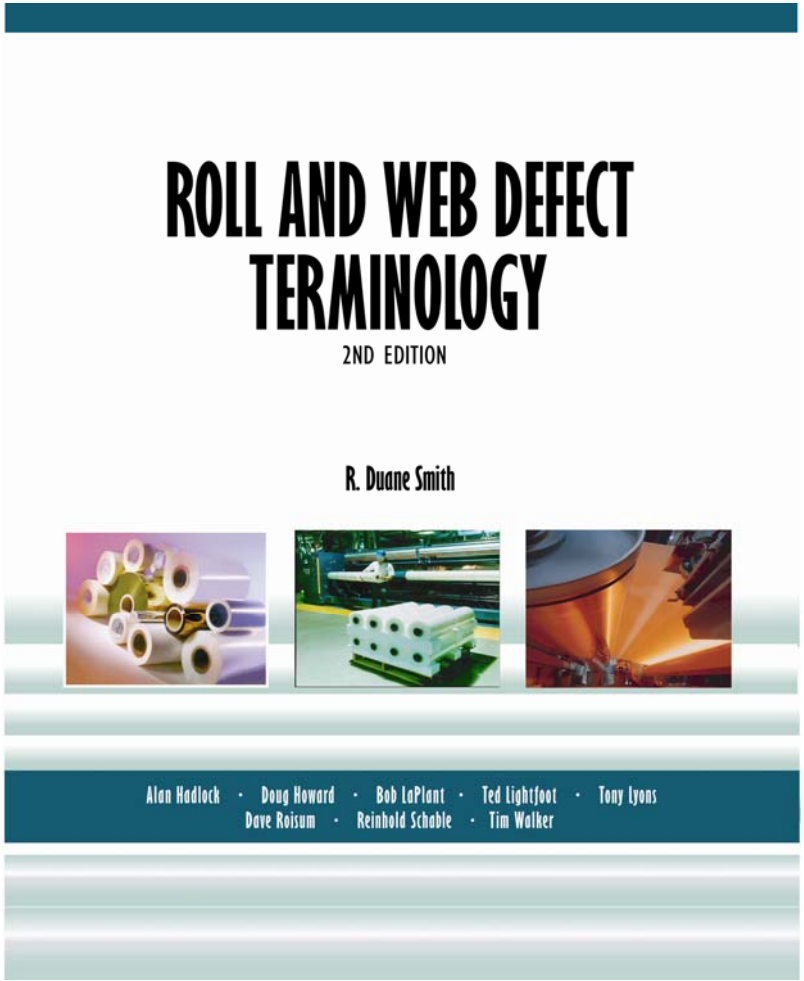
REMEDIES FOR SLITTER RINGS

1. Ensure that slitter rings are properly fixtured when grinding so that eccentric edges will not be ground into the rings.
2. Ensure proper clearance tolerance between the knife ring I.D. and its mounting shaft or hub. With hub mountings, be sure surfaces are clean and tighten screws evenly, working progressively around in a circle.
3. Check for bent-spindle wobble and correct if necessary.
4. Where extremely narrow lower rings are used, it may be possible to stack two or more rings against each other to reduce wobble.

REFERENCES

1. Pfeiffer, J.D., "Analysis of the ring patterns formed," Tappi (1969).
2. Schable, R., "Spotlight on slitting: axial, radial run out," *Paper, Film & Foil* (1992).
3. Frye, K., "Finishing defects: slitter rings and slitter runout," Tappi J. 69(11): (1986).
4. Pfeiffer, J.D., "Principles of web slitting," *Proceedings, 4th International Conference on Web Handling*, Web Handling Research Center, Oklahoma State University, June 1–4, 1997.
5. Schable, R., "Annular rings offer clues," *Paper, Film & Foil* (1993).

Clean and Concise Format For Roll and Web Defects

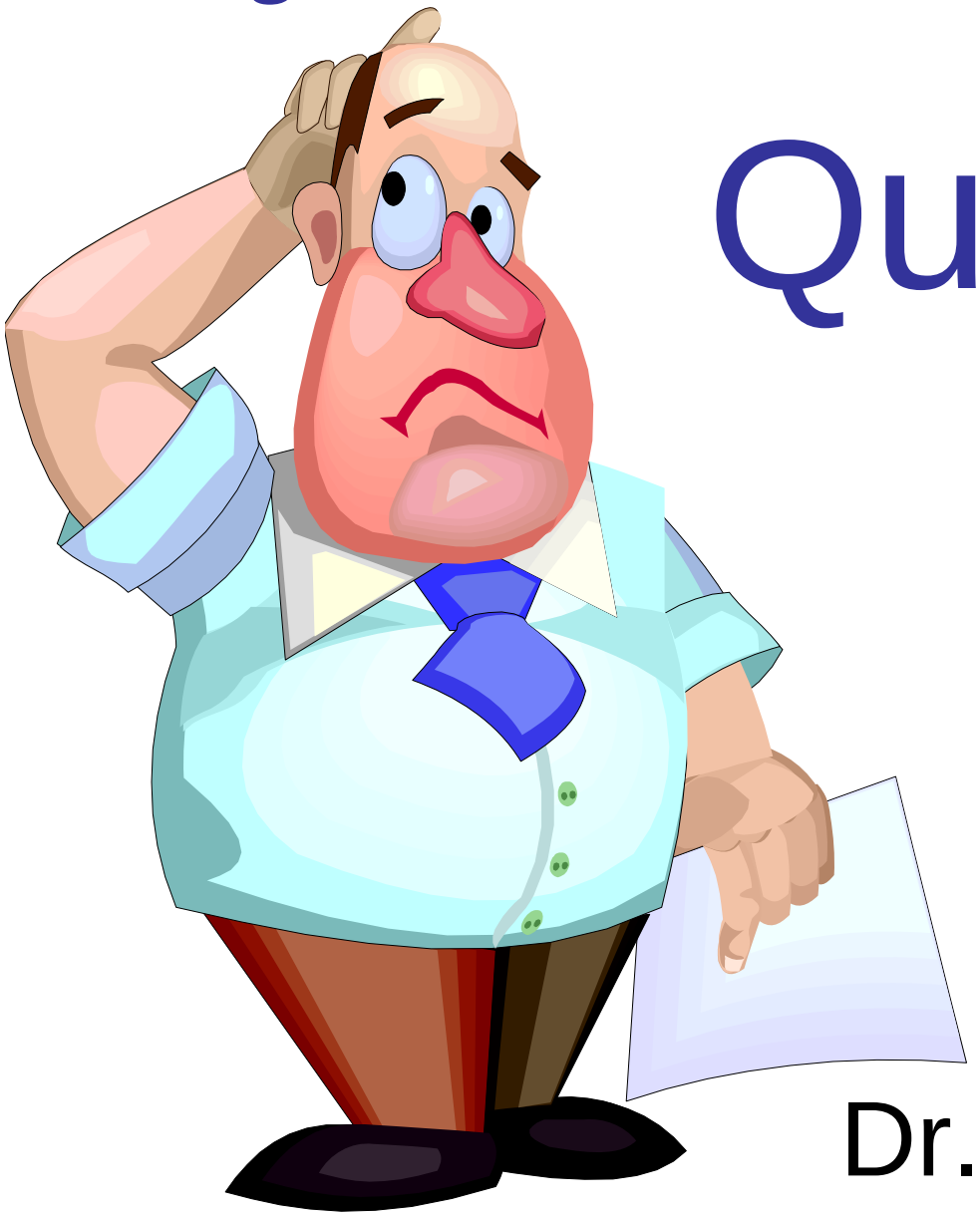


Special Pricing at this Short Course

List Price $210+$10 S&H

Short Course Special $119.

Challenges of Web Handling and Winding



Questions

????

