Hybrid Extrusion Coating Lines

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ABSTRACT

In an attempt to reduce costs or justify the purchase of an extrusion coating line, converters may attempt to combine two independent operations. True cost savings or project justification can be achieved in this way, but more often the end result is less then satisfying.

This paper will examine the pros and cons of various extrusion coating hybrid line arrangements, describing practical limitations and bottom-line expectations.

INTRODUCTION

A hybrid line is one that combines the features of normally separate processes into one piece of equipment. This is done:

• To increase the flexibility of the equipment and give the converter the ability to adjust to changes in market demands.
• To combine two processes that would normally be accomplished at different times to reduce material handling and consequently costs.
• To help justify the purchase of a piece of equipment by insuring that the line will be operating the majority of the time, running one process or another.

What follows will be a number of hybrid arrangements. Each will be investigated, detailing changeover requirements going from one process to the next, and more importantly where the combined process limits the individual one.

Combination cast/coating line

What it does – A line that will run extrusion coating but can be re-configured to run cast film onto the laminator (casting unit).

Changeover needed – May need second chill roll, replace backing roll assembly with air knife, have ability to install vacuum box on die, screw change, and possible die replacement.

Where am I limited - Your cast film is going to limit what you can do with this arrangement.

• Die – Cast film utilizes special internals to more evenly distribute the resin. Extrusion coating use a basic “T-slot” internal configuration. Running cast film on an extrusion coating T-slot die can result in gels and longer purging times. The shorter land area in the T-slot die means less pressure generation, again reducing the quality of film you can make. This can also lead to the more viscous cast film resin running down the center of the die, making it difficult for your APC system to compensate. The shorter lands can also lead to increased die swell when running cast film products.
On the extrusion coating side, you can run an extrusion coating product on a coathanger die, but the internal geometry will not permit running an edge bead reduction die. Also, any extensive deckling destroys the positive flow paths created by the internal geometry.

- Carriage/laminator movement – Cast film lines traditionally have a stationary die. The curtain is stabilized first before the casting unit is introduced. Any adjustment is made by moving the casting unit. This is different then a traditional extrusion coating line where the laminitor is stationary and carriage moves.

Laminator movement is also needed to permit running at the 3 o’clock position when running extrusion coating product, and move to a 12 o’clock position when a cast film product is needed. Using a standard extrusion coating carriage without this extended movement would result in an increased air gap, slowing the cooling process of the film. This will increase the crystalinity of the final product, which causes reduced clarity.

- Chill roll finish – The chill roll finish in extrusion coating normally is either a mirror finish where optics are important, or something closer to 60 rms when stripability is needed. Cast film on the other hand, runs closer to 20 rms. Unless you change the chill roll you are either sacrificing optics or striping ability.

- Web path - The position of the stationary die in a cast arrangement can play havoc on how you will run your extrusion coating product if the extruders are not perpendicular but in line with the rest of the equipment. Placing the extruders in a perpendicular arrangement makes it easier to locate an unwind, a treater, and a coater/dryer.

- Screw design – In most all instances you need different screws for cast compared to coating. Fortunately, there are adapter designs that will permit you to change a screw without taking the die and feedblock (if coex) apart. This can change a 12 hour changeover to a 2 – 3 hour one.

- Winders – If a winder is to run both cast film and an extrusion coated product, it will need to operate in a very large tension window. Cast film line tension and winders are normally not much more than 1 PLI (pound/linear inch). This is the low end of what you see in an extrusion coating line and may not be sufficient to run certain laminate structures. However light flexible packaging and cast film can co-exist happily. Most dedicated cast film winders run jumbo rolls at a maximum of approximately 24” diameter. This is not sufficient to run extrusion coating products economically.

Dedicated cast film lines often use driven idlers because of the low running tension. This feature is rarely included in an extrusion coating line.

- Extrusion coatings traditionally operate at widths from 52 – 80” wide. Cast film often run at wider widths.

- Extrusion coating lines run with one or two extruders. Most cast film structures use 3 or more extruders.

**Bottom Line**

You need to be realistic on what you can expect in this arrangement. If running cast film off an extrusion coating line arrangement, realize that the compromises you need to accept. Unlike a dedicated cast film line, there will be differences in die design, and line configuration, which will result in a reduced quality cast film compared to a dedicated line.

