APPLIED WEB HANDLING CONFERENCE 2008

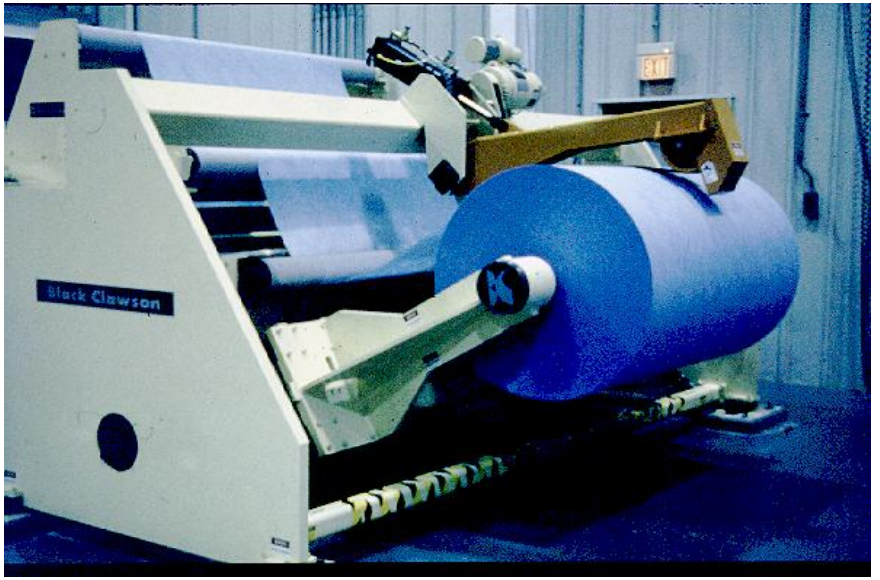
Practical Considerations for Zero Speed Splice Unwinds

Neal Michal

Technical Leader

Types of Unwinds
Start / Stop

Undriven Roll Stand



Floor Lift with Surface Drive Belt

Included with permission of Black Clawson Converting Machinery

Types of Unwinds Continuous

Turret with Surface Drive Belts

Turret with Driven Spindles

Included with permission of Black Clawson Converting Machinery

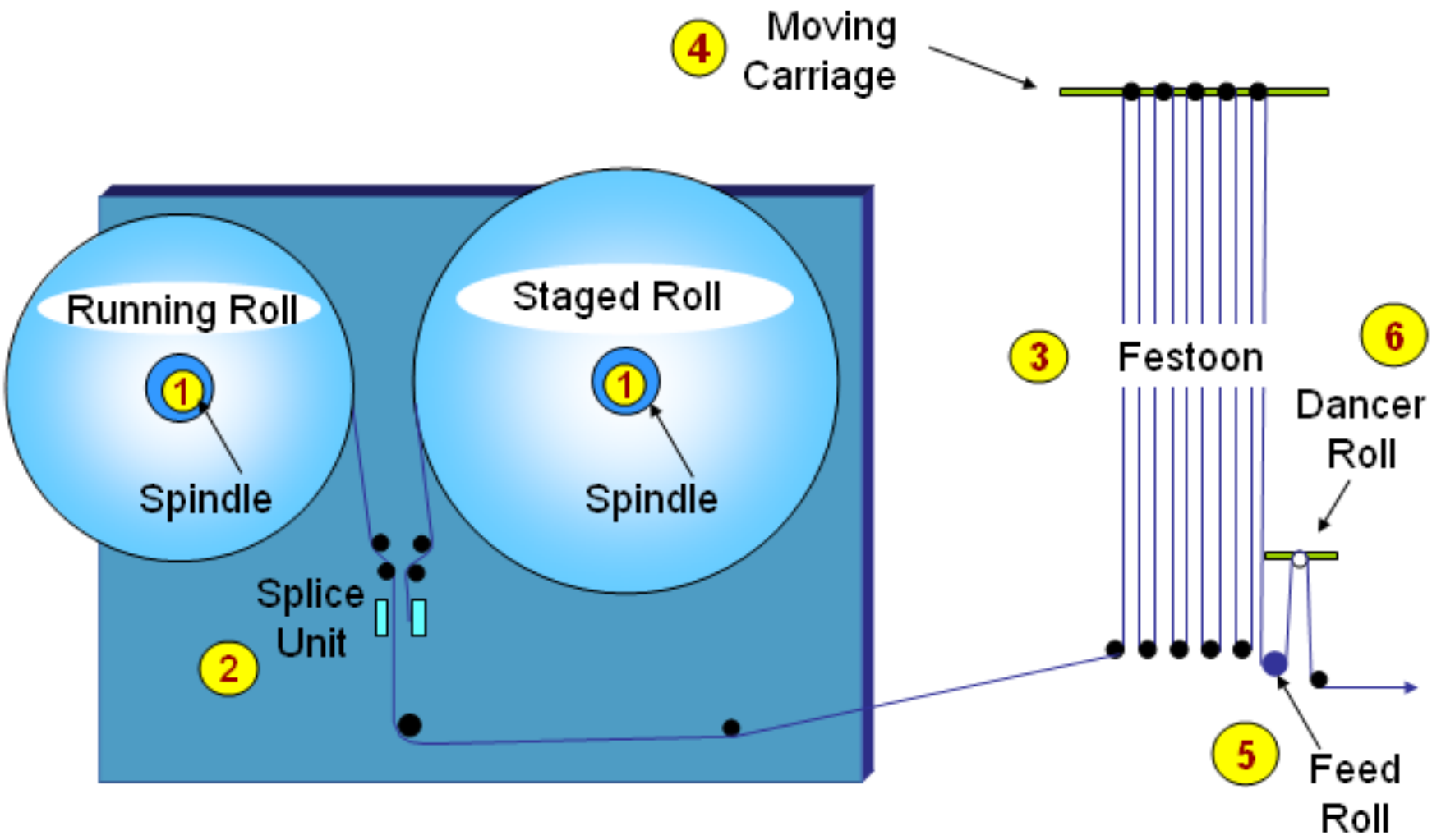
Zero Speed with Accumulator

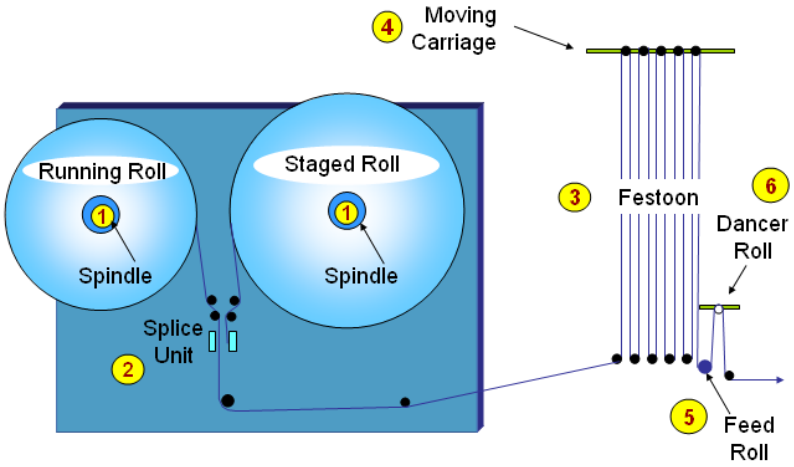
Included with permission of Martin Automatic Inc

Benefits of a Zero Speed Splice Unwind

- No concerns about speed match
- Opportunity to make a better splice
- Splice design – Butt or Lap
- Splice type – Heat seal, Ultrasonic, Tape, and Hot Melt
- Some splices can be sold into final product
- Ability to splice into / out of eccentric rolls
- Ability to splice into / out of rolls with a wider range of diameters

Major Components

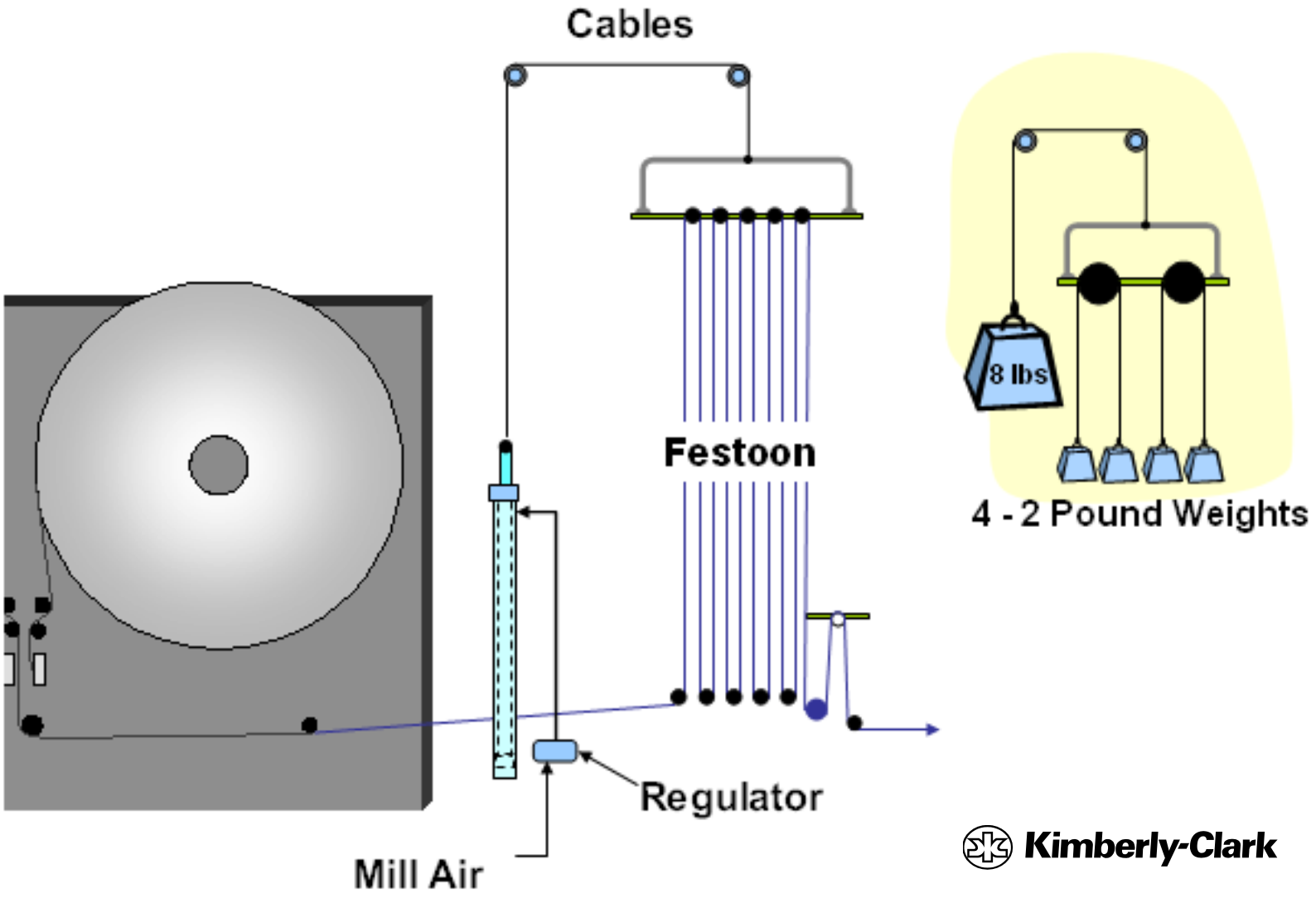




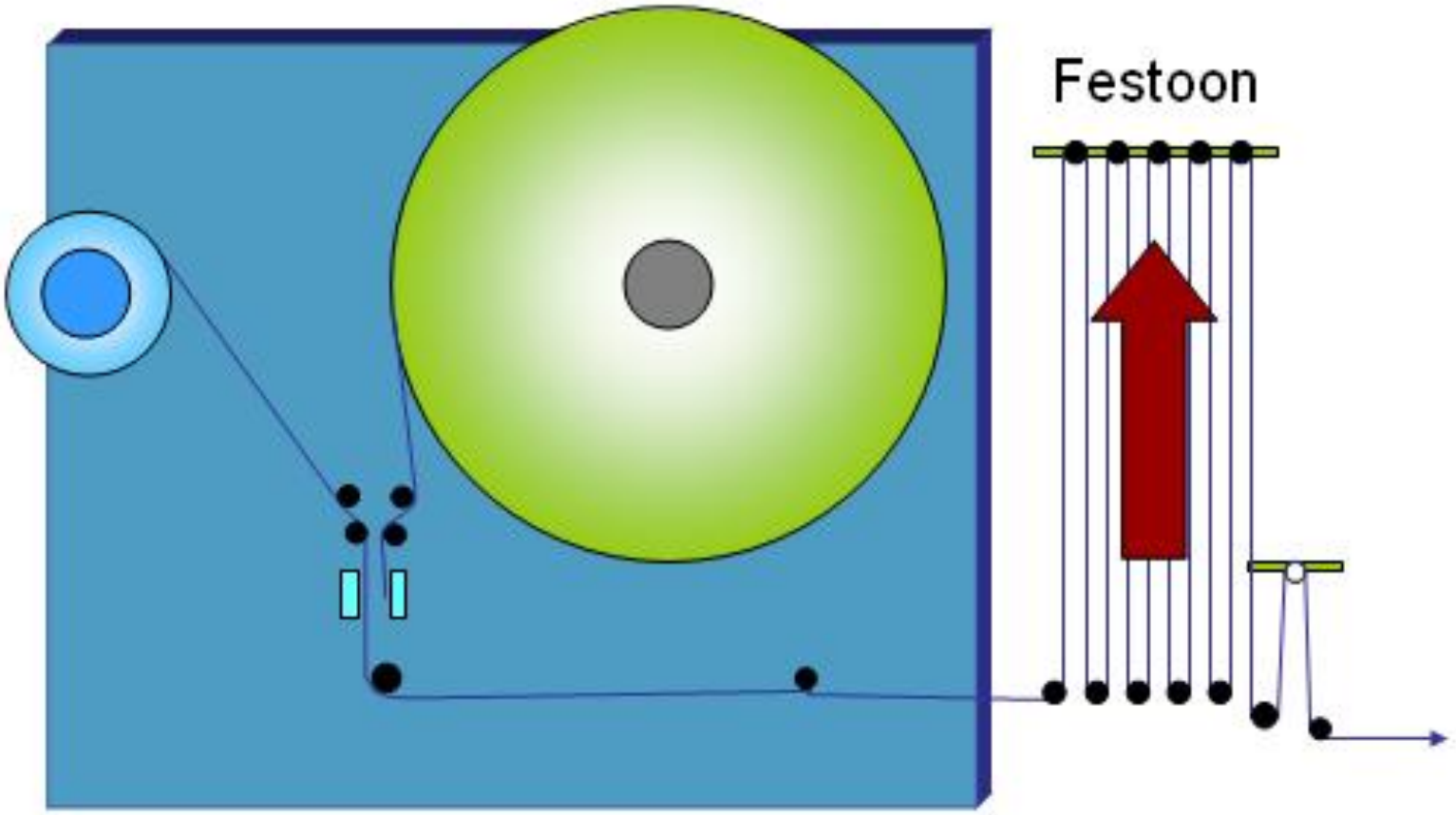
Major Components

- Two spindles, Splicer, Idlers, and Festoon.
- Spindles are cantilevered for narrow webs; chucks are often used for wide unwinds
- The festoon provides web storage for zero speed splicing with uninterrupted machine operation.
- The festoon consists of a moving carriage and fixed set of rollers
- Feed Roll and Dancer are optional.
- The dancer is used to control tension into the process.
- Festoon and dancer can be controlled by a number of methods

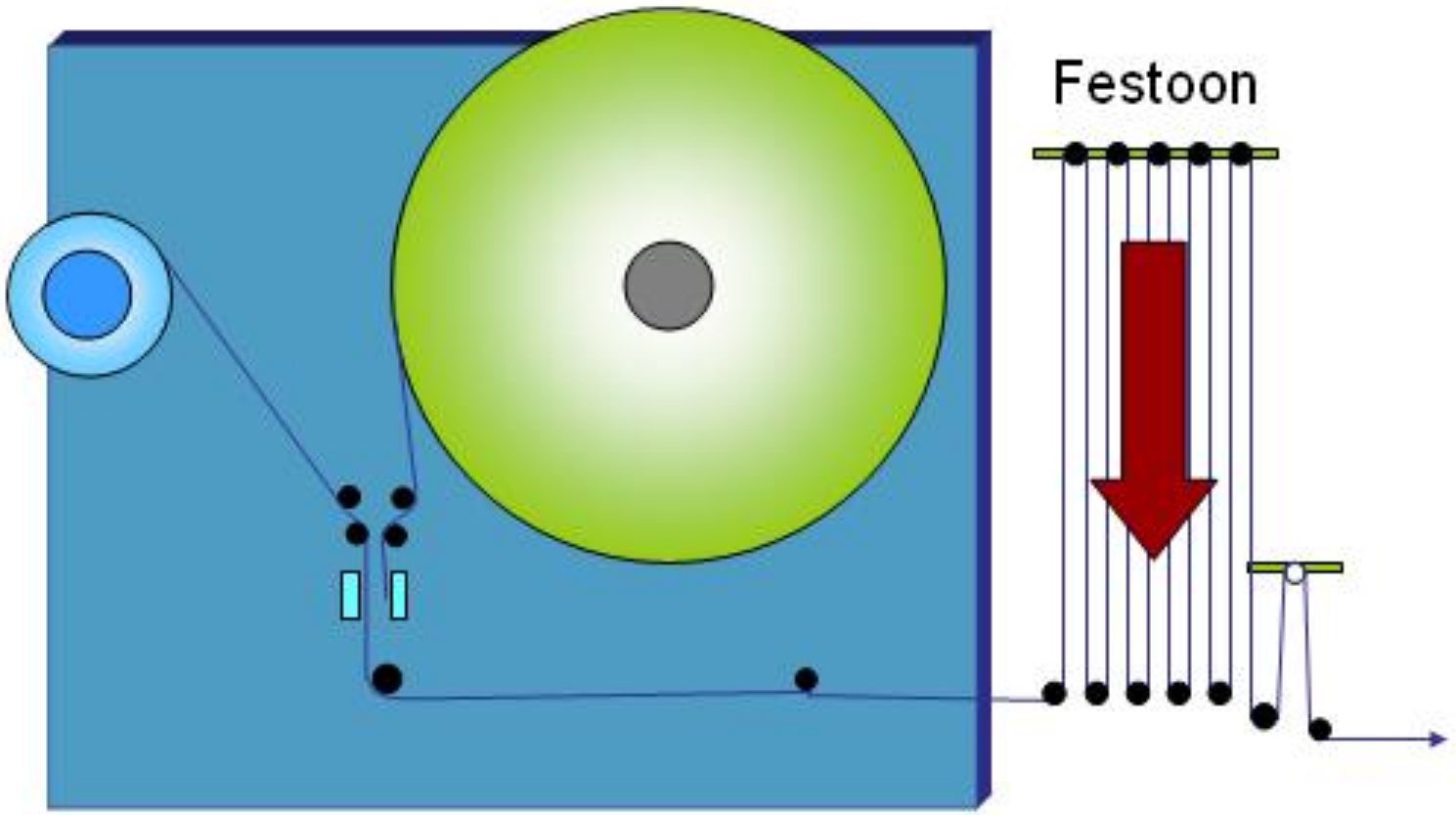
How do they work?
Tension



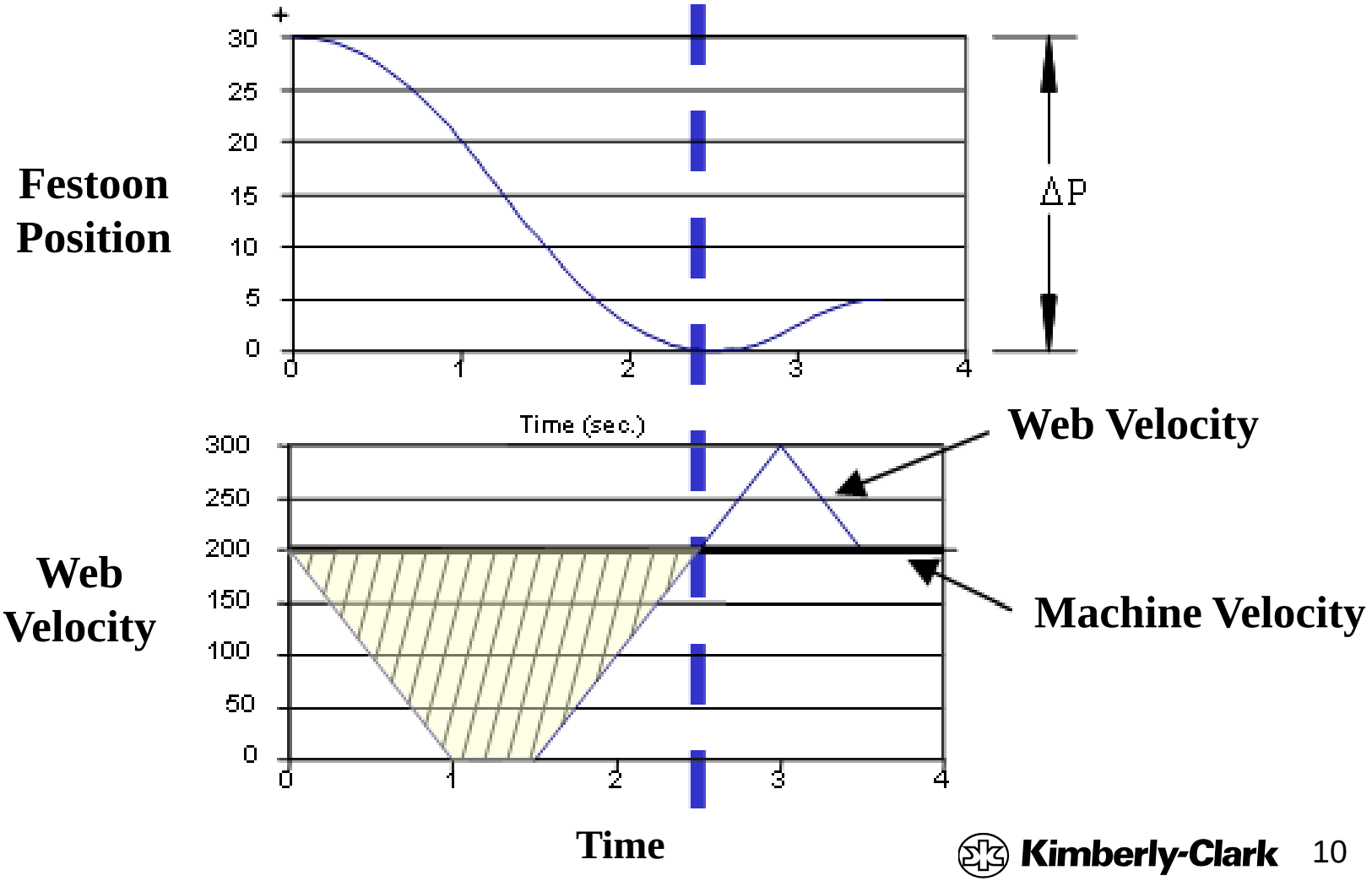
Fill the Festoon for the Splice



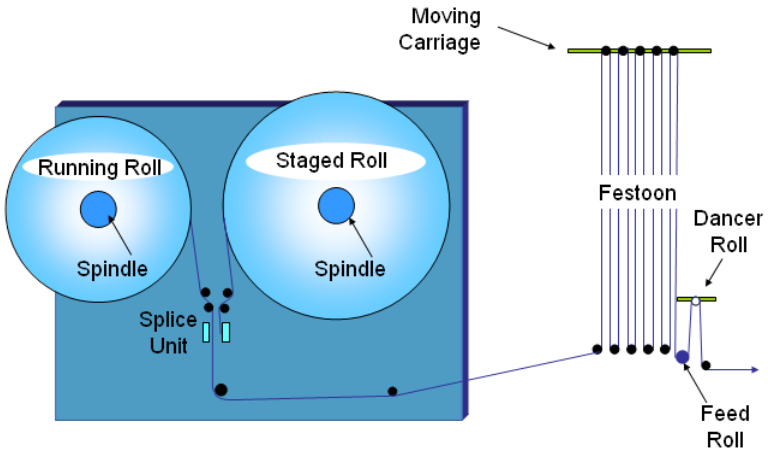
Decelerate expiring roll to stop
Splice into the new roll
Accelerate new roll up to speed



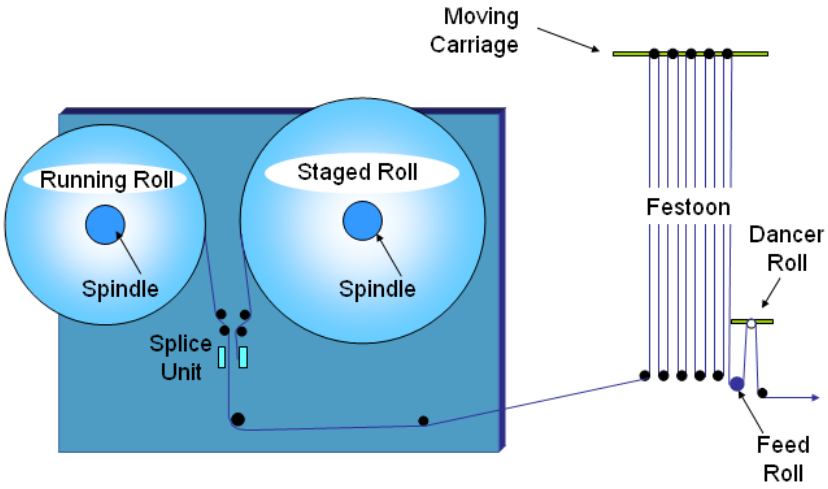
Timing and Storage



Optimization



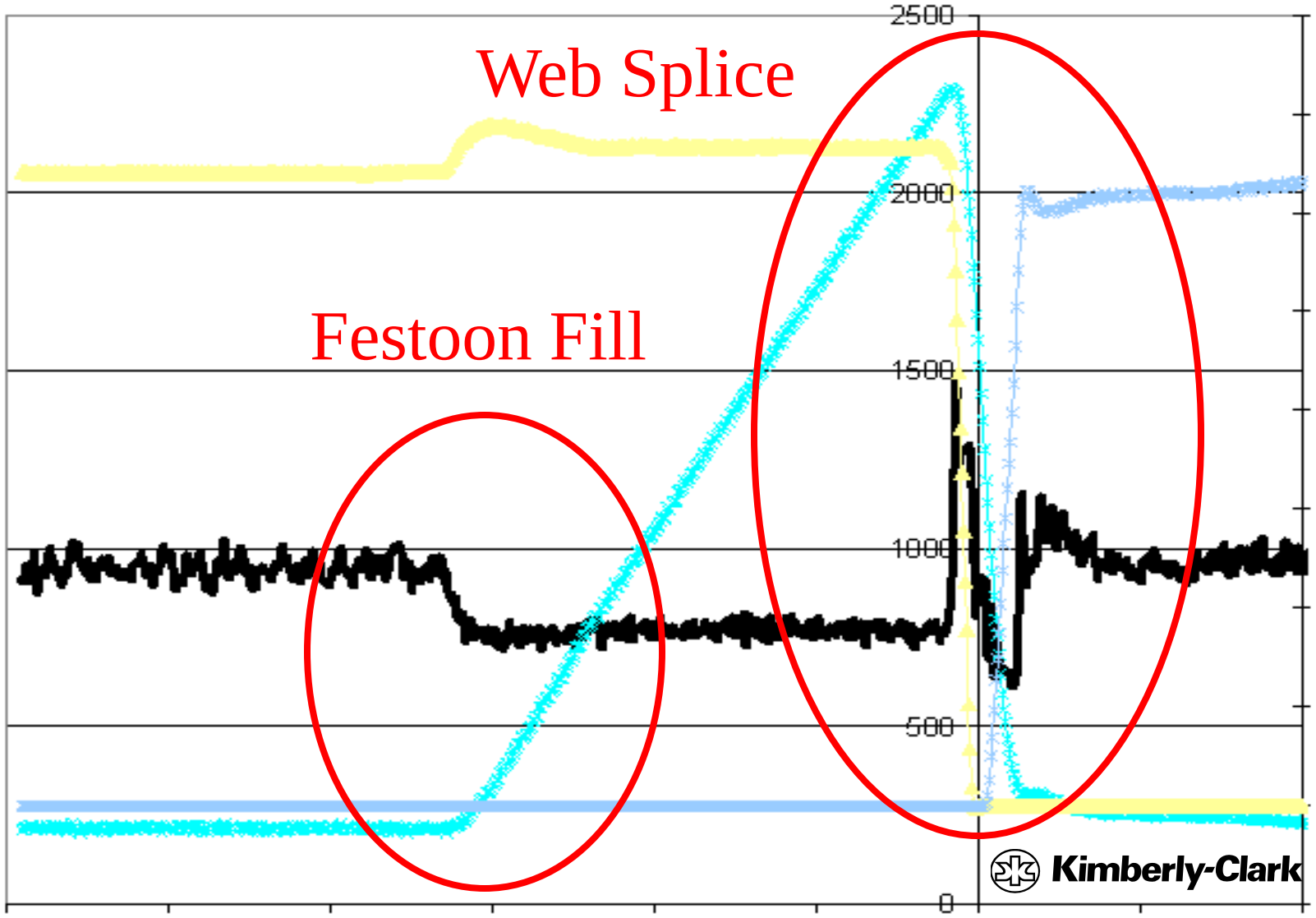
- Balance out the carriage mass
- Design of experiments
  - Festoon tension for reliable splice
  - Dancer tension for downstream process
  - Accel / decel rates
  - Festoon run & splice heights
- Calculate tension in units of force/width
- Analyze all splice failures
- Digital camcorder will catch most failures



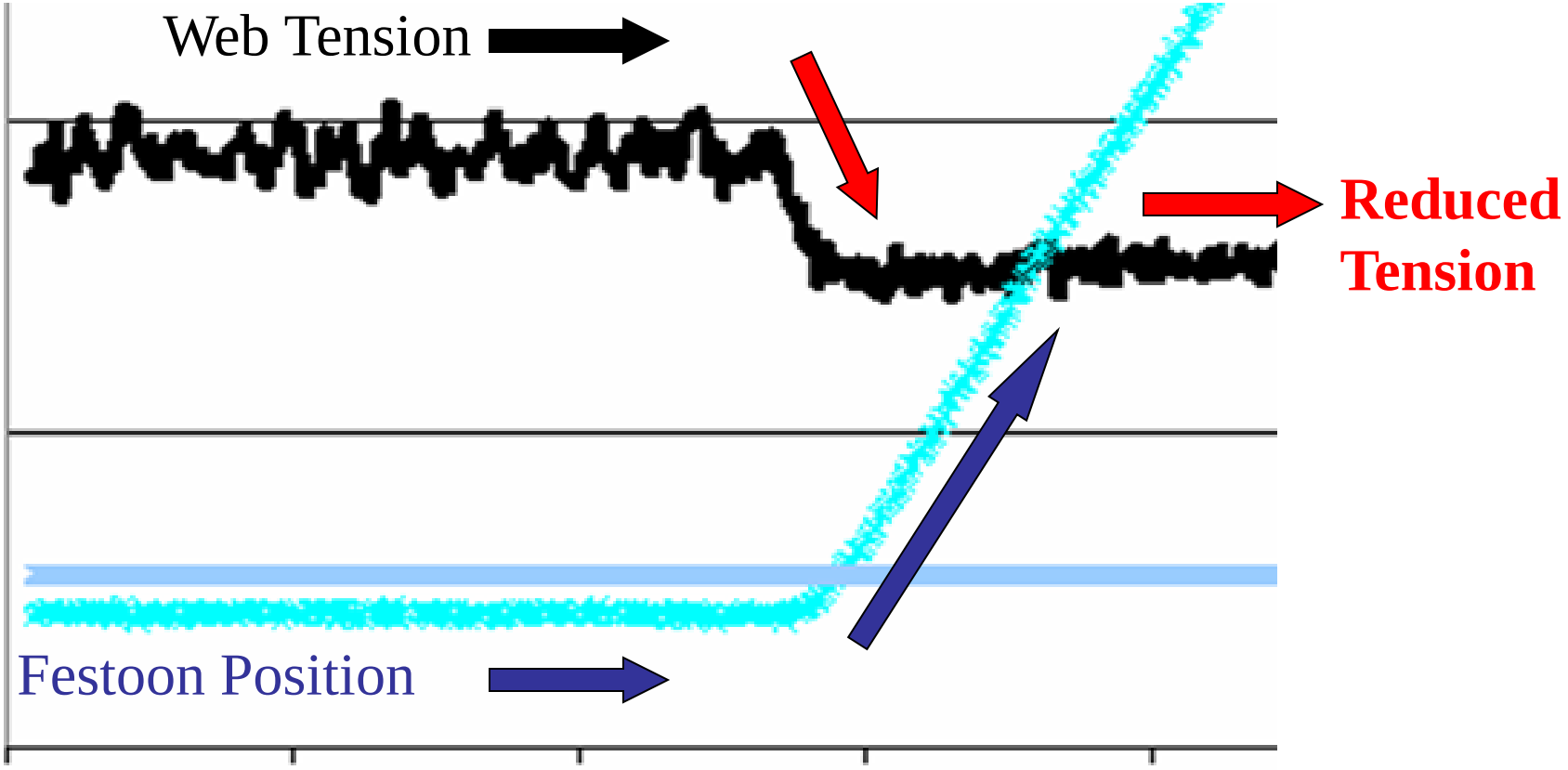
Advanced Troubleshooting

- Load cells and trend charts are recommended
  - Festoon entrance – widest tension variation
  - Festoon exit – health of festoon idlers
  - Exiting unwind – downstream process
- Web sensors document width & centerline
- Cameras & video recorders for random failures
- Material trials to find process capability

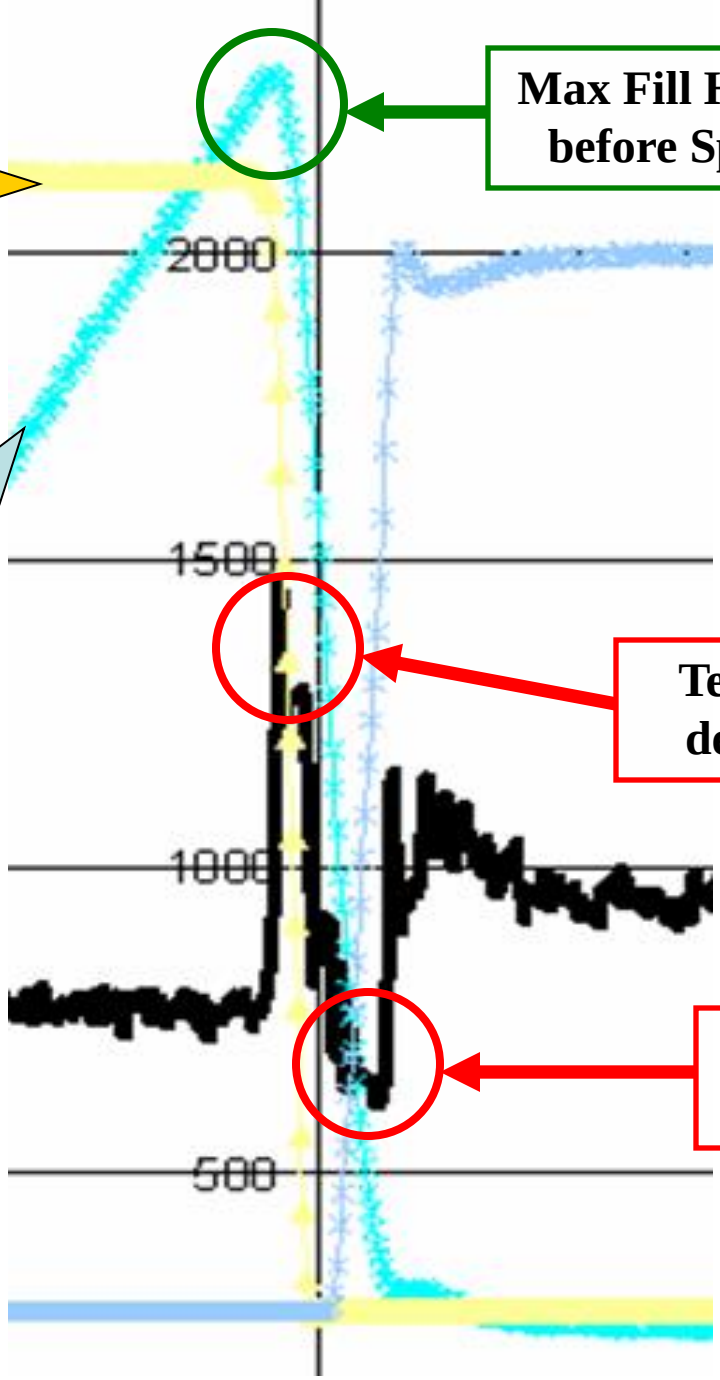
Zero Speed Unwind Splice
Tension Profile