Slide Courtesy of

Dr. David Roisum

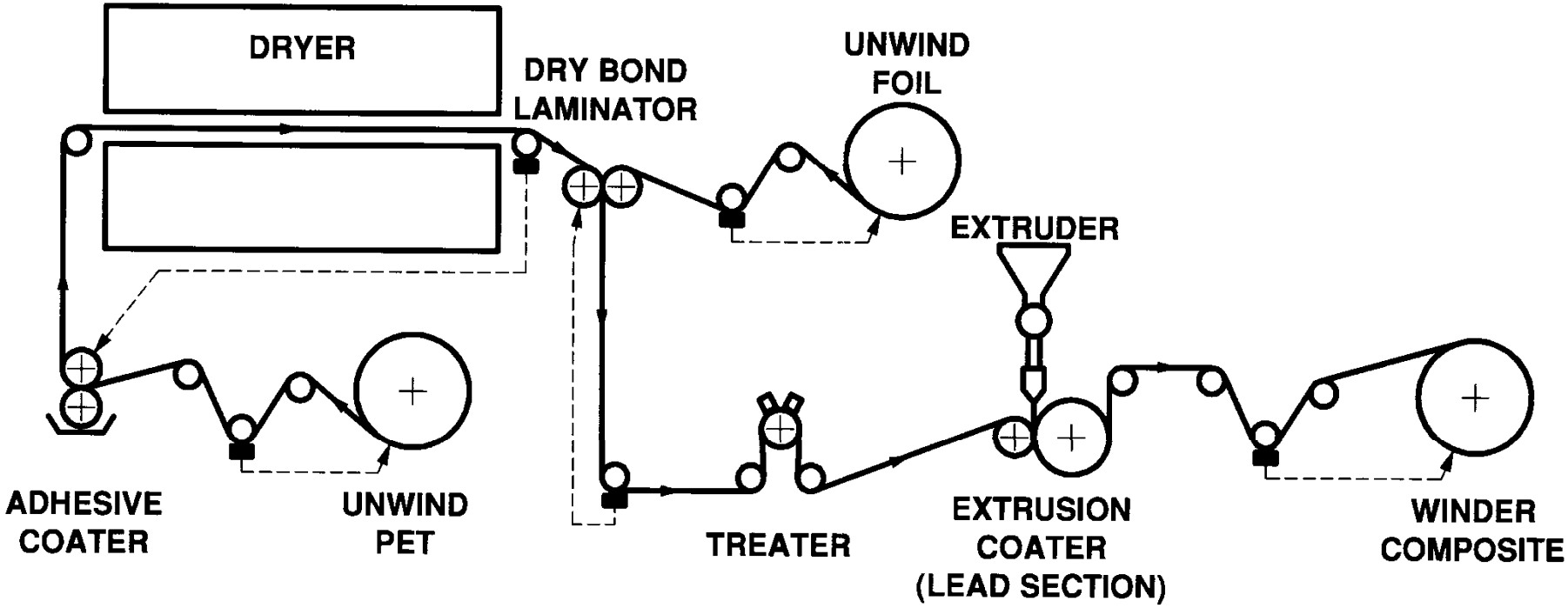
Web Handling & Winding Case Study

Based on a true Situation - Slightly Altered to Protect Confidentiality

Problem Description:

A manufacturer of the flexible packaging material used to form consumer fluid containers was having a defect called "Tunneling"

Typical Coating, Laminating and Extrusion Coating Machine Line



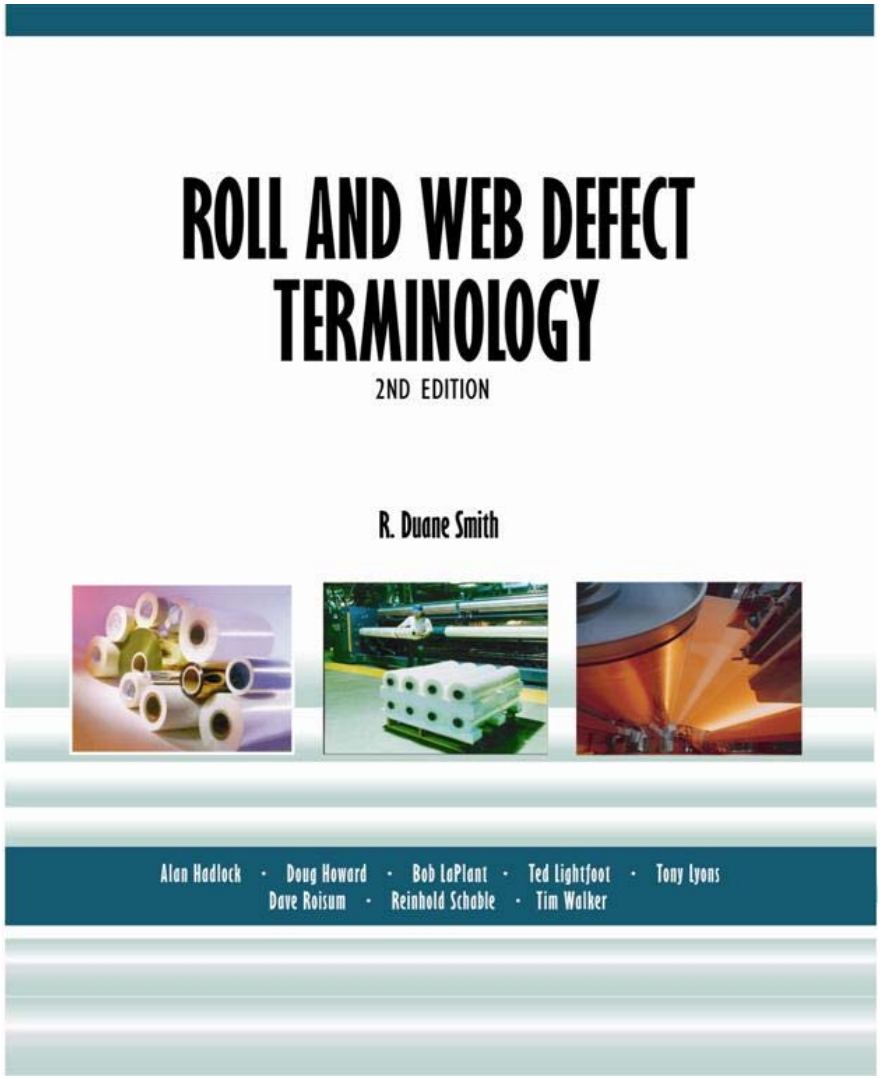
Problem Description:

Tunneling is where a small area across the web delaminates between the PET film and the Aluminium Foil

The tunneling defect occurs after the dry bond lamination & before the PET film and aluminum foil laminate is extrusion coated with the polyethylene.

Roll and Web Defect Book

On Page # 350



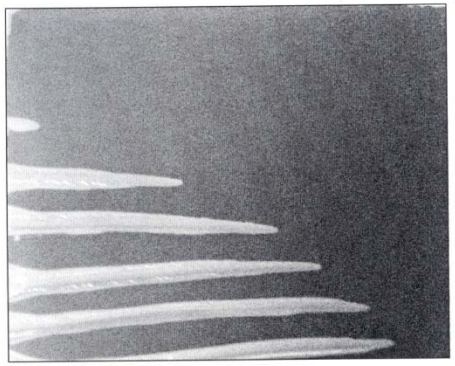
CLASSIFICATION:

- WEB DEFECTS - FILM EXTRUSION AND LAM.
- REF. NUMBER WD- FE&L -42

TD TUNNELING

SYNONYMS

ALSO KNOWN AS: FINGERS, BUCKLES, PUCKERS, TUNNELING - TRAVERSE DIRECTION.



DEFECT DESCRIPTION

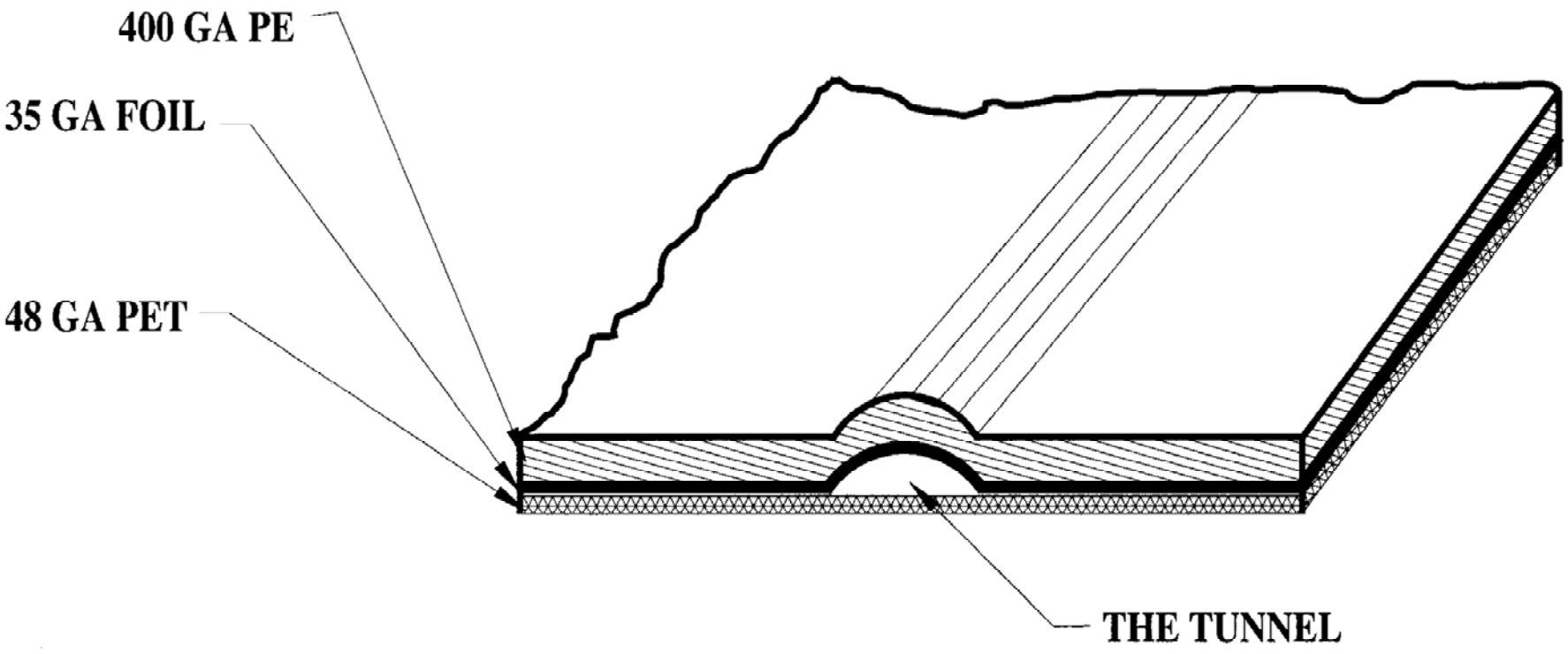
TD Tunneling: Relatively narrow buckles in one layer of a laminate which run back and forth in the transverse direction or diagonally across the sheet. They may run completely across the sheet, or only partway across.

