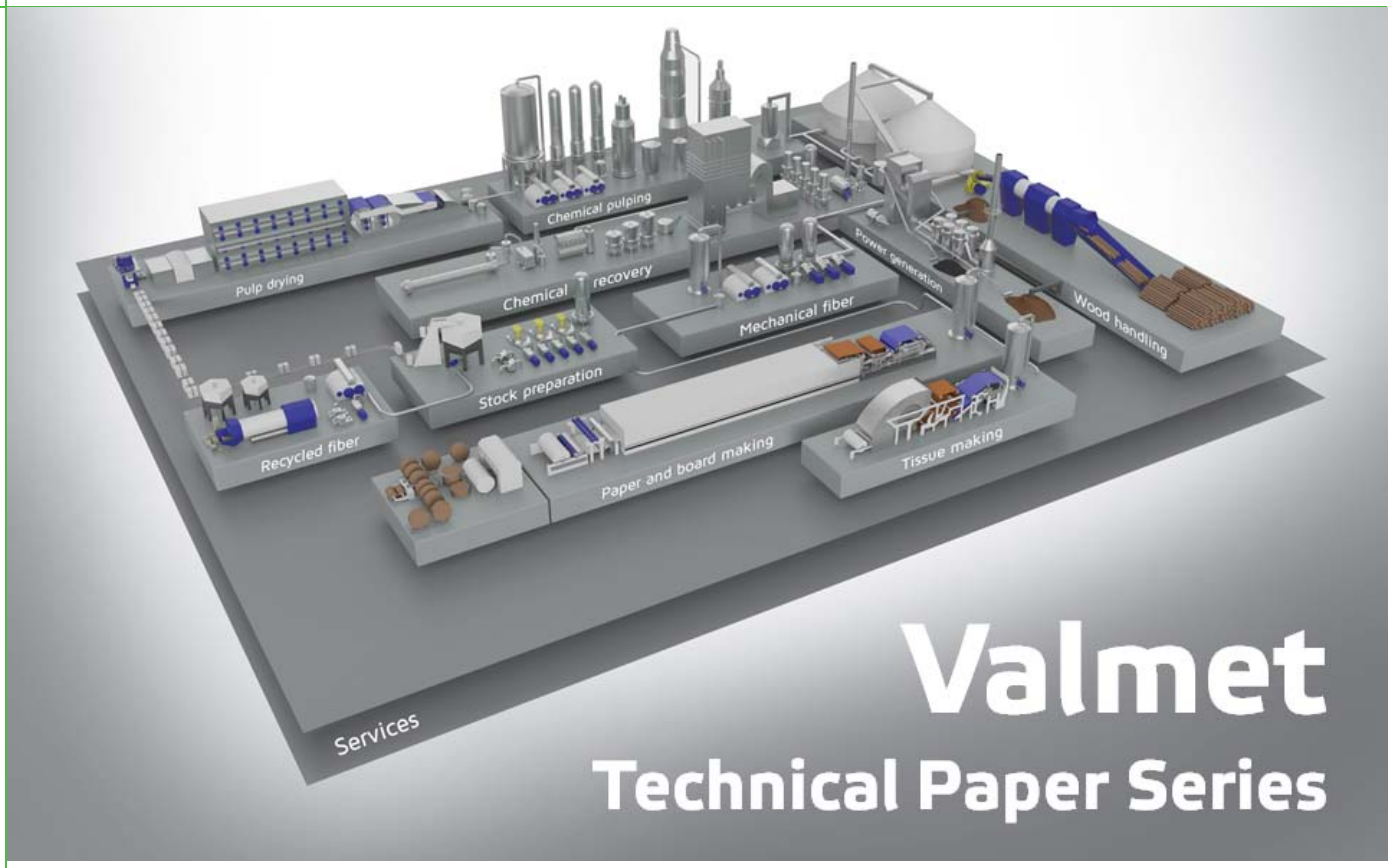

360ºRolls - performance and cost

Executive Summary

By questioning their current operating models, paper mills greatly increase the chances of success in the search for lower costs, better availability, and higher efficiency. Valmet's new 360°Rolls approach enables papermakers to achieve better results with a 360° view of rolls and the roll environment. Rather than concentrating on single products, the focus is firmly on the whole process, including production and maintenance.

With 360°Rolls, Valmet makes its papermaking, equipment and process expertise, workshops and service centers available to mills in a close, jointly beneficial partnership to increase mill performance while lowering total mill costs.

This white paper describes the 360°Rolls concept, with analysis of each area of benefit in terms of revenue impact, asset management, lifecycle costs and risk mitigation. Examples of the proper use of current rolls technology are presented, as well as common roll-related challenges that can be overcome with the 360°Rolls approach. Roll cover technology is briefly presented, as well as the multi-tiered customizable agreements structure of 360°Rolls. The paper ends with a comprehensive review of several 360°Rolls case studies.

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Up with performance, down with cost

Rolls account for as much as 60% of the value of a paper machine, which means their optimal performance is crucial. Roll changes lead to a lot of downtime, especially if those roll changes are unexpected. Roll performance has an impact on, for example, sheet release, paper profiles, paper quality, and dewatering, and all are directly connected with the results achieved. In addition, rolls can also limit the production efficiency of the machine.

360ºRolls sees the big picture

360°Rolls – Valmet's new approach to roll maintenance – addresses the mill's main business drivers. It means deep understanding of the customer's production and maintenance processes and how different factors, such as fabrics, roll covers, and doctor blades, have an effect (**Figure 1**). The papermaking process functions at its best only when all factors related to rolls perform well and seamlessly together.

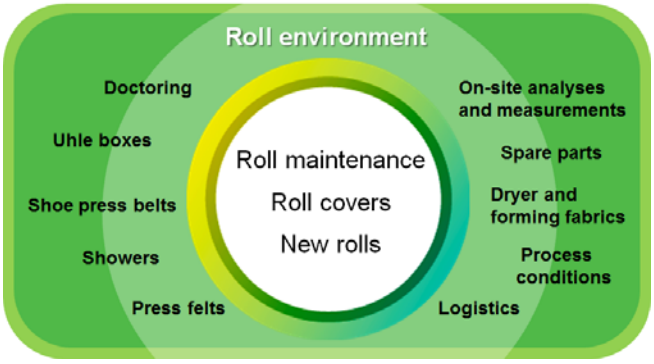

Figure 1. In the new 360°Rolls approach, roll maintenance takes into account the entire roll environment. The papermaking process performs in the best possible way if all factors related to rolls perform well and seamlessly together.

Cooperation between the papermaker and Valmet in roll-related issues is the foundation of 360°Rolls. The joint goal is to lower roll life cycle costs and increase the cost efficiency of the paper machine. Cooperation also provides the mill with access to the latest results in energy efficiency, safety, end product quality, and materials technology through Valmet's continuous R&D process.

Increased revenues from operations

It is now harder than ever to achieve revenues from papermaking; and as already stated, rolls play a major role in this. By improving roll availability, unexpected downtime can be avoided. Further, by extending roll lifetime and avoiding possible failures, production line efficiency can be improved. Good roll performance also improves paper quality and increases the amount of saleable tonnes.

Process performance is improved, for example, with efficient dewatering and better sheet quality. Efficient dewatering results in savings in steam consumption and improves runnability due to an optimized forming section couch roll drilling pattern or press nip rolls that allow higher loading. Better sheet quality may come from QuickChange reel spools that reduce bottom waste or zone-controlled press and calender rolls improving profiles.

Revenue is also generated by improved roll runnability. For example, press center roll and dryer cylinder release coatings reduce press-to-dryer draw and decrease sheet breaks, with PressJade ceramics for the center roll and DryOnyx H release coating for dryer cylinders. Better runnability is also obtained due to higher dryness from couch suction roll or press nip rolls.

Putting assets into productive use

Traditionally, mills have invested in their own roll maintenance tools, staff, and roll workshops. However, considering how to use assets in the most efficient way and how much should be tied into rolls can pay off. It should also be remembered that maintaining and developing the capabilities of staff is not free either.

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Figure 2. The benefit of the new approach is the added value that comes from better paper machine efficiency through increased roll reliability, control changes, better doctoring or energy savings, among others.

Investment costs are lowered due to longer roll lifetimes. Suction roll shells with accurate drilling patterns, the correct dimensioning, optimal shell material and high surface smoothness yield long lifetime expectancies. Rolls with a low level of vibration enable longer cover regrinding intervals and improved felt lifetimes, while reducing vibration-related process disturbances. These characteristics are found, for example, with high-precision tube rolls and coater backing rolls, deflection-compensated rolls with active vibration dampening, and covers with better marking resistance and high wear resistance.

Minimized risks

Every mill wants to minimize risks, including maintenance-related risks. One way to do it is to ensure maintenance efficiency. Risks increase when the skills and experience of staff disappear as specialists retire or resources are otherwise cut. Maintenance planning and implementation as well as foreseeing necessary investments call for experience and special know-how. Risks are also presented by the availability or quality of spare parts. Problems can also arise when the maintenance history of rolls is unknown.

Risks are minimized by preventing unexpected shutdowns with improved reliability and availability. Highly reliable, current technology rolls result in fewer roll-related unexpected shutdowns and increased production. Fully compatible spare rolls fit easily into the machine and utilize common main spare parts. Roll condition monitoring further improves reliability, for example C-type suction rolls with vibration sensor monitoring the condition of the pilot bearing, or FinBow spreader rolls with vibration sensors.

Lower life cycle costs

Roll life cycle costs are made up of upkeep, service and repairs. Under- or over-servicing increases costs, not the other way around. However, the highest costs arise from disturbances that lead to shutdowns. One way to lower life cycle costs is to use resources efficiently (**Figure 3**).

The new 360°Rolls thinking is about optimizing, sharing work and allocating resources correctly. If a mill has its own strong resources, Valmet provides only maintenance support and expertise. However, if there are no such resources, Valmet can be more actively involved in the mill's daily operations. It is not a question of outsourcing maintenance but about using resources efficiently.

Lifecycle cost savings are achieved by many factors. Reducing maintenance costs is accomplished by extending maintenance intervals and/or reducing the number of wearing parts. This is achieved by using non-contacting Valmet Seal Strip Lock suction roll seals, durable less wearing roll covers such as polyurethane or ceramics, zone-controlled rolls with hydrostatic/dynamic lubrication, and efficient cleaning showers to keep suction rolls clean.

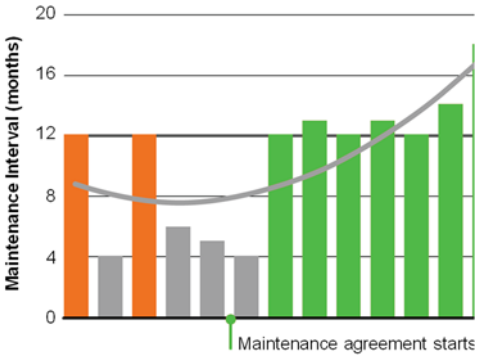

Figure 3. Taking the right measures at the right time lowers costs. This real-life example shows the impact of proactive maintenance on couch roll lifetime.

Costs can also be reduced by lowering friction which leads to lower power consumption. This is accomplished with suction rolls with non-contacting seals, zone-control with reduced oil load, and dryer cylinders with a release coating producing less doctoring friction.

Steam consumption savings at the dryer section are gained due to the higher dryness in the wet end with proper press rolls and couch suction roll. Water consumption is reduced with suction rolls having efficient internal oscillating high-pressure showers (used periodically), and non-contacting suction seals which can be operated with less lubrication water (on a case-by-case basis).

Documentation and training – keys to learning and developing

It should be stressed that nothing changes in the new 360°Rolls approach unless a mill wants change. For example, if the staff has always changed roll seals during scheduled maintenance shutdowns, they will continue to do it in the future. However, if needed, Valmet will provