Executive Summary

Draw is one of the most common tools used by operations to improve the runnability of the machine. In order to improve web quality and increase machine efficiency, reducing web draw throughout the paper machine is essential.

Valmet has done extensive product development work in this field. Our concepts and ideas have been successful on numerous applications. As leader in this field, Valmet technology can be applied to all machine configurations with field proven process know-how available throughout the world.

The purpose of this article is to highlight some of the effects as they were recorded on our Pilot Machine. We will also illustrate how to combat the side effects of draw using the following tools: Release EQ, ReleaseEye, ReleaseGap, center roll coatings, HiDrain, TrimBox, HiRun, VacModification, and others.
Paper Making Draw Control Effects and Solutions

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Process Issues Related to Draw

Draw is one of the most common tools used by operation to improve the runnability of the machine. The first open draw experienced in a paper machine is off the first smooth surfaced center roll. Aside from making the machine more susceptible to web breaks and inevitable lower efficiencies, increased draws also affect final web properties. The purpose of this article is to highlight some of the effects as they were recorded on our Pilot Machine. We will also illustrate the required tools to combat the side effects of draw.

Sheet Properties - Papermaking currency

The sheet web is inherently created with a certain amount of currency (i.e. its internal properties). As it makes its way through the paper machine, some other properties are created. Unfortunately, as it makes its way through the machine, it also loses some of these currencies. For different paper grades, some of these currencies will have greater values. In the case of coated grades, light weight coated grades, and directory grades, porosity is a very sensitive issue due to the coating and printing processes to which the sheet will inevitably be subjected (especially in the case of LWC). During pressing, the invaluable sheet consolidation occurs where fiber-to-fine bonds are created. When the sheet is subjected to large open draws, these bonds are broken and thus create fissures in the web structure.

Draw, by definition, is the pulling of the sheet between one drive group and another. The forces used to create this draw, which break these fiber bonds, have other strength property effects such as Tensile Energy Index. Basically, the sheet becomes weaker, the more we pull it over an open draw.
Linting - Avoiding the intangibles
Although most sheet properties are measurable either on line, or in a laboratory, linting is a subjective property. The effect of this property will depend entirely on the utilization of the final product. It is clear however, that linting occurs when the fiber-to-fine bonds are broken. This linting can also manifest itself in the dryer section where high dryer can temperatures make fines adhere to the dryer surfaces. Unfortunately, as previously mentioned, this property is difficult to measure. However, it is known that when the draws are high, bonds are broken, which in turn can manifest itself as a linting problem.

Of course, there are plenty of other properties that are directly affected by the amount of draw used off of the center roll. The challenge therefore remains; how to find the correct solution to solve the appropriate problem.

Solutions - Applying proven technology
Before applying new technologies, it is important to understand what is occurring at the sheet transfer point, and to resolve these problems in order of their importance. The principal forces that must be overcome are the adhesive and pressure forces (Figure 3). Each one of these can be overcome, or at least minimized with different equipment.

Sheet Release - Center roll conditioning
The condition of the center roll surface is the primary factor that affects how the sheet will adhere to the center roll. Although the type and roughness of roll surface is very important, the manner in which it is conditioned is just as important. Conditioning a ceramic covered roll is accomplished by utilizing the proper showering techniques. In general, a ceramic roll surface needs to remain hydrophilic, and one variable, which permits this condition to exist, is having an even water layer on its surface. This water layer can only exist if the correct showers are utilized with a double doctor that can easily maintain an even profile. The Valmet Double Doctor (Figure 4) is designed specifically with high stiffness and low deflection values for this purpose. Along with the double doctor, the correct blade needs to be selected for the environment. Valmet’s wide range of ValEco blades will ensure that blade life is optimal while trying to maintain the ideal roughness.

Open Web Draw - The pressure component
Once the sheet is successfully off the center roll, it must be transferred with as little shear force as possible. However, this is difficult to do if the pressure differential on each side of the sheet is too high. In order to solve this problem, we must first minimize the amount of air in the area, and also on the surface area upon which this pressure reacts. This is accomplished with geometry changes in the area.
The next step is to minimize the pressure difference by negating the overpressure with, for example, a Release EQ device (Figure 5) adding pressure below the sheet.