CAUSES OF TD TUNNELING

1. TD tunnels usually occur at the laminating nip.
2. When this defect is seen at the laminating nip, the most common cause is a slack web which gathers behind the nip and passes through periodically. Because the slackness is not constant across the web, the tunnel is somewhat diagonal. The slackness can be caused by skew or a buckle lane in the film or by roll misalignment.
3. An undriven rubber roll can require excessive nip force to keep it turning. If this force is sufficient to stretch the edges of the film or compress the center, TD tunnels can form.
4. TD cockling can also cause TD tunnels if the adhesive strength is not sufficient to hold the layer flat.
5. TD tunnels that form later in the process require one layer to be under sufficient compression to overcome the adhesive force and to buckle.

Problem Description:

TUNNEL DELAMINATION



Product Structure:

Material	Caliper	Thickness %	Tensile Modulus
PET	**.00048"**	10.4%	**500,000 psi**
Foil	**.00035"**	7.6%	**10,000,000 psi**
PE	.0040"	82.0%	25,000 psi
Structure	.00483"	100%	

Product Web Width 42"

Remember this slide????

Web Tension -Films and Foil

PRODUCT	TENSION LEVELS
Polyester	0.5 to 1.5 lbs./inch/mil
Polypropylene	0.25 to 0.50 lbs./inch/mil
Polyethylene	0.25 to 0.30 lbs./inch/mil
Polystyrene	0.25 to 1.0 lbs./inch/mil
Vinyl	0.05 to 0.2 lbs./inch/mil
Aluminum Foils	0.5 to 1.5 lbs./inch/mil
Cellophane	0.5 to 1.0 lbs./inch/mil
Nylon	0.10 to 0.25 lbs./inch/mil

The Suggested Tension for each Product Used in the Laminate

Suggested Tension

PET .5-1.5 pli/mil x .48 mil x 42" **= 10-30#**

Alum Foil .5-1.5pli/mil x .35 mil x 42“ **= 7-21#**

PE .25-.3 pli/mil x 4.0 mil x 42” **= 40-48#**

Web Tensions being ran on extrusion laminating process:

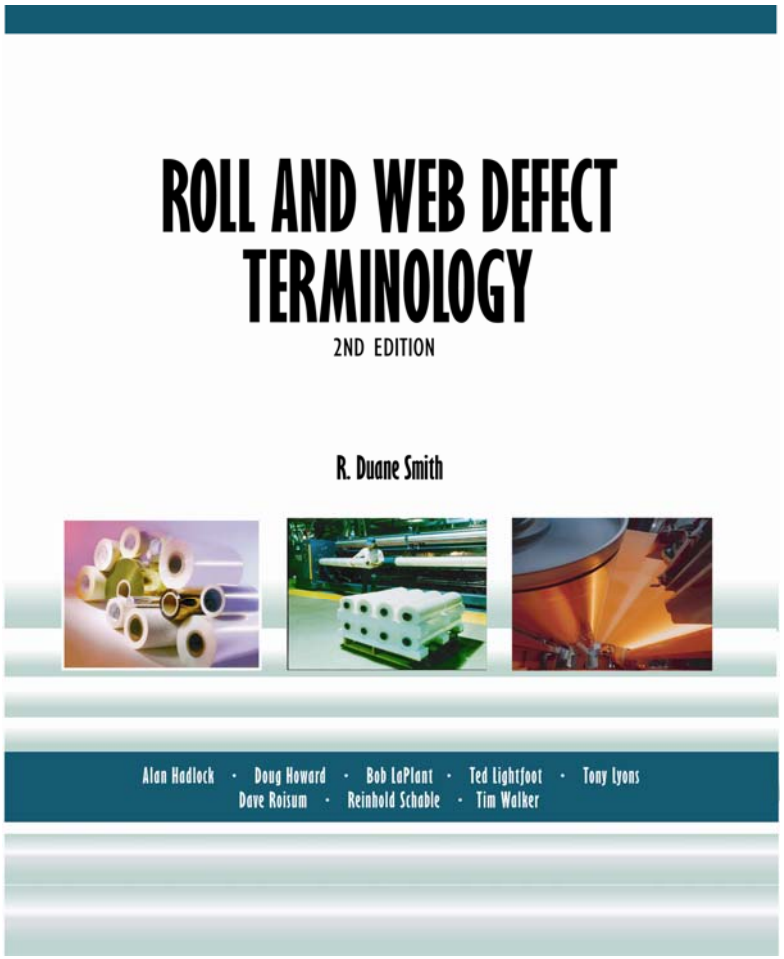
.48mil PET unwound at 30# tension

.35mil Foil unwound at 10# tension

4.8mil laminated and extrusion coated Sheet wound at 80#, constant tension

Possible Causes:

From information in the Extrusion and Laminating Chapter (#8) in the Roll and Web Defect Terminology Book:



Possible Causes:

Chapter #8- Extrusion and Laminating Defects

For a laminating process, each material should be strained by approximately the same amount before laminating to prevent defects curling and tunneling

Strain = Stress/Modulus of Elasticity (E)

= (Tension/Area)/Modulus

= Tension/(Area x Modulus)

Solution to Tunneling Problem

***Since*:** The Area x Modulus (E) (.00035 x 10,000,000) of aluminum foil is much greater than the polyester (PET) film (.00048 x 500,000).

***Then*:** For a laminating process: the **foil** should be pulled at the **high end** of the tension range and the **polyester film (PET)** should be pulled at the **low end** of the tension range.

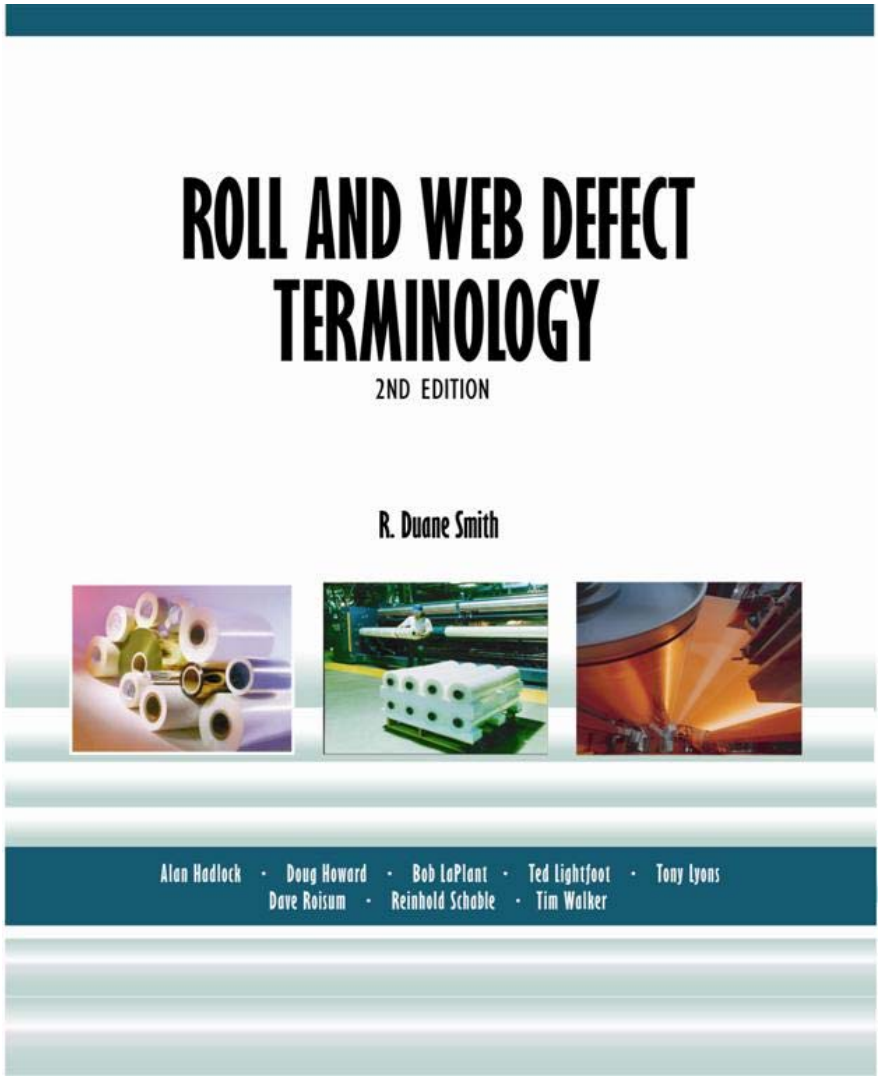
Solution to Tunneling Problem

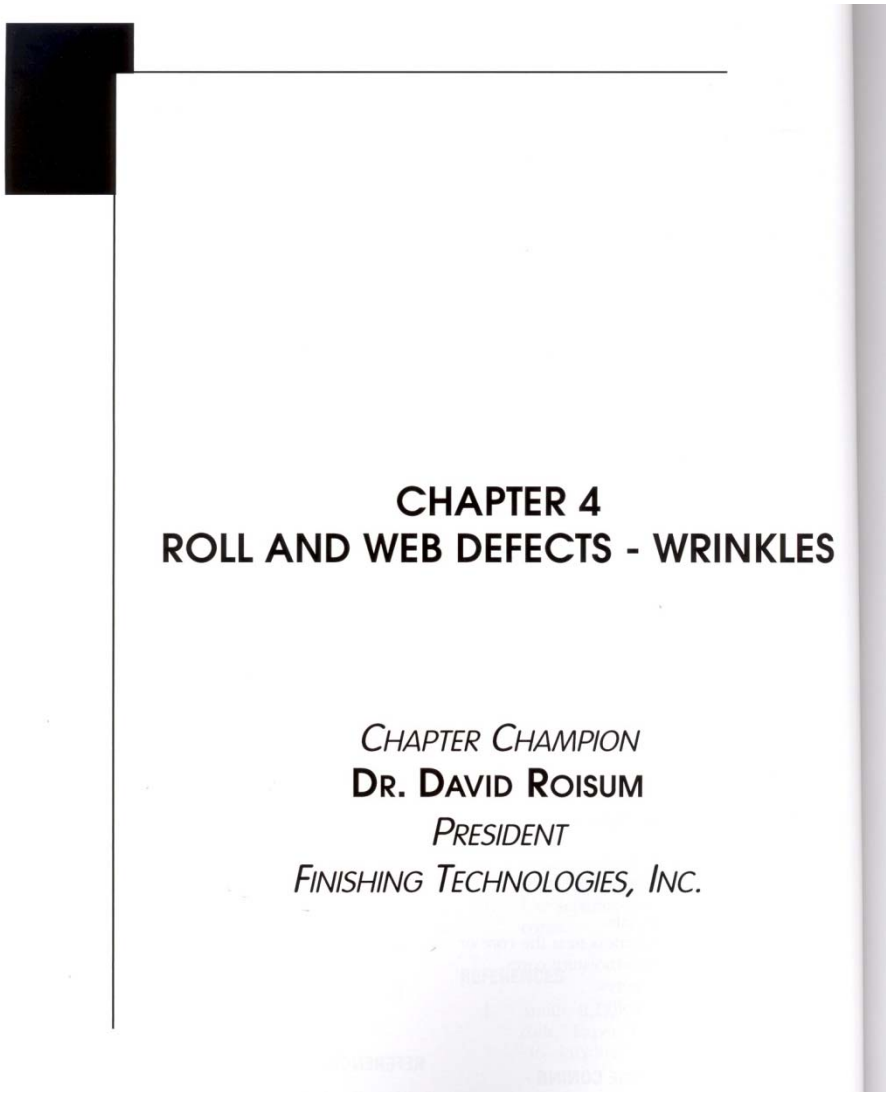
Pulling higher tension on the foil (20# vs. 10#) and lower tension on the polyester (10# vs. 30#) will eliminate the tunneling problem!

However

We still have a web handling problem! Pulling higher tension on the foil causes tension wrinkles (diagonal lightning bolt wrinkles) in the long web lead before the laminating nip.

From Dr. David Roisum's Chapter on Roll and Web Defects- Wrinkles





CHAPTER 4
ROLL AND WEB DEFECTS - WRINKLES

CHAPTER CHAMPION
DR. DAVID ROISUM
PRESIDENT
FINISHING TECHNOLOGIES, INC.

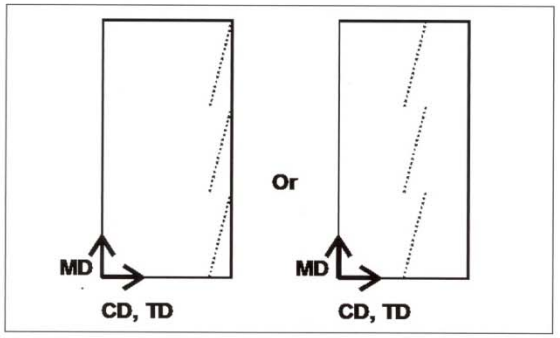
Diagonal Shear Wrinkles

on pages 150-&151

DIAGONAL SHEAR WRINKLE - ASYMMETRIC

SYNONYMS

ALSO KNOWN AS: WRINKLES - SHEAR, LIGHTNING BOLT WRINKLES.



DEFECT DESCRIPTION

Diagonal Shear Wrinkle - Asymmetric: Wrinkle(s) are oriented at an angle with respect to the machine direction. The higher the angle, the greater the shear stresses. All wrinkles point to the same side and may favor that side. Wrinkle pattern tends to be evenly spaced. Wrinkles sometimes "walk" sideways. The common mechanism for all subclasses are that something (e.g., roller or web) is "crooked."

CAUSES OF DIAGONAL SHEAR WRINKLE - ASYMMETRIC

1. Roller misalignment in the parallel (tram) direction is the most common cause. Wrinkle points to the narrow side and walks to the wide side.
2. Roller diameter variation.
3. Roller nip pressure variation.
4. Uneven pull (e.g., from narrow drive rollers, edge trim tension or direction).
5. Uneven temperature (film, foil) or moisture (paper, nylon).
6. Baggy lane or web, tight lane.
7. Gauge or other web profile variation, whether inadvertently or by design.

DIAGONAL SHEAR WRINKLE - ASYMMETRIC

REMEDIES FOR DIAGONAL SHEAR WRINKLE - ASYMMETRIC

1. See above to undo the specific root cause as applicable. Work on roller quality before working on web quality if not certain of the root cause of crookedness.
2. Change tension (try both raising and lowering).
3. Use effective spreading or flattening only as a last resort.
4. Improve web uniformity and quality.

REFERENCES

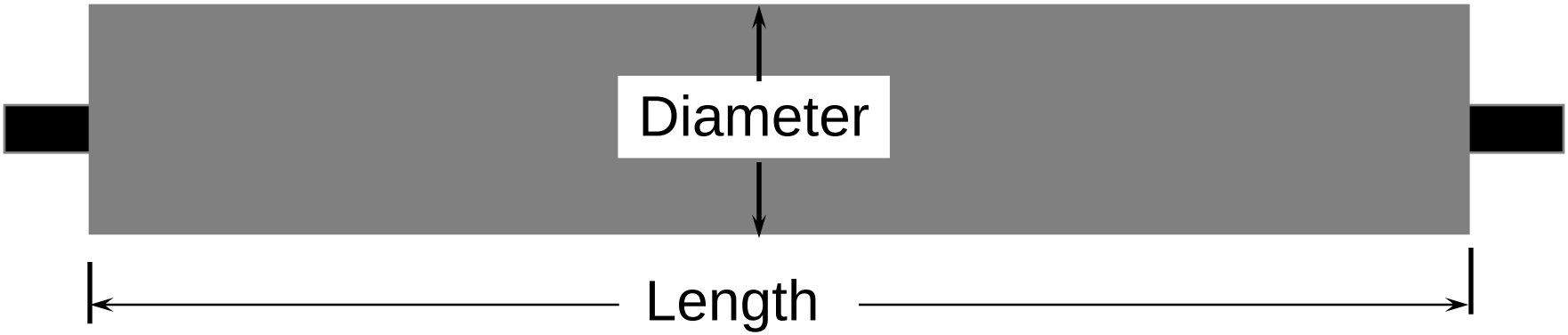
1. Roisum, D.R., "What causes diagonal shear wrinkles?," *Converting Magazine* (1994).
2. Roisum, D.R., "The mechanics of wrinkles," TAPPI Journal. (1996).
3. Roisum, D.R., "The mechanics of spreading," TAPPI Journal. (1993).
4. Walker, T.J., "The signs of shear wrinkles," *Paper, Film, and Foil Converter* (2004).
5. Good, J.K., Kedl, D.M., Shelton, J.J. "Shear wrinkling in isolated spans," Proceedings, Fourth International Conference on Web Handling, June 1997:462–480.