Festoon Fill



Web Splice



Expiring Roll RPM

Max Fill Height before Splice

New Roll RPM

Festoon Builds Height for Splice

Tension Spike during decel of expiring roll

New Tension

Reduced Web Tension Before Splice

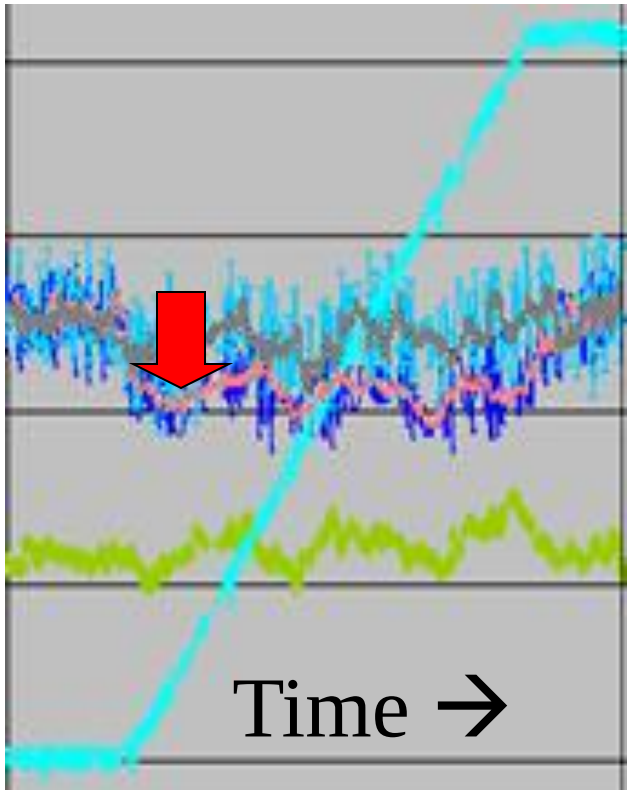
Tension Drop during acceleration of new roll

Festoon Height @ Steady State

Advanced Troubleshooting Examples

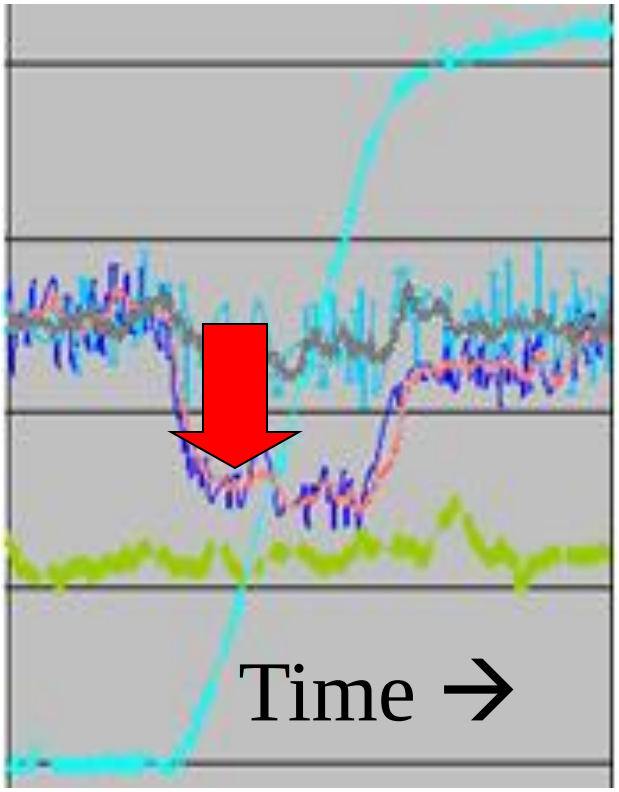
Festoon Fill Rate

Slow



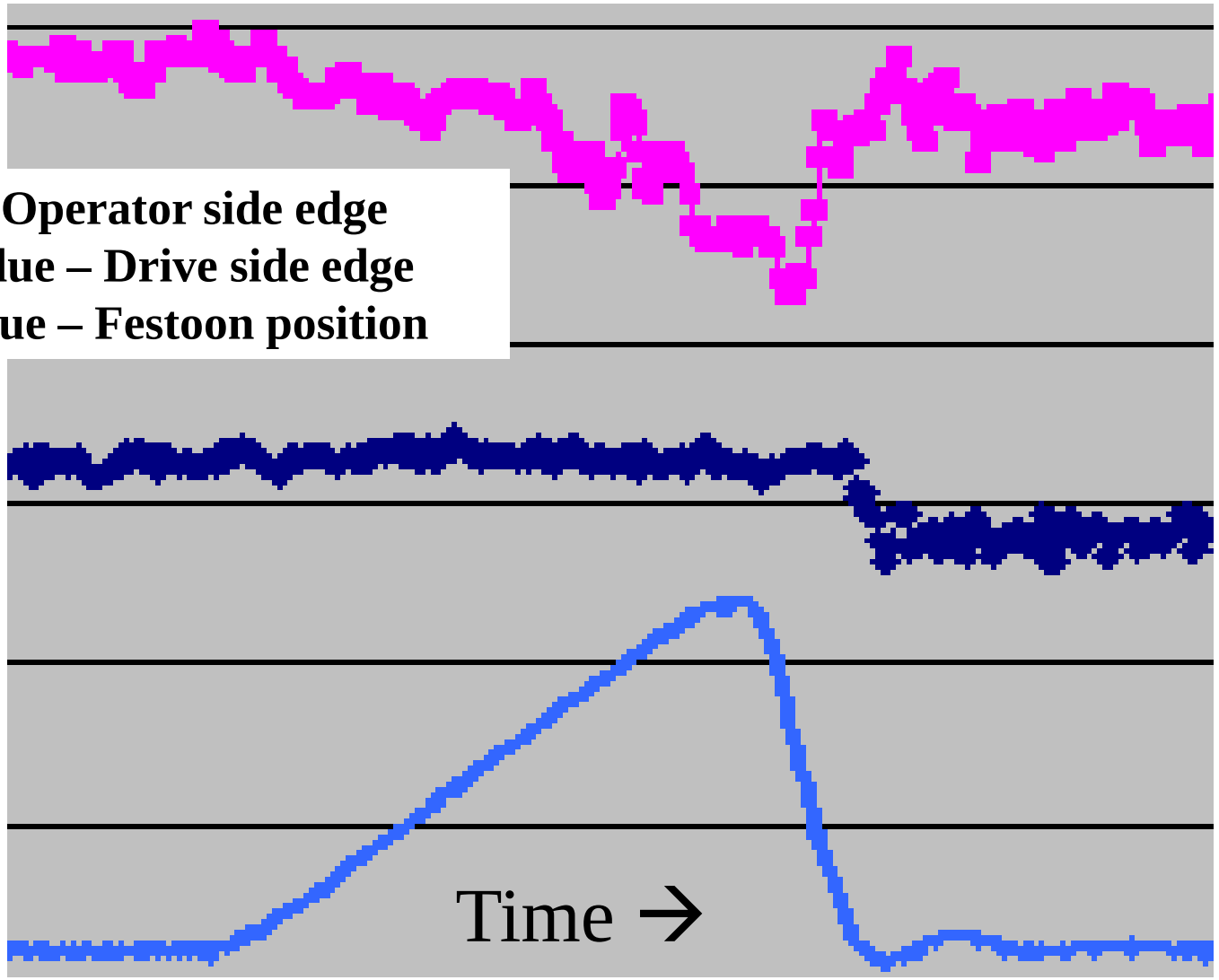
Tension →

Fast

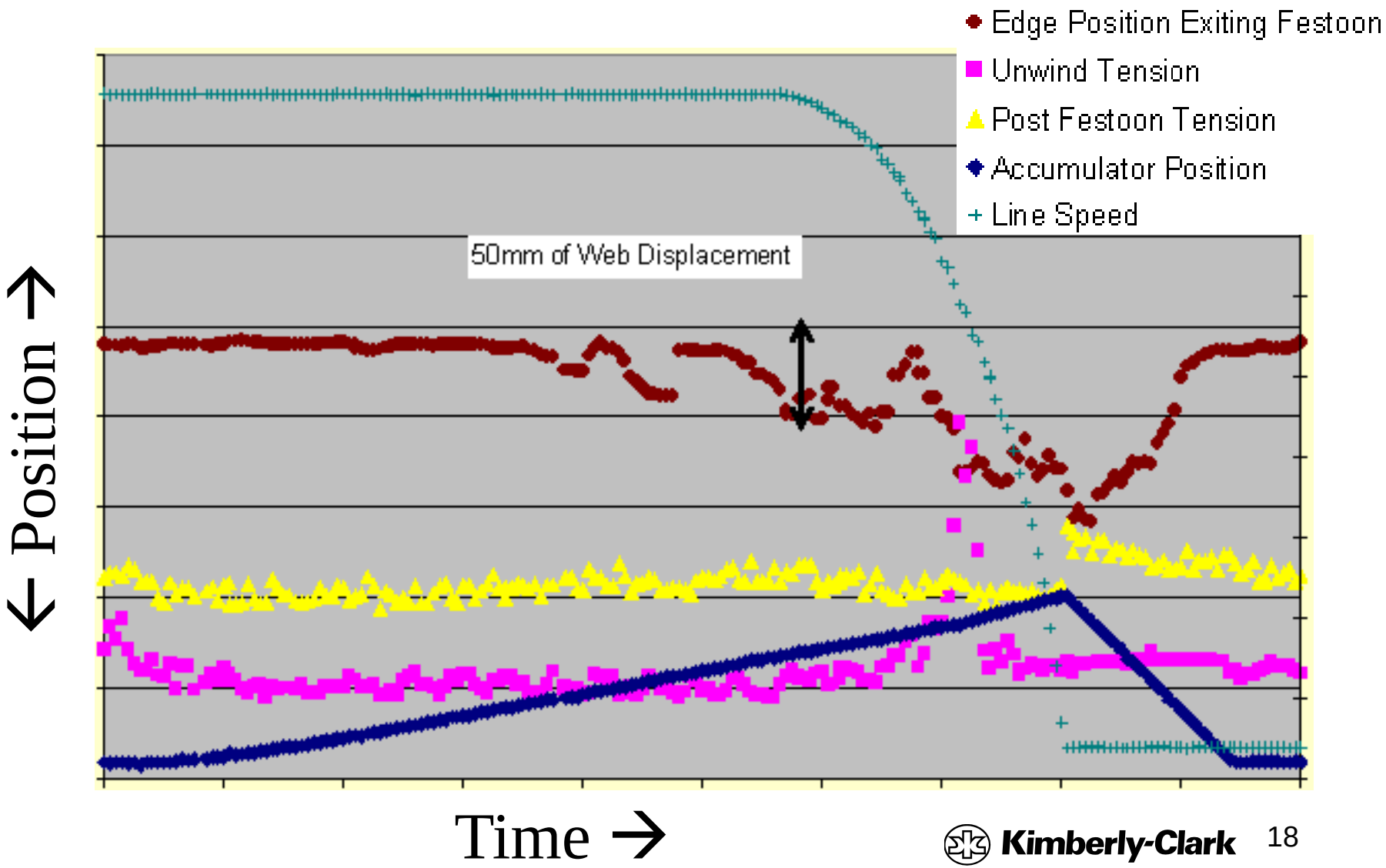


Moving Carriage Mis-alignment

Red – Operator side edge
Dark Blue – Drive side edge
Light Blue – Festoon position

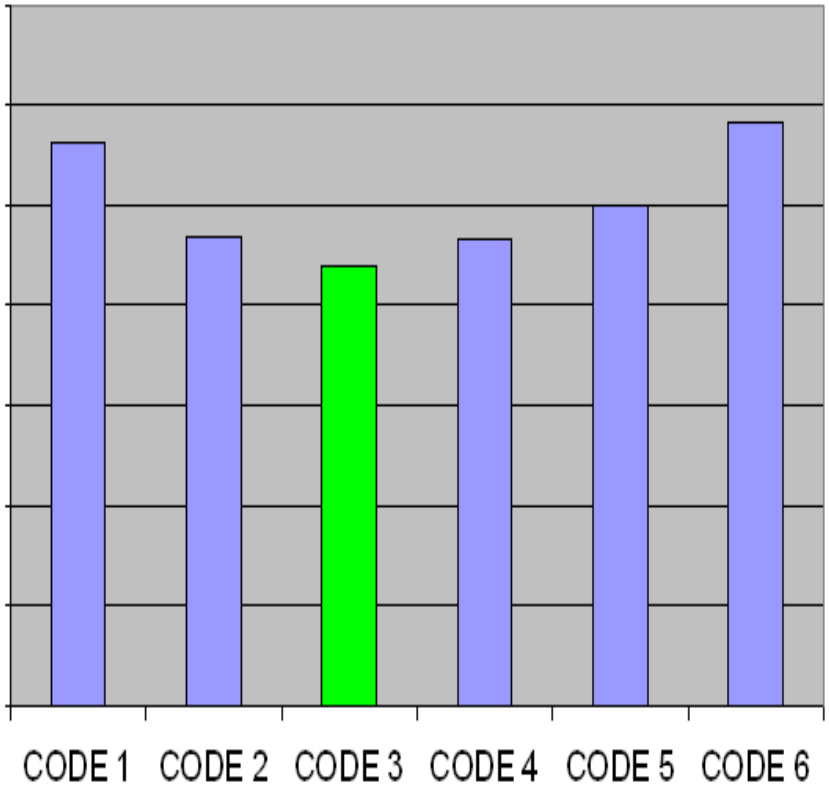


Festoon Fill – Web Collapse



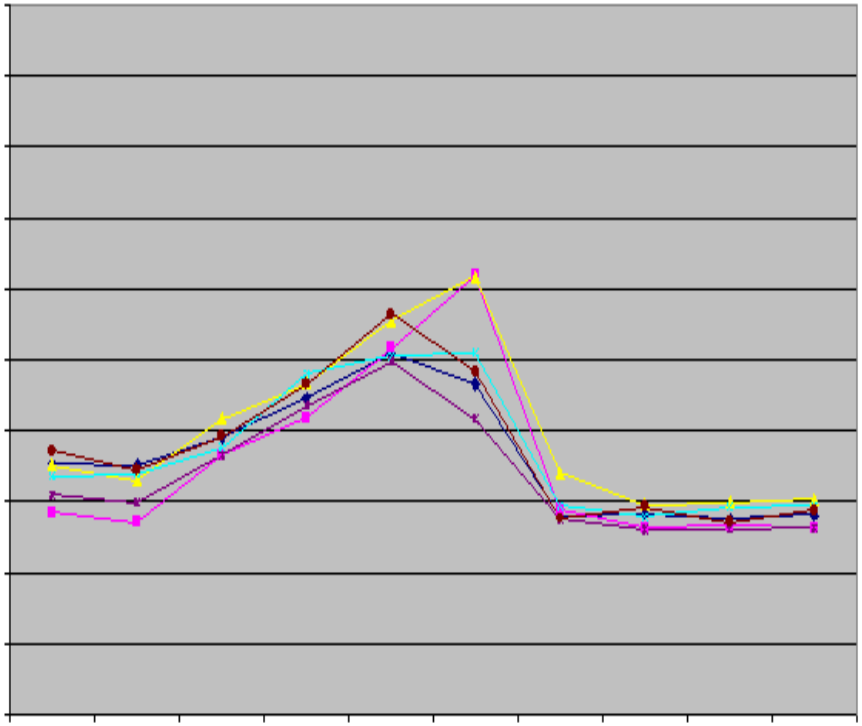
Web Weave

Magnitude



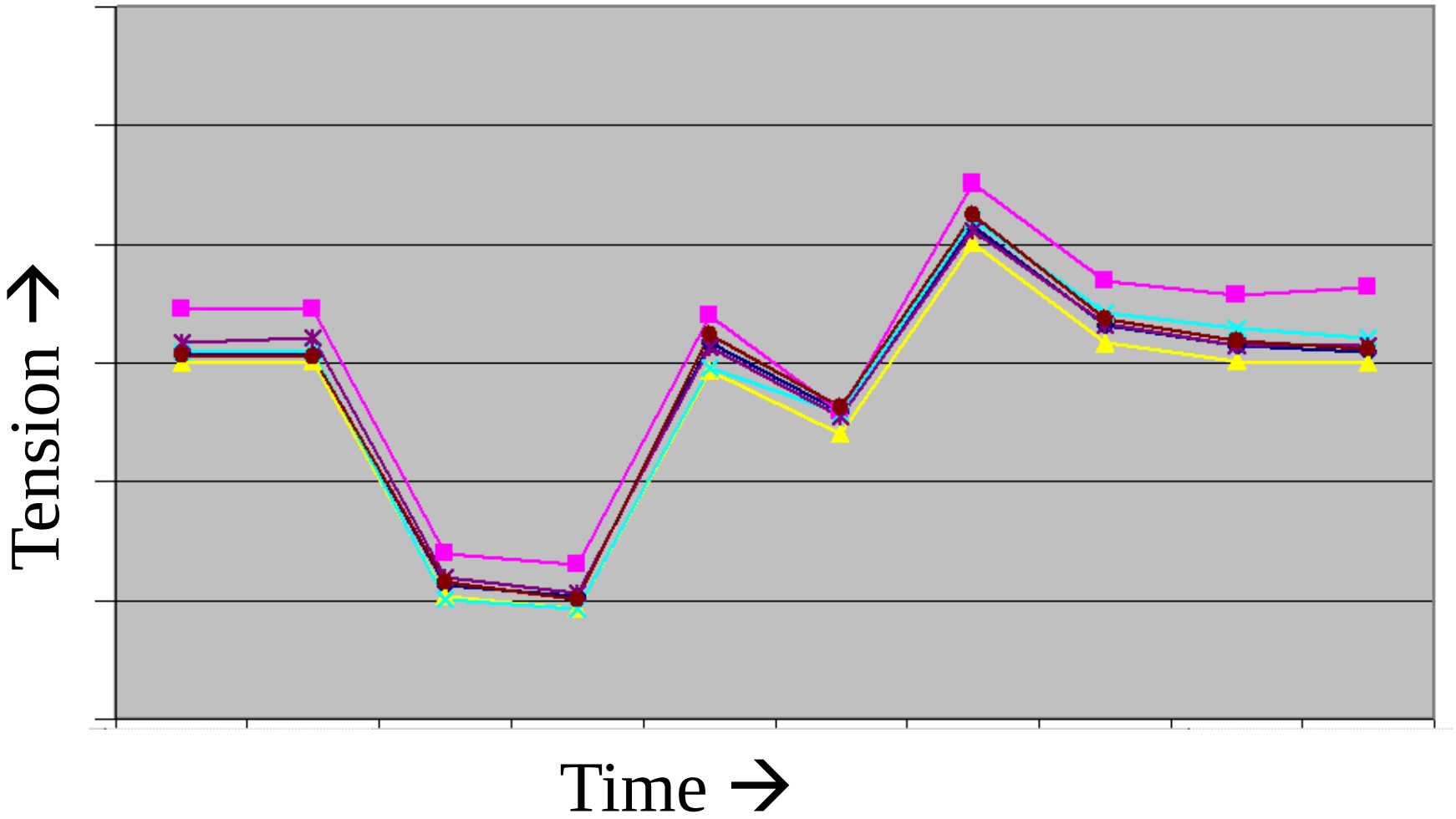
Materials

Period



Time →

Material Trials



Questions for Optimization

- What tension is needed to run well?
- How much tension spike can my splice take?
- What is the lower tension limit?
- How fast do I decelerate & accelerate?
- Wrinkles – When? Where? What type?
- Does my web weave or shift?
- How should I control my unwind?
- Do I need a feed roll or a dancer?
- Define issue – Material? Unwind? Settings?
- How can I improve process capability?

Current Research

- Several dozen papers on winding, wrinkling and air / web interaction (WHRC, Good, others)
- Focus is on a single roller in an open span
- Finite element codes are time intensive
- Unwinds are more important than winding for many high speed converting operations
- Four papers on accumulators (Pagilla, Shelton)
- “Dynamics of a Web Accumulator” (Shelton)
- Most unwind information is internal, confidential and empirical in nature
- Existing papers are not well understood
- Equipment designs do not reflect research

“Top Ten” Research Needs

1. Validated computer models are needed
2. Air / web interaction within a festoon
3. Multi-span interaction: tension, wrinkles, lateral
4. High speed –vs- traction for a porous web
5. Larger rollers –vs- wrinkles –vs- roller mass
6. Mis-alignment of a moving carriage
7. Should we drive rollers in the festoon?
8. Importance of carriage friction & mass
9. What is the best general arrangement?
10. Other web handling aids?

Industry Needs for Unwinds

- Open innovation: Fundamental & applied research to develop value priced robust solutions
- Delicate webs / higher speeds / lower tension
- Better mechanical designs & integrated controls
- Stronger splices that can be sold into the product
- Turnkey installations that are easy to commission
- Strategic partnerships: OEM's, research, & end use customers are desired

Questions?

Neal Michal
nmichal@kcc.com
(770) 587-7378