You need to pick the right cast film product to run. LDPE and CPP are good candidates. Barrier films, PET, PVC, and stretch film is not possible to run because they require such specialized extrusion or winding equipment. The number of extruders you have on your extrusion coating line will often determine what cast film product you could run.
CAST EMBossing/EcTRUSION CoATING LIINE

What it does – Like the cast/extrusion coating line, this line is designed to run both an embossed product as well as an extrusion coated one.

Changeover needed – Depending upon the cast embossed pattern, you may need to change the chill roll. Depending upon the extrusion coating product you are running, a different screw may be needed.

Where am I limited - This combination is often used in the diaper film industry. The line is a cast embossed line with a non-woven introduced into the embossing nip, resulting in a coated non-woven used for a more cloth-like diaper backsheet. In this arrangement both embossed and extrusion coated products can be made effectively. The cast embossed station provides the cooling needed (either through dry or wet embossing) to cool the rubber roll in contact with the hot film during embossing. The limitation occurs when trying to run additional extrusion coated products on the embossed configuration.

- Nip configuration – Either dry or wet embossing requires a large rubber roll (20” +). The footprint created by this large of a rubber roll precludes running flexible packaging without a real wrinkle issue.
- Winder – Like the cast/extrusion coating option, the winder must be able to run the lighter tensions required for the cast embossed product and coated non woven product, and still handle the heavier tensions required when running traditional extrusion coating products.
- Unwind – some high speed diaper unwinds may use heat to fuse the non woven material to make continuous transfers. This design would not lend itself to running paper and scrim.
- Die – There are similar limitation as described in the cast/extrusion coating example.
- Extruder configuration – Like the previous example, putting the extruders perpendicular to the line simplifies running extrusion coating products on a cast/embossed line.
- Screw design – Both coated non woven and diaper film may be able to be run on the same screw. If additional extrusion coating products are to be run, an alternate screw configuration could be needed.

Bottom Line

This is one of the easiest hybrid line configurations to achieve. Adding extrusion coating equipment (Unwind. Treater) will permit you to run simple extrusion coated products. In addition to coated non-woven, the extrusion coating line could also run scrim (woven films) and light papers, but do not expect that you will be able to compete with high speed dedicated extrusion coating lines. Also, confirm that your unwind will work with both non-wovens, paper and scrim.
PRINTING OR EXTRUSION COATING

What it does – Have a primer coater with the ability to print.

Changeover needed – The changeover is made by replacing rolls in a basic primer coater to go from priming to a simple single color “logo” print. This can be done in a couple of ways depending on your printing process:

- **Gravure printing** – This is the simplest arrangement. The base piece of equipment is a two roll coating station. The changeover is made by replacing the bottom gravure roll with an anilox roll.

- **Flexo Printing** – It gets a bit more complex if you need to run a flexo print. You may require this if you are not simply doing a static print, but want to change a part of the print on a regular basic such as a date. In this instance you will need a three roll coater. The bottom anilox roll transfers the ink to the application roll. The web then is threaded between the rubber applicator roll and the back-up roll. The application roll can be provided as a sleeve system to accommodate quick changes in the print.

  A sleeve system on the applicator roll is needed if your print constantly changes. If the part of the print that changes is small (like a date), you could still use a gravure printer as described above, with a small ink jet printer used for the changeable print. The ink jet printer could be placed just before the winder.

Limitations

On the surface this seems to be a very simple hybrid system to accomplish as long as you are not talking about a major equipment changeover. Flexible packaging lines are good candidates since you often have a 2 or 3 roll prime coater which can be switched from prime coating to printing.

Dryer sizes for a water based primer should normally be sufficient for running similar speeds while printing. You must make sure that your inks are water based if your primer was water based.

The true limitation is the financial advisability of running a print on an extrusion coating line. This is discussed under the bottom line.

Bottom line

It is possible to turn a primer coater in an extrusion coating line into a single color printer. Costs would be minimal if running a gravure print, more costly if running a flexo. The question is will this change make economic sense. What is the income you can make on your extrusion coating line versus a single color printing line? Add this to the fact that an average extrusion coating line runs at 1000 FPM while a single color print line can easily run at 2500 FPM, and the economic viability of this hybrid arrangement takes a real hit. You would only look to make this change if your extrusion coating line not running 24 hours/day. What is more common is doing both extrusion coating and printing in line.
PRINTING AND EXTRUSION COATING

What it does – Permitting an existing extrusion coating line to print and extrusion coat in line.

Changeover needed – To both print and coat, you will either have to add a printing unit, or if you have a tandem line with two priming units, modify one of them as described in the previous example. 
Introducing a printer into an extrusion coating line is not a problem mechanically; the limitation is related more to the process.

Limitations  By combining two processes into one line, you are introducing the potential for an error in one process adversely affecting the ability to run the other. In a dedicated printing line, if a problem comes up, the line can be shut down then started up again once the problem is fixed. In extrusion coating, this is not the case. The extruder will need to be backed out and dropped to a drool screw speed until the problem on the printer is fixed. For the best of companies and the simplest of problems, that can mean a loss of 15 - 20 minutes of production time at a minimum. This loss of resin as well as production time goes directly against your bottom line.

Additionally, any time spent dialing in the printer and making proofs while the extruder is in line means additional waste. For a single color logo this may be little or no time. Multiple colors can mean more time and more waste.

Your labor can also add to your limitations. A person responsible for priming on an extrusion coating line may not be up to the task of running a printing unit. Printing problems such as blade wear and nip impression are similar to priming issues, but can more directly result in an unacceptable print. This may not be an issue for a simple logo, but unacceptable for something like a bar code.

Bottom Line - Scheduling can often lead you to determine what is best for your operation. Long runs with a consistent single color logo print can work as long as you have the equipment. Multiple colors requiring registration may prove too complex to attempt on an extrusion coating line.
ADHESIVE LAMINATION AND EXTRUSION LAMINATION

What it does – A basic extrusion coating line has an unwind, coater/dryer, laminator, auxiliary unwind, winder and extrusion station. An adhesive laminator has the same basic line equipment with the substitute of an adhesive laminator instead of an extrusion coating laminator. The combined unit will be able to run both extrusion coating and solution coating on the same line by having both an adhesive laminator as well as and extrusion coating station.

Equipment and Changeover needed

Coater/Dryer

Both an adhesive coating line and traditional flexible packaging extrusion coating line have a coater/dryer. That’s where the similarities end. The coater/dryer in an adhesive coating line has the potential to be more expensive and complex then one used as a basic extrusion coating primer applicator.

An extrusion coating dryer normally dries a simple polyamide primer with a 5% solids and a laydown of only ½ wet pounds per 3000 square feet. This may require a 15 foot roll dryer to run 1000 FPM. Adhesives can be much thicker with more water. An adhesive being applied at 60 lb per 3000 sq feet with up to 50% water will need a much different dryer. With the greater water content, the dryer will have to be larger; run hotter, or you will need to run much slower on a dryer designed just for a primer.

Due to the varied adhesive formulations, a single zone dryer may heat the solution up too fast causing it to skin over, reducing the ability to further dry the web. Due to these reasons a more expensive dryer may be needed.

Similarly, an extrusion coating line traditionally has a 2 roll gravure or transfer roll coater. A gravure coater may work fine if you are only putting down 10 – 15 lb/3000 sq ft. Depending upon the end product the adhesive laydown and solid percentage could be much higher, requiring the coater to do more splitting of the adhesive to get to your final coat weight. This is achieved by transferring from multiple rolls in a 3 roll or more coater. If the end finish of the coating is important, a reverse roll coater could be needed.

Adhesive coating may need multiple coater configurations, requiring a cartridge system to permit quick changes in the number and configuration of the coater rolls. Like the dryer example, the hybrid line will probably need a more expensive coater initially.

Laminator

To get the best of both worlds, the hybrid line should have both an adhesive laminator and extrusion coating laminator. Unlike the extrusion laminator which is designed to cool the incoming melt curtain, the adhesive laminator has a heated roll designed to reactivation the dried adhesive. You may ask why not simply provide a heater in the chill water loop of the extrusion laminator. This could be done, but the extrusion laminator’s location means the dried adhesive will go over a number of idlers before hitting the extrusion laminator. Also, the adhesive laminator is often designed with adjustable idlers for the primary and auxiliary web. The idlers insure an optimum pre-heating of the substrates before coming together. Using an extrusion laminator for adhesive lamination eliminates that advantage.

If both types of laminators are used on a line, you have options in supplying each laminator from your auxiliary unwind. The simplest way is to have two auxiliary unwinds. Alternatively, a secondary idler path can take the web from the auxiliary unwind at the extrusion coating position, over the extrusion laminator, to the dry bond laminator.