Shear Wrinkles

Diagonal Wrinkles are tension induced wrinkles which can be caused by cross machine differences in the thickness of the web and are exaggerated by *roller deflection, roller misalignment and/or long web leads*

Remember this slide????

Idler Roller Diameter



Roll Diameter

- **Generally** $\frac{\text{LENGTH}}{\text{DIAMETER}}$ = 16 or Less, i.e. @ 64” = 4”
- **Paperboard or Stiff Material, Consider Bend Radius**
- **Roll Deflection, *Rule of Thumb:***
  - **Generally .015” per each 100” of Roll Face**
  - **<u>Less… If Handling Unsupported Foil</u>**
  - **More… If Handling Extensible Web Materials**

Remember this slide????

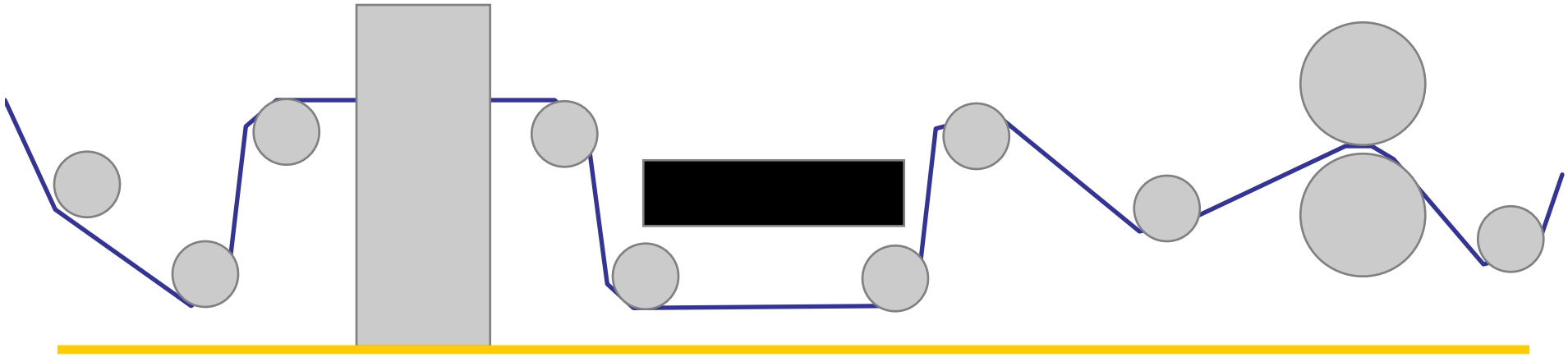
Web Handling Roller Alignment

Rollers Should be Level & Tram within .010”/ 100” (.001”/ foot)

Greater Allowable Misalignment for Extensible Materials (stretchy films)

Less Allowable Misalignment for Non Extensible Materials (aluminum foil)

Remember this slide????



Idler Roller SPACING

"Rule of Thumb", Roll to roll spacing -2/3 Web Width

- ***Thin (.0003) Aluminum Foils*, use 24" max.**

- Longer spans if a spreader roll is used after the longer span.

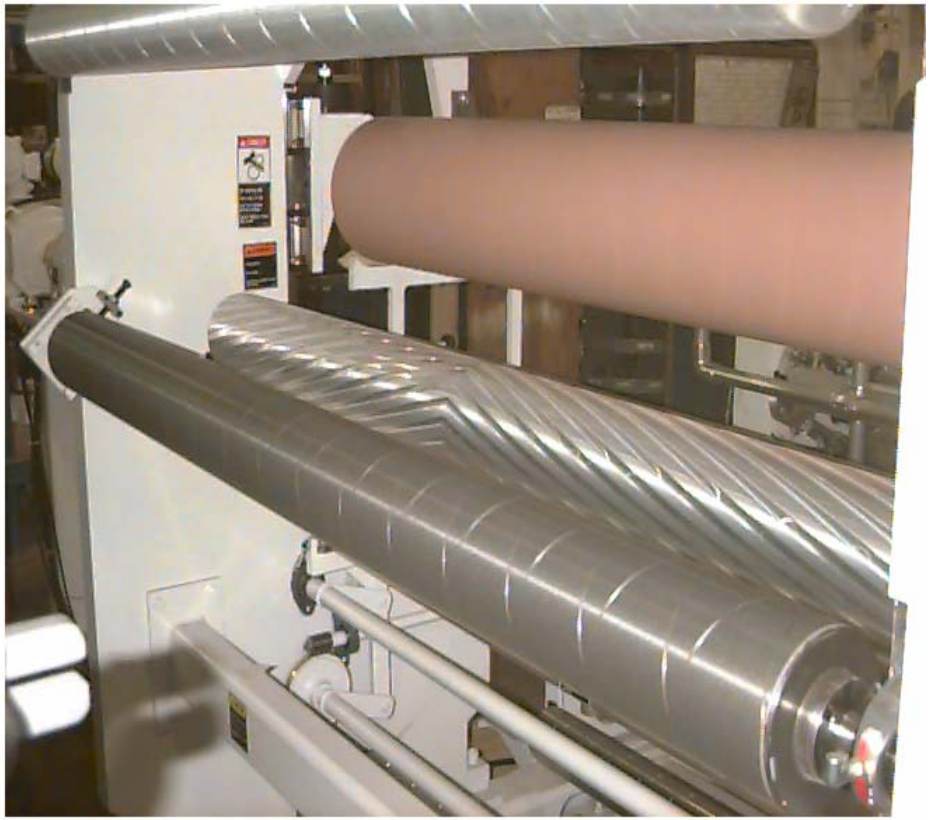
To Eliminate The Foil Wrinkles

A Herringbone Spreader Roll should be added to the line just before the Foil Laminating Nip. Adding this roll will shorten the long draw and provide spreading just before laminating.

This spreader will also help compensate for possible deflection &/or alignment problems which can generate wrinkles on unsupported foil.

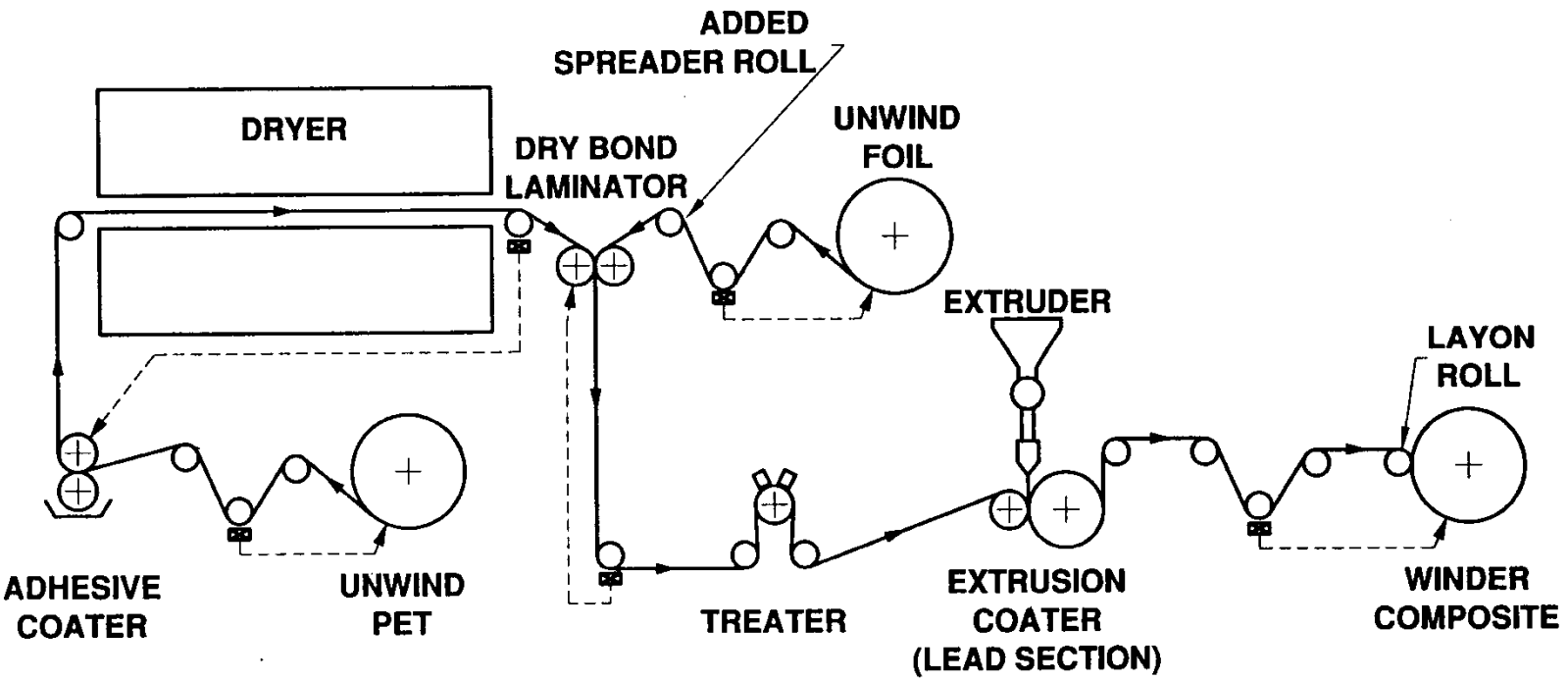
Remember this slide????

HERRINGBONE SPREADER ROLLS



- Outward grooves machined into shell
- Roll is directional
- Works well on foil web paths
- Keep to less than 90 degrees wrap for foil

Adding a Spreader Roll before the Laminating Nip Allowed Pulling Greater Tension Without Generating Wrinkles



Case Study in Film Ext & Laminating:

Suggested Tension

PET	.5-1.5 pli/mil x .48 mil x 42"	**=**	**10-30#**
Alum Foil	.5-1.5pli/mil x .35 mil x 42"	**=**	**7-21#**

Solution to Tunneling Problem :

Decreasing the Web Tension on the PET film from 30# to 10# and

Increasing the web tension on the foil from 10# to 20# after adding web spreading

Eliminated the tunneling problem!

Now For The Winding Problem

Case Study - Winding

Based on a true Situation - Slightly Altered to Protect Confidentiality

Problem Description:

This same manufacturer of the flexible packaging material used to form consumer fluid containers was having a winder defect called Buckling

Winding Problem

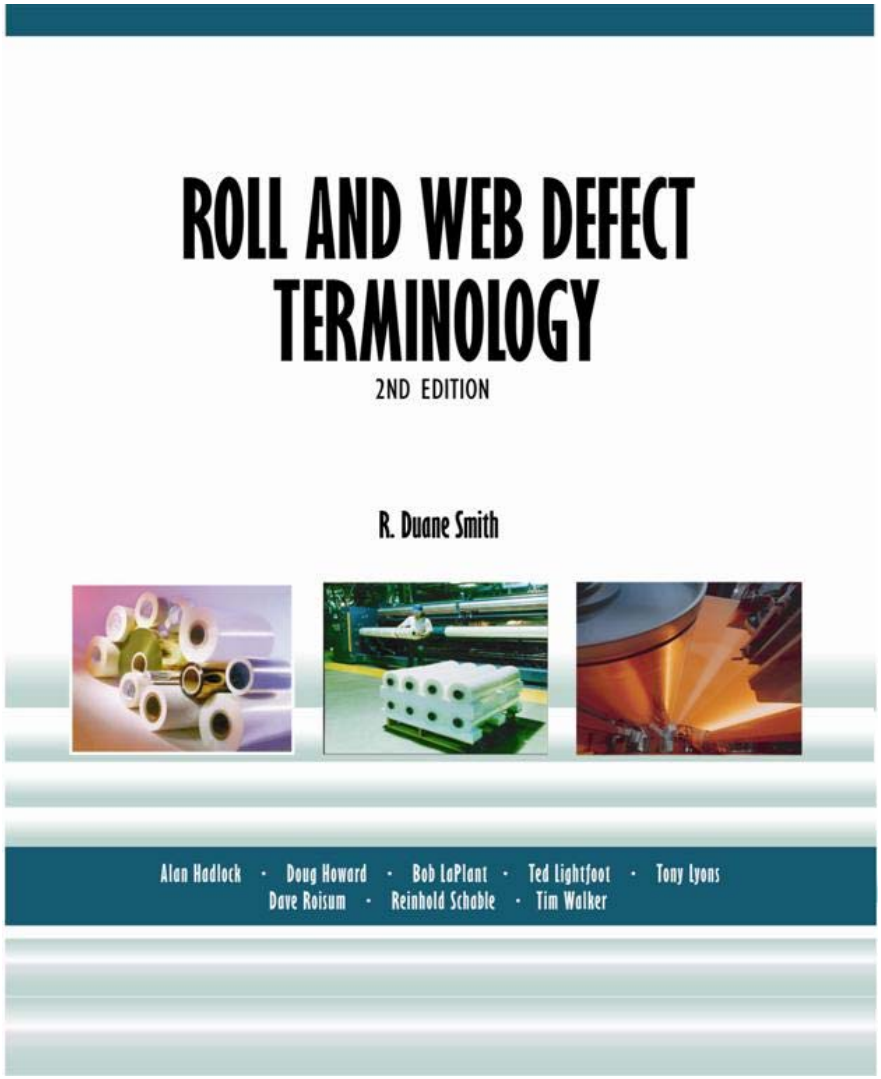
The composite structure is wound on 7" O.D. fiber cores to a diameter up to 36".

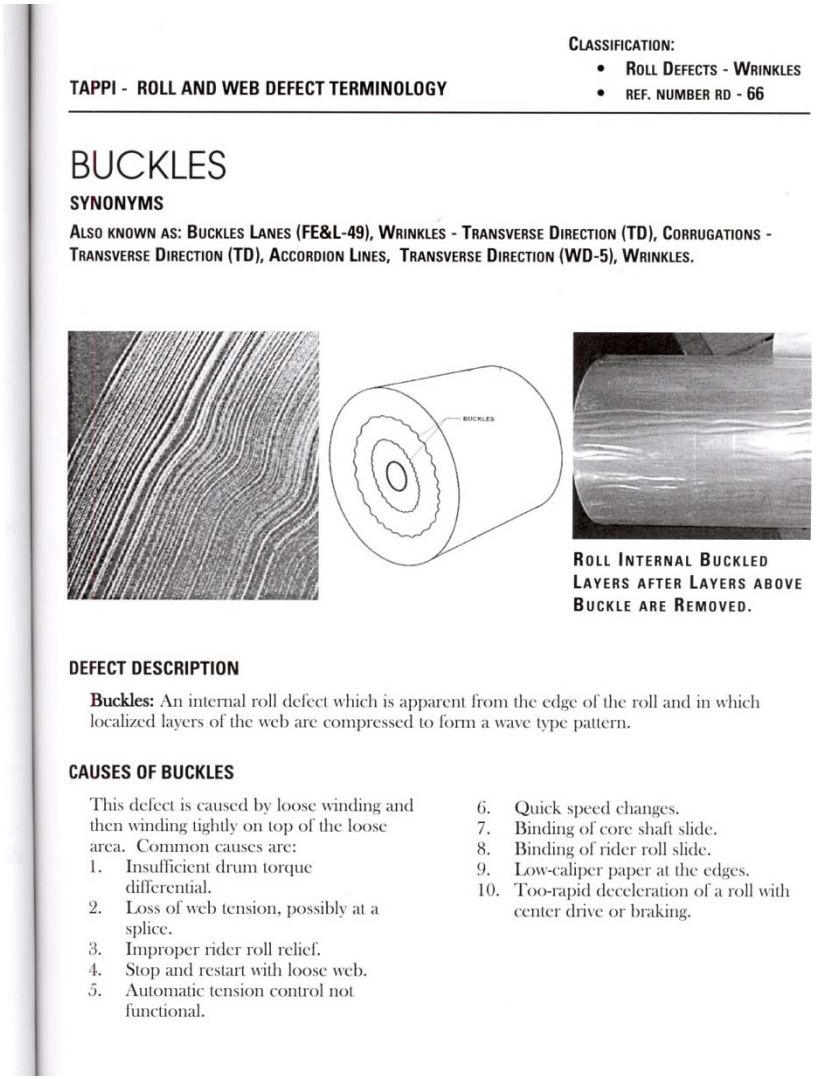
The rolls are being center wound <u>without a nip</u> at a <u>constant tension of 80#</u>.

Problem Description:

The finished rolls look excellent right off the winder however, after they have been stored for a day or longer, buckling wrinkles which caused pleat type fold overs across the web show up in the first couple inches of material wound on the core. This material was rejected as scrap at the subsequent operation which resulted in considerable scrap costs.

In Roll and Web Defects on Page 139





TAPPI - ROLL AND WEB DEFECT TERMINOLOGY

CLASSIFICATION:
- ROLL DEFECTS - WRINKLES
- REF. NUMBER RD - 66

BUCKLES

SYNONYMS

ALSO KNOWN AS: BUCKLES LANES (FE&L-49), WRINKLES - TRANSVERSE DIRECTION (TD), CORRUGATIONS - TRANSVERSE DIRECTION (TD), ACCORDION LINES, TRANSVERSE DIRECTION (WD-5), WRINKLES.