**DrawManagement - your toolbox for draw issues**

Proper draw management solutions will solve draw related problems - without any major investments. The draw between the press and dryer section effects many issues. It has a great influence in web break sensitivity, Scott Bond and porosity, for example. When the draw exceeds 2%, the break tendency starts to increase very rapidly. This is why the right scope of draw management solutions, such as runnability components, trim management solutions and center roll geometry optimization, become necessary.

**Unique benefits**

Paper mills can achieve significant savings in pulp costs, when paper makers are able to choose pulp on the basis of quality, not properties that contribute to good runnability. This means, for example, that there is less need for refining or mixing in expensive Kraft pulp. Energy is also saved.

![Figure 5. Incoming (p1) pressure is countered by pressure from ReleaseEQ device (p2).](image)

![Figure 6. Valmet’s comprehensive scope of solutions for draw management](image)
Comprehensive range of solutions for draw management

Valmet offers the right solution for each draw management application. This means better runnability, fewer breaks, improved quality, and cost savings. Draws can be managed by appropriately combining the following solutions:

- **ReleaseEQ™ air curtain for center roll release control**: ReleaseEQ overcomes the pressure differential between the top and bottom sides of the paper sheet after the center roll by creating an air curtain under the sheet. This relieves sheet tension at the center roll and less draw is needed for sheet transfer to the dryer section.

- **ReleaseEye™ center roll release point measurement**: ReleaseEye is a measuring device for detecting and optimizing the sheet release point from the press section center roll.

- **ReleaseGap™ press section geometry optimization**: Optimizations may include changing distances between rolls, changing felt loop and roll geometries, modifying or replacing blow boxes or PressRun rolls, or combinations of these.

- **Center roll coatings**: Premium center roll coating options provide excellent release properties and perfect runnability.

- **HiDrain™ high-vacuum suction box**: The main advantage of HiDrain is its ability to provide maximum dryness after the forming section. Another advantage is an improvement in runnability because a drier web is easier to transfer to the press section.

- **TrimBox™ trim suction boxes**: TrimBox ensures that the edge trims follow the inner fabric down to the couch pit instead of getting picked up and taken to the press section. TrimBox provides better runnability and improved production line efficiency, as well as safer operating environment.

- **Nip load optimization**: New suction roll shells facilitate higher suction roll nip loads. This means improved overall runnability with reduced sheet break sensitivity.

- **HiRun System™ blow boxes**: The HiRun System concentrates on solving special runnability problems at the first dryer groups. Web release from the dryer cylinder is facilitated by means of a very powerful vacuum zone.

- **VacModification™**: Converting single-felted dryer groups into a vacuum roll concept improves runnability through high, adjustable vacuum levels and decreases web elongation due to larger roll diameters.

- **Dryer section modifications**: Changing group length and drive arrangement, and coating dryer cylinders.

The remainder of this paper will briefly review the DrawManagement tools individually.
ReleaseEQ enhances runnability

ReleaseEQ improves web handling after the center roll. It does this by optimizing the air pressure balance between the bottom and top side of the sheet, which results in less need for sheet draw (Figure 5). Thanks to this, ReleaseEQ enables speed increases and reduces paper porosity. In addition, it can be used to adjust cross direction tension profiles.

The device is equipped with a fully automated cleaning system (Figure 7) with connections to break automation controls. An integrated optimized lubrication shower for the center roll doctor blade keeps the roll surface clean.

ReleaseEQ typically has four individually adjustable CD zones for release line optimization.

Less draw is needed for sheet transfer to the dryers at existing machine speeds. As the total draw is reduced by at least 5% at existing machine speeds, there is potential for speed increases. In addition, due to the lower draw and lower tension in the sheet, the potential for breaks is reduced.

ReleaseEQ also provides improved sheet strength properties and better sheet properties after coating. The air curtain minimizes possible re-wetting caused by the center roll doctor blade shower.

ReleaseEye for optimized draw control

Draw differences between the center roll and the separate press or the dryer section affect press section runnability. The ReleaseEye measuring device uses a laser beam to locate the paper web release from the center roll in the press section. With this information you can reduce the number of breaks in the press section by adjusting the release point to the right position. For example, after a grade change it is important to know how the wet end operation has changed or how the center roll surface is doing.

The device is designed to withstand demanding paper machine conditions and it comes with an acid-proof cover and self-cleaning blow system.
For trend curve information and break control, the output can be connected to machine automation. The trend curves of draw differences and release point give valuable information of changes in wet end operation. The number of wet end breaks can be reduced by adjusting the release point from the center roll to the right position. The device can also be used as break detecting equipment at the center roll. On-line measurement and on-line drive speed control are possible. ReleaseEye allows continuous follow-up of the stability of the wet end process.

**ReleaseGap press section geometry optimizations**

With the ReleaseGap concept, any of the following open draw geometries may be optimized: PressRun roll distance from center roll, felt loop geometries (3-nip air handling), transfer and/or modification of PressRun blow boxes or replacement of existing transfer blow boxes, 1st and 2nd paper roll distances and geometry (4-nip), paper roll moving equipment (4-nip), and speed differences between main rolls.

With paper roll grooving in the 4th press position at one mill, draw was reduced from 0.92 % to 0.57 % at a speed level of 1400 m/min. Draw could have been reduced further at this mill if not limited by other drying section runnability. At another mill, grooving in the 4th press position reduced draw from 1.35 % to 0.95 % at a speed level of 1700 m/min, and decreased porosity. The same mill had excellent results with paper roll grooving in the center roll position.

Replacement of a conventional plain PressRun roll with a suction assisted PressRun roll can also reduce draw. On an LWC machine with a SymPress B press section running 1620 m/min, the press to dryer draw was reduced 0.3 – 0.5%.

ReleaseGap provides several benefits. Less speed difference at existing machine speed is needed for sheet transfer from press to dryers. Capacity is provided for speeding up the machine line, and potential for higher production is provided. Runnability in the PressRun area is improved. Breaks in the press and dryer sections are reduced. Sheet strength properties are improved, as are sheet properties after coating.

**Center Roll Coatings**

Enhanced press section functionality is the driving force behind Valmet’s ongoing research of coatings for center press rolls and shoe press counter rolls. When developing ceramic coatings, Valmet has taken into account the factors that have a crucial impact on roll runnability: sheet release, surface topography, surface...
charge and surface energy, dirt repellence, wear resistance, chemical resistance and doctorability. As a result, Valmet provides a premium ceramic coating option for every application. Coating options include PressGem W, PressGem F, PressGem E, PressJade and ValRok STD (Figures 12 & 13).

Ceramic coating Typical application Properties

<table>
<thead>
<tr>
<th>Ceramic coating</th>
<th>Typical application</th>
<th>Properties</th>
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</thead>
<tbody>
<tr>
<td>ValRok STD</td>
<td>• Standard applications</td>
<td>• Cost-effective</td>
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<tr>
<td></td>
<td>• Mechanical paper grades</td>
<td>• Reliable, proven solution</td>
</tr>
<tr>
<td>PressGem W</td>
<td>• Wood containing paper grades with high filler content</td>
<td>• Excellent release properties</td>
</tr>
<tr>
<td></td>
<td>• Long nip press</td>
<td>• High wear resistance</td>
</tr>
<tr>
<td>PressGem F</td>
<td>• Fine paper</td>
<td>• Excellent release properties</td>
</tr>
<tr>
<td></td>
<td>• Difficult sheet release conditions</td>
<td>• Superior doctorability</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Perfect runnability</td>
</tr>
<tr>
<td>PressGem E</td>
<td>• Paper grades with high filler content</td>
<td>• Hard and durable</td>
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<tr>
<td></td>
<td></td>
<td>• Premium wear resistance</td>
</tr>
<tr>
<td>PressJade</td>
<td>• DIP and TMP containing paper grades</td>
<td>• Excellent release properties</td>
</tr>
<tr>
<td></td>
<td>• Corrosive environments</td>
<td>• Premium runnability</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• High corrosion and wear resistance</td>
</tr>
</tbody>
</table>

Figure 12. DrawManagement includes a premium ceramic option for every application.

Ceramic coatings are ideal for the harsh conditions of center press rolls and shoe press counter rolls. Our new ceramic coatings are each made of two compatible layers. To further improve the excellent release properties and corrosion resistance of these coatings, we have included a special deep surface treatment for the ceramic material. The surface treatment compound, which Valmet has exclusively developed for these new coatings, penetrates into the pores of the ceramic layer. This treatment permanently enhances the ceramic layer, throughout its entire thickness.

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<td>800 – 1100</td>
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<td>500 – 650</td>
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<tr>
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<td>●●</td>
<td>●</td>
<td>●</td>
<td>●</td>
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Figure 13. Valmet’s ceramic coatings feature unique performance.
PressJade
Let’s take a closer look at one example, PressJade, Valmet’s new-generation ceramic coating for center rolls. Thanks to its revolutionary compounding, PressJade has unique surface properties not seen among ceramic coatings earlier. Like granite, PressJade makes the roll surface anionic. The negative surface charge together with the hydrophilicity of the coating provides excellent release properties. The draw remains low and stable. PressJade also exhibits a low tendency to collect deposits, which further improves the runnability of the press section. The raw material combination of PressJade makes it ideal for doctoring.

PressJade is extremely corrosion resistant. Conductivity, the measure of corrosion tendency, is as much as 100 times lower with PressJade than with competitive ceramic coatings. PressJade has specifically been developed for the demanding conditions of de-inked and thermo-mechanical pulps. It is at its best in the production of newsprint and LWC.

HiDrain for efficient dewatering
A HiDrain high vacuum suction box will yield maximum dryness and a uniform web after the forming section. Slots of the ceramic cover of the suction box are fitted with finger-like adjustor blocks that can be set at the required suction width.

The suction box features one suction chamber with an adjustable vacuum level. Drained water is piped out through the back of the suction box to a water separator. The suction box and suction piping have connectors for pressure sensors that can be connected to a video display.

The edges of the fabric are lubricated by three showers. The front of the suction box is equipped with a ceramic shower pipe that will extend the useful life of your forming fabric. A shower pipe is also mounted above the box to keep it clean.

The design of the box facilitates installation next to the pickup roll for minimal rewetting and maximum dryness.
The main advantage of HiDrain is its ability to provide maximum dryness after the forming section (Figure 15). This high vacuum suction box is so efficient that you may not need a suction roll before the box, and having a plain roll in this position will save you money. You also get a more uniform web after the forming section.

The HiDrain solution works excellently with rebuilds, and its construction is sturdy and vibration-free. HiDrain is self-cleaning and therefore requires minimal maintenance. Vacuum adjustment is handled by an automatic valve, and video monitoring for vacuum control is available as an option. The HiDrain high vacuum suction box is available for all machine speeds and widths.

**Trimbox for optimized edge trim control**

The TrimBox system consists of small vacuum boxes located under the pick-up roll on both the front and back sides of the paper machine. TrimBox ensures that the edge trims follow the inner fabric down to the couch pit (Figure 16), instead of being picked up and taken to the press section which can cause expensive felt damage.

Adjustment of the suction width can be equipped with remote control system for achieving operational safety, improved efficiency and utilization convenience.

The TrimBox suction piping is connected to existing high vacuum suction box line or equivalent, depending on the vacuum level required. The suction piping has an automatic valve that keeps the main pressure at a suitable level. The piping is designed with a descent to avoid plugging.

**Convenient design and benefits**

TrimBox has an acid proof frame with a slotted ceramic cover. Boxes are automatically lifted into their operating positions by pneumatic cylinders when the control system receives a ‘wire run’ signal from the machine control system.

Conversely, when the information ‘wire crawl, wire stop’ is signaled, the boxes are lowered. Without the remote control option, the suction width is adjusted manually with adjuster screws. A hand valve also makes it possible to fine tune the level of vacuum in the box. The under pressure levels used, depending on the drive speed, are between 15-25 kPa.

The TrimBox system delivers these benefits: better runnability, increased dry base paper strength due to reduced wet straining, safe operational environment due to the remote control, and savings in raw material. TrimBoxes are an
effective way to increase draw between the former and press sections.

**Nip Load Optimization with Duplok suction roll shells**

The powder metallurgical duplex stainless steel shell, Duplok, is perfect for suction rolls in the most heavily loaded positions. Duplok (Figure 18) allows for increased suction roll nip loading as well as increased machine speed. Higher press dryness results, with typical values depending on the press type: 0.3 - 1.0 % units for lightweight paper grades, 0.5 - 1.5 % units for heavier grades. This decreases steam consumption in the drying section, improves sheet wet strength after the press section, and improves overall runnability while reducing sheet break sensitivity. The benefits of Duplok include increased nip load capability and faster machine speed, which leads to more production.

Polyurethane cover (Figure 19) benefits include a longer felt lifetime due to soft roll cover. The soft cover also provides a longer nip which allows more time for water removal. There is also more open area due to grooving and/or blind drilling, which also makes for larger water removal capacity.

**Examples**

At one mill, a new Duplok shell with polyurethane cover was installed. Nip loading increased from 120 to 140 kN/m. Results included an increase in paper dry content after the press, a speed increase of 60-80 m/min, and a shorter felt start-up period with no reduction in felt lifetime.

At another mill, a new Duplok shell for the press suction roll was installed. The suction roll cover was changed from a hard coating to a polyurethane (blind drilled, grooved) cover which increased the open area. Nip loads increased significantly, with the first nip increasing from 85 to 100 kN/m and the second nip increasing from 95 to 120 kN/m.

**HiRun provides excellent sheet stability**

The HiRun System concentrates on solving special runnability problems on first dryer groups. The web release from the dryer cylinder is facilitated by means of a very powerful vacuum area. The HiRun web release zone guarantees that the web and the tail...
will follow the dryer fabric in all running conditions.

At the beginning of the dryer section, the web dries rather slowly. This means that, with increasing machine speeds, it becomes more difficult to maintain web stability. Due to the natural underpressure created when the paper web is separated from the dryer cylinder surface, the paper web is more inclined to follow the smooth cylinder surface than the dryer fabric (Figure 22). This critical bottleneck can be avoided by placing a proper runnability system in the first groups of the dryer section.

The HiRun System runnability concept offers solutions for different requirements depending on the grade and the targeted speed. The HiRun System is designed with a separate high vacuum zone where paper is taken off the dryer cylinder. This high vacuum area ensures tail and web transfer from the cylinder to the next VacRoll, and provides excellent runnability.

The HiRun System has many benefits, proven in production situations. It provides the potential to raise speeds, help tail threading and improve machine productivity. The system delivers these advantages: control of the web draws to optimize paper properties, fewer breaks due to reduced draws, higher production speeds due to improved web stability, faster tail threading, less sensitivity to changes in dryness, savings in furnish costs, and improved overall productivity.

VacModification

Converting single-felted dryer groups into a vacuum roll concept improves runnability through high, adjustable vacuum levels and decreases web elongation due to larger roll diameters (Figure 23). The web travels along both convex and concave surfaces, which causes paper elongation and contraction of up to 0.4%. As a result, the web’s tension falls and corrective measures are needed.

Web tightening is only possible at group gaps. Tension is enhanced through: large vacuum roll diameter, which leads to less elongation and contraction; and symmetric dryer fabrics which also provides less elongation and contraction.
VacModification benefits accrue in three main areas. The large roll diameter produces better runnability, less centrifugal force, more time for evaporation, maximum dryer felt wrap, minimum roll deflection, and minimum vibration. The roll design features no wearing parts, a high vacuum level, a large open area, and more effective edge support. The resulting paper quality benefits include less CD shrinkage, even tension profiles, uniform paper shrinkage, and uniform CD/MD ratio.

**Why employ the VacRoll concept?**

First, VacRolls provide excellent drying efficiency. They feature the longest web wrap on the dryer cylinder, and the longest evaporation time at the VacRoll.

Second, VacRolls provide the best runnability. There are high and adjustable vacuum levels. The web elongation is the lowest due to the largest roll diameter. There is high vacuum inside the roll even without the web, which makes tail threading and web widening easy and fast.

**Dryer Section Modifications**

Dryer section modifications fall into several areas, including changing group length, drive arrangement, cylinder coating and gap modification. It is important that dryer groups are small enough to prevent the web from slacking. VacRoll diameters must be sufficiently large. Drive positions at the end of the group are critical. A totally supported sheet transfer will minimize draw. The DryOnyx Z thermal release coating (Figure 25) is the preferred dryer cylinder treatment for superior release properties.

Benefits of dryer section modifications include excellent release and non-stick properties, minimized draw, easy broke handling, improved tail threading, superior cylinder surface wear, increased efficiency due to improved runnability and fewer breaks.

**Conclusion**

As machine speeds increase, draw related problems increase exponentially. Wet end draw continues to be a source of discussion among paper makers. Valmet's field proven technology applied throughout the industry can contribute to the successful process efficiency improvements for paper and board producers.

*This white paper combines technical information obtained from Valmet personnel and published Valmet articles and papers.*

*Valmet provides competitive technologies and services to the pulp, energy and paper industries. Valmet's pulp, paper and power professionals specialize in processes, machinery, equipment, services, paper machine clothing and filter fabrics. Our offering and experience cover the entire process life cycle including new production lines, rebuilds and services.*

*We are committed to moving our customers' performance forward.*