Limitations – Dryer size and coater configuration will determine the flexibility, speed and quality of any adhesive lamination you will create. The basic extrusion coating line configuration normally has the
winder too far away to permit running simply an adhesive coating (instead of lamination) due to picking of the adhesive as it goes over the transport idlers.

**Bottom Line** – This hybrid configuration comes down to paying the additional dollars for the more complex coater/dryer and the dry bond laminator. If you adhesive dries effectively and can be applied by a gravure coater, your cost increase drops.

You have to see if running a simple adhesive lamination on an extrusion coating line is cost effective. This configuration does give you the ultimate flexibility if you currently are doing adhesive lamination and plan to go into extrusion coating, but do not know if all your products will translate into the extrusion coating realm.
MULTI SLITTING AT WINDER

What it does – Instead of winding up a full roll then having it go to a slitter rewinder, simply run multiple slits at the winder. This theoretically reduces additional handling of your product, reduces scrap, and can eliminate the amount of equipment you need.

Equipment and Changeovers needed – There is minimal equipment changeover. You would need to initially purchase a winder and roll/shaft handling system with the ability to slit, spread and wind as well as offload and re-core shafts for multiple rolls. For slippery or difficult to wind materials, this would be a winder that has both center and surface winding ability.

A winder design to slit multiple rolls will need multiple slit assemblies. After slitting the individual rolls (strands) need to have at least a 1/16” - 1/8” separation while winding. So the web would have to be moved 1/16” - 1/8” times the number of strands you are trying to wind up. This is done in cast film regularly by simply having a bleed trim and reintroduced the bleed into the extruder as reclaim, but would be unacceptable in extrusion coating where the bleed would simply be waste.

In extrusion coating the separation would have to be accomplished by physically separating the individual webs. This can be done by single or by dual bowed rolls for separating multiple strands (usually 5 or more).

Bowed spreader rolls will open up the gap between rolls. Shaft deflection will reduce it. Once a web is slit, you no longer have the stiffness of the roll contributing to the overall stiffness of roll/shaft assembly. Instead the shaft alone needs to resist deflection. Deflection in the shaft can cause the strands to have dished edges and to move closer to each other as the rolls get larger in diameter. This can create interleaving which will cause you to lose the web. For this reason slitting in line will often require a larger diameter shaft to combat the deflection. This larger shaft diameter may not be acceptable for your end customer.

Shaft design can also be different when running multiple rolls. When winding non-extensible materials, very often a differential shaft instead of a locked-bar shaft is used. Trying to run multiple strands with a locked-bar shaft can result in rolls with different diameters, different surface speeds, and subsequently different draw of the web going into the rolls. This problem manifests itself with increased gauge variation and incompressibility of the finished roll.

Limitations – Slitting in line in extrusion coating is possible, but up to the point where the cost of potential downtime outweighs the advantage of running multiple rolls. Downtime can occur for a number of reasons which are prevalent in both single roll winders as well as multiple roll winders but the issues are multiplied for each roll in multiple roll winding. They include:

- Scrap or downtime for slitter set-up and maintenance. Even with computer controller automatic slitter positioning, the time to change the slitter positioning or to change out a worn slitter is time that your line is not in production making salable product.
- The shaft diameter and resulting core I.D. must have a sufficient critical speed to make roll changes at full production speed and must be stiff enough that shaft deflection does NOT cause excessive dishing and possible interweaving problems.
- Slackness and web wander – This can occur because of web bagging, roll to roll variation if a differential shaft is not used, wandering from web skew, and equipment alignment issues. Each one of these issues can cause you to lose a roll and shut the line down.
- Roll transfers – The transfer sequence must be aligned and calibrated to a much higher level then one transferring a single roll. If one strand does not transfer successfully, the entire line is shut down.
- Roll handling off the winder and the recoring and shaft loading must be efficient so that this does not affect the production speed of the line.
If running smaller diameters to prevent strand interweaving, the winder needs to have a fast enough cycle time to not effect over all line speed.

If your process in not under complete control, winding roll quality problems can occur. Complete control means consistent tension, gauge variation, line speed, coat weight, etc. It is rare to see this sort of complete control when running multiple extrusion products in short runs.

Attempting to slit in line when a process is not in complete control means any removal of defects will be much more complicated since the defect could then be distributed over multiple strands. A slitter rewinder will still be required as a secondary operation to remove defects from the incoming raw materials and/or from the extrusion coating line.

**Bottom Line**

Mechanically, there is no reason why an extrusion coating line cannot run multiple slits in line to a point. Extensible films and nonwovens are better candidates for inline slitting than non extensible materials such as extrusion coated paper and paperboard.

The problem is that the conditions needed to make this a profitable venture (long production runs and complete control of the process), are rarely seen. This limits the opportunities to take advantage of this hybrid design. Even if these conditions are achieved, putting slitters at the winder will never provide a roll equal to what you get off a dedicated slitter rewinder.

The best chance to make this design work is to run a dedicated, very controlled product with a single center slit or maybe two slits at a relatively small roll diameter.

**CONCLUSION**

You can increase the versatility of an extrusion coating line by incorporating a hybrid design. But this decision should be entered into lightly. No line designed to run multiple processes could run those processes as well as a line dedicated to just one product.

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WHY HYBRID DESIGNS?

- Reduce cost
- Increase Flexibility
- Fill up extrusion coating line
Line Evaluation

- What it does
- Changeover needed
- Where am I limited
- Bottom Line
Hybrid options to be evaluated

- Cast film/extrusion coating
- Embossed film/extrusion coating
- Printing on an extrusion coating line
- Print and extrusion coat at the same time
- Solution coating/extrusion coating
- Slitting in line
Cast Film/Extrusion Coating Line
Cast/Extrusion Coating Line

- **What does it do?**
  - Make cast film and extrusion coating on the same line

- **Changeovers needed**
  - Possible secondary chill roll, replace backing roll with air knife, add vacuum box and possible new die
Cast/Extrusion Coating Line
Cast/Extrusion Coating Line
Cast/Extrusion Coating Line-EC configuration
Cast/Ext. Coating Line – cast configuration
Cast/Extrusion Coating Line - Limitations

- Die land
Die Land Difference

Short Land

Longer Land
Cast/Extrusion Coating Line - Limitations

- Die
- Carriage movement causes die buildup
Cast/Extrusion Coating Line - Limitations

- Die land
- Carriage movement causes die buildup
- Chill Roll Finish
- Web path
Cast/Extrusion Coating Line - Limitations
Cast/Extrusion Coating Line - Limitations
Cast/Extrusion Coating Line - Limitations
Cast/Extrusion Coating Line - Limitations

- Die land
- Carriage movement causes die buildup
- Chill Roll Finish
- Web path
- Screw design
- Winders
Pick the right film – CPP and LDPE are good candidates.

You will not make as good a product as you would see on a dedicated film line.
Embossed Film/Extrusion Coating Line
Cast Embossed Film/Extrusion Coating Line

- **What does it do?**
  - Makes cast embossed film and extrusion coating on the same line

- **Changeover needed**
  - Possibly change screw and chill roll
Cast Embossed/Extrusion Coating - Limitation

- Nip Configuration
STEEL ROLL

LOAD

RUBBER COVERED ROLL

FOOTPRINT

STEEL ROLL
Cast Embossed Line
Cast Embossed/Extrusion Coating - Limitation

- Nip Configuration
- Winder design
- Die design
- Extruder configuration
- Screw design
Don’t expect to run high speed flexible packaging, but if you are looking to coat non-wovens, paper, and scrim, this hybrid design can work.
Print or Extrusion Coat
Print or Extrusion Coat

- What does it do?
  - Permit you to do a simple print or extrusion coat on the same line
- Changeover needed
  - Modify existing prime coater
Print or Extrusion Coat - Changeover

Gravure Coater

Smooth Roll Coater

Replace with Anilox Roll
Print or Extrusion Coat-Changeover

- Maintain Back-up Roll
- Rubber roll (possible sleeve)
- Replace gravure w/anilox
Print or Extrusion Coat – Bottom Line

- Make sure dryer size is sufficient
- Make sure inks and primer are compatible (solvent/water based)
- Cost to run flexo
- What does it cost you to run your extrusion coating line as a logo printing line?
Print and Extrusion Coat
Print and Extrusion Coat

- What does it do?
  - Permit you to do a simple print and extrusion coat on the same line
- Changeover needed
  - Modify one of the existing prime coaters or add a printer
Print and Extrusion Coat - Changeover
Print and Extrusion Coat - Limitations

- Time spent getting printing proofs is money lost on the extrusion coating line.
- Time spent with printer problems means backing out the extruder = 15 – 20 minutes minimum.
- Extrusion people are not necessarily printer people.
The longer the run the better this hybrid arrangement can work.

Single color logo has better chance of working than multiple color in register printing.

Be aware of requirement for flexo or gravure print before purchasing hybrid line or attempting retrofit.
Adhesive Lamination and Extrusion Coating
Adhesive Lamination and Extrusion Coating

- What does it do?
  - Permit you to make an extrusion coating and adhesive lamination or coating on the same line.
- Changeover needed
Adh. Lam & Ext. Coating – Changeovers needed

- More complex coater
Adh. Lam & Ext. Coating – Changeovers needed

Gravure Coater

Smooth Roll Coater
Adh. Lam & Ext. Coating – Changeovers needed

- Direct Gravure
- Offset Gravure
- 5 Roll
- 2 or 3 Transfer Roll
- Rod
- Reverse Roll
- Flex Bar
- Die
- Curtain Coating
- Air Knife
- Knife over Roll
- Dip & Squeeze
Adh. Lam & Ext. Coating – Changeovers needed
Adh. Lam & Ext. Coating – Changeovers needed

- More complex coater
- Larger and more complex dryer
<table>
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<tr>
<td>5% solids</td>
<td>56% solids</td>
</tr>
<tr>
<td>15’ dryer – 1 zone</td>
<td>60’ dryer – 3 zones</td>
</tr>
<tr>
<td>1000 FPM</td>
<td>600 FPM</td>
</tr>
</tbody>
</table>
Adh. Lam & Ext. Coating – Changeovers needed

- More complex coater
- Larger and more complex dryer
- Adhesive Laminator
- Adhesive laminator – separate or individual piece of equipment
Adhesive Lamination - separate unwind
Adhesive Lamination - separate unwind
Adhesive laminator – alt web path
Adhesive laminator - alt web path
Adh. Lamination & Ext. Coating – Limitations

- Upfront costs of coater/dryer and adhesive laminator will dictate flexibility of line.
What is the cost effectiveness of having this flexibility (larger up front cost)

What is the cost effectiveness of running adhesive laminations compared to extrusion coating.
Slitting in Line
Slitting in Line

- What does it do?
  - Run multiple finished rolls of the winder instead of taking a full width roll to a slitter rewinder

- Changeover needed
  - Purchase of more expensive winder up front.
Slitting in Line – Changeover

- Winder requires 1/16”- 1/8” space between individual rolls (strands)
- Require single bow roll (5 strands or less) or dual bow rolls
- Shaft needs to support slit rolls without deflection
2.970" 5 LEDGE SOLID STEEL
SINGLE 60" WIDE CENTERED 4800 POUND ROLL ON AT 85" LONG SHAFT

DEFLECTION AT ROLL ENDS .154"

WITH A SINGLE ROLL AT 4800 POUNDS THE DEFLECTIONS ARE .154" AT EDGES OF ROLL.
STRESS IS SAFE AT 17,000 PSI.
2.970" 5 LEDGE SOLID STEEL

TWO 30" WIDE, 2400 POUND ROLLS CENTERED WITH 1" GAP ON AT 85" LONG SHAFT

DEFLECTION AT ROLL ENDS .542"

WITH TWO 2400 POUND ROLLS CENTERED WITH 1" GAP THE DEFLECTIONS ARE .542" AT CENTER EDGES OF ROLL. BENDING STRESS IS NOT SAFE AT 37,000 PSI.
Slitting in Line – Limitations

- Winder requires 1/16”- 1/8” space between individual rolls (strands)
- Require single bow roll (5 strands or less) or dual bow rolls
- Shaft needs to support slit rolls without deflection
- Differential versus locked bar shafts
Slitting in Line – Limitations

3” Locked Core Shaft
Slitting in Line – Limitations

3” Differential Shaft
Slitting in Line – Limitations

3” Camlock Differential Shaft
Slitting in Line – Limitations

- Problems this introduces
  - Slitter knife axial runout
  - Neighboring strand contact
  - Slackness and web wander
  - Roll transfers
- Require complete process control
- Web defects
May work if:

- Minimal web width and product changes
- Process is very consistent
- Better if substrate is compressible
- Keep slits to (1 - 2)
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Presented by:

Please remember to turn in your evaluation sheet...