ROLL INTERNAL BUCKLED LAYERS AFTER LAYERS ABOVE BUCKLE ARE REMOVED.

DEFECT DESCRIPTION

Buckles: An internal roll defect which is apparent from the edge of the roll and in which localized layers of the web are compressed to form a wave type pattern.

CAUSES OF BUCKLES

This defect is caused by loose winding and then winding tightly on top of the loose area. Common causes are:

1. Insufficient drum torque differential.
2. Loss of web tension, possibly at a splice.
3. Improper rider roll relief.
4. Stop and restart with loose web.
5. Automatic tension control not functional.
6. Quick speed changes.
7. Binding of core shaft slide.
8. Binding of rider roll slide.
9. Low-caliper paper at the edges.
10. Too-rapid deceleration of a roll with center drive or braking.

Problem Description:

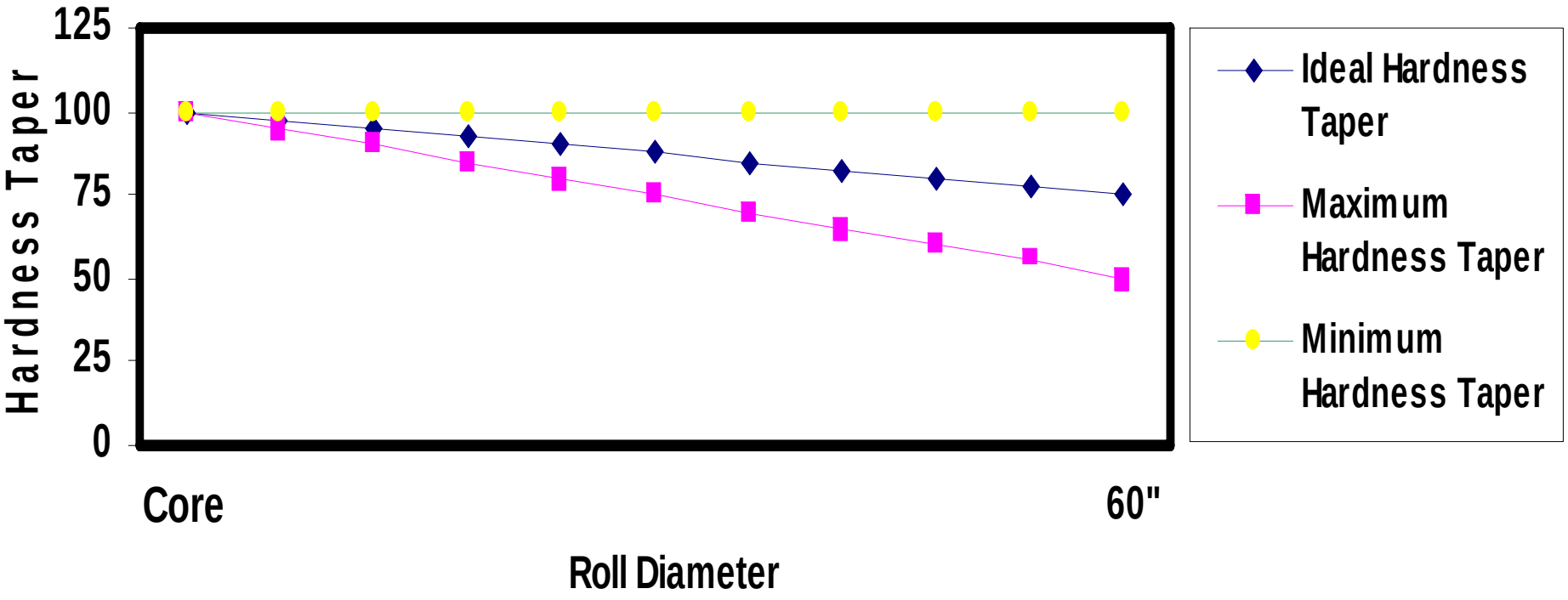
- **The warm web wound into the roll is curing during storage. This causes the outer surfaces to contract and the inner wraps towards the core to be put under high compressive stresses.**
- **These high compressive stresses force any air that was wound into the roll to be compressed and/or forced out the sides.**
- **The web is being center wound at a constant 80# tension without using a layon roll to nip the winding roll at the point the web enters the roll.**

The Solution for Buckling Problem

This Laminated Flexible Packaging product needs to be wound with a very tight start and then taper the roll's hardness as the roll builds. Due to the cooling or curing action of the material, we would suggest a 25% to 50% winding tension taper.

Remember this slide????

ROLL HARDNESS PROFILE



From Chapter #21 of TAPPI Film Ext. Manual – 2nd edition, 2005

Remember this slide????

T.N.T. - Tension Principle of Winding

Common Practice is to start winding with 50% greater tension then the unwinding tension.

(See chart on Typical Tension Values- Paper suggesting unwinding at .035 x basis weight and winding at .055 x basis weight.)

Remember this slide????

Suggested TENSION VALUES **Paper**

PAPER, Basis Wgt.	TENSION LEVELS
15 lbs./ream (3000 sq.ft.)	0.5 pli
20 lbs./ream	0.75 pli
30 lbs./ream	1.0 pli
40 lbs./ream	1.5 pli
60 lbs./ream	2.0 pli
80 lbs./ream	2.5 pli

Unwinding Tension (pli) = paper basis weight x 0.035

Winding Tension (pli) = paper basis weight x 0.055

Conversion Factors lbs./3000 ft^2 x 1.63 = = grams/sq. meter

pli x 5.6 = kg/cm

The Suggested Tension for each Product Used in the Laminate

Material	Tension/Mil	x	Thickness	x	Width	=	***Suggested Tension***
PET	.5-1.5 pli/mil	x	.48 mil	x	42"	=	**10-30#**
Alum Foil	.5-1.5pli/mil	x	.35 mil	x	42	=	**7-21#**
PE	.25-.3 pli/mil	x	4.0 mil	x	42“	=	**40-48#**

Total Tension = 57# to 99#

Remember this slide????

Tension Principles of Winding

Taper Tension

Reduce the tension smoothly as the roll diameter increases:

0 - 50% taper, 25% common

Taper Tension reduces - telescoping, end crowning, starring and buckling problems

T.N.T. - Tension Principle of Winding

To obtain the req'd. tight start, it is suggested that winding tension at the start be about 100#.

(10# PET, 20# foil and 40# for the PE = 70# plus 50% greater starting tension = approx. 100#)

Then tapering the winding tension to 50# (50% taper) at a 36" diameter.

T.N.T. -Nip Principle of Winding

This application AIR is NOT our Friend!

Should use the nip from a lay-on roll to build the desired roll hardness and to minimize air wound into the roll.

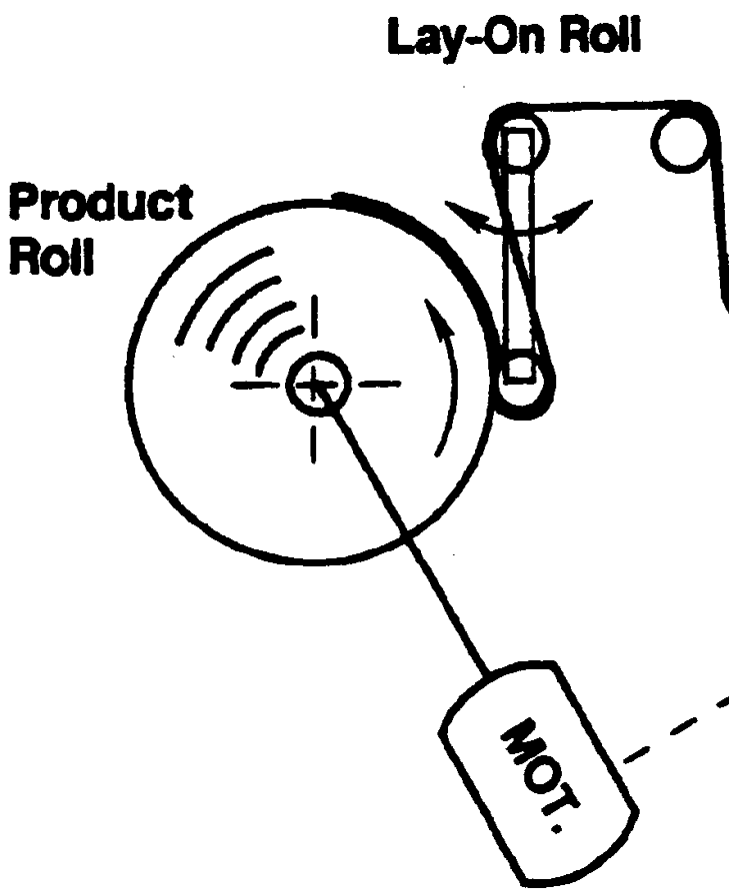
Another *Rule of Thumb-*

Suggested starting nip is 3 times the starting tension or

3 x 100# =300#.

Remember this slide????

Nip Principles of Winding



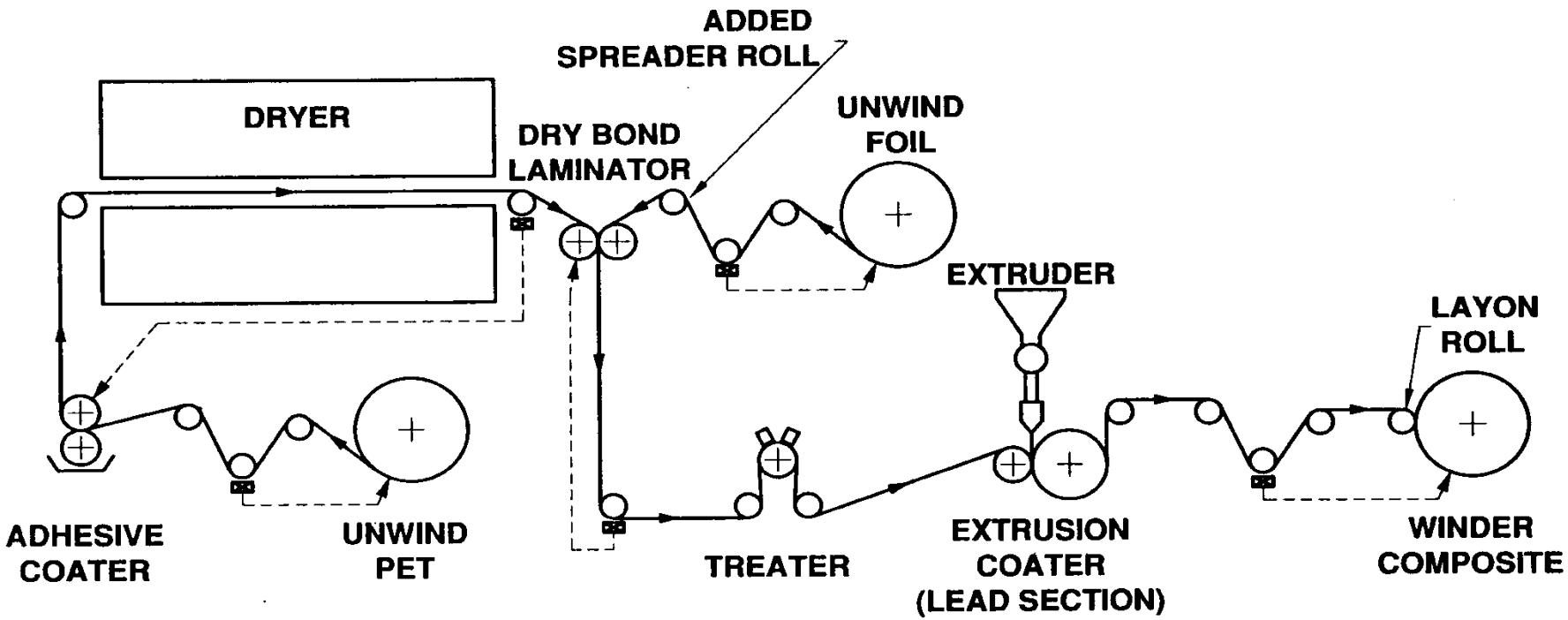
- Nip Load should be tapered as roll winds to prevent starring and telescoping. However,
- Larger winding roll's dia. drags more air and produces a Nip Taper Loading with a constant loading pressure.

T.N.T. -Nip Principle of Winding

This nip load can be held constant as the hydraulic pressure of the air reduces the nip due to the amount of air being brought into the nip as the winding roll's diameter builds.

If greater roll hardness taper is desired, then the nip load can be decreased as the winding roll's diameter builds to further decrease the inwound tension as the roll winds.

Lay-on Nip Roll Added to the Winder – To remove air from the winding roll.

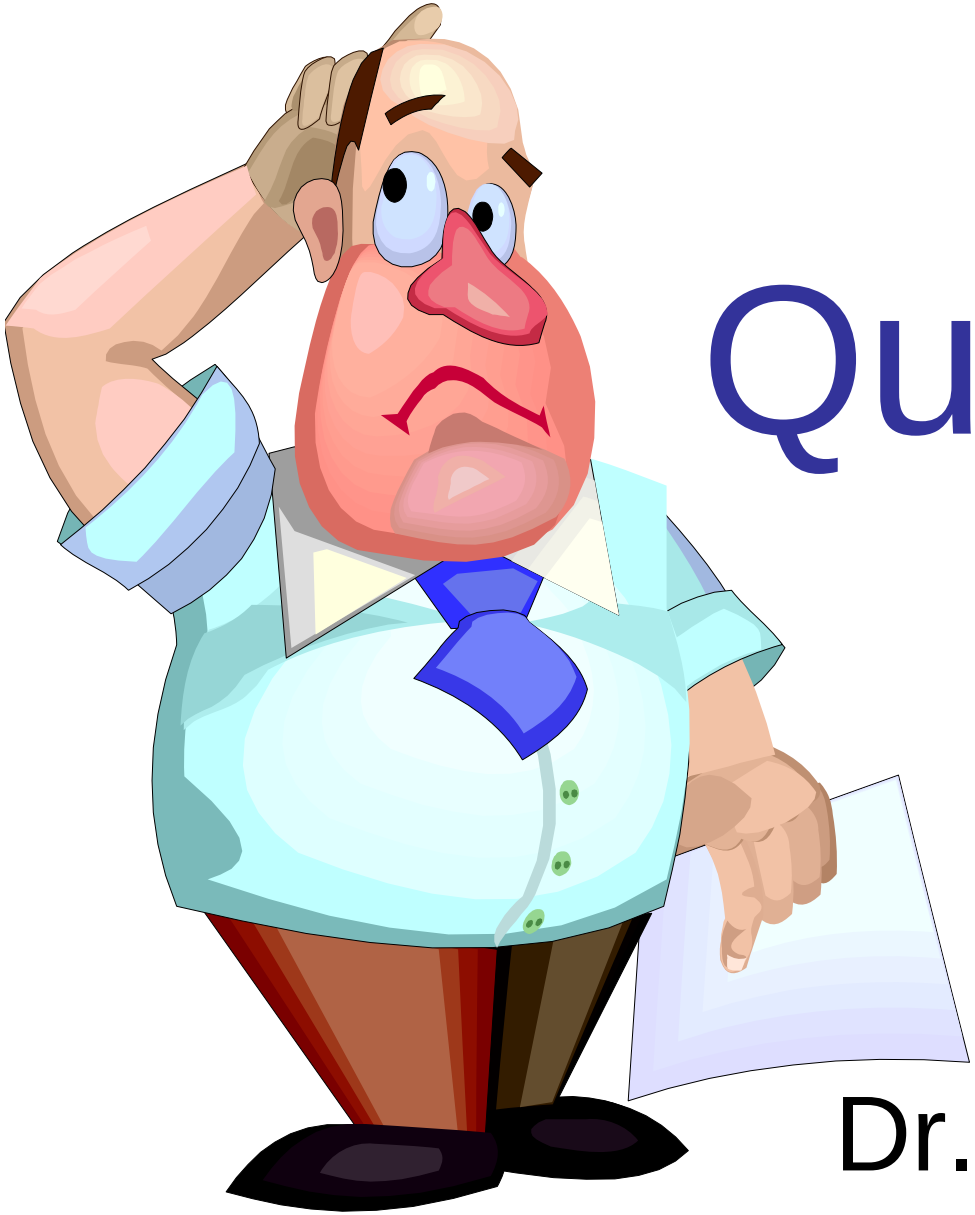


The Solution for Buckling Problem

- **By increasing the Winding Tension to 100# at the start and then tapering to 50# at a 36" diameter.**
- **Then by adding a nip roll which was used to supply a 300# Constant Nip to evacuate the air.**
- ***The Buckling Problem as the roll cured was eliminated!***

We covered a Lot of Material in a Short Time

- **Challenges in Web Handling**
- **Challenges in Web Spreading**
- **Challenges in Slitting**
- **Challenges in Winding**
- **Challenges in Eliminating Roll and Web Defects**



Questions ????

Slide Courtesy of

Dr. David Roisum

Remember this slide???? It was a long while ago !!!!

174 slides in 90 minutes

Goal of this Presentation:

That you will take back at least a few Gold Nuggets from the information presented and apply these to improve the Productivity & Profitability of your converting operation

Thank You!!!

TAPPI

2010 PLACE Extrusion Coating

Short Course

Challenges of

WEB HANDLING AND WINDING

R. Duane Smith

Black Clawson Converting Machinery / D-S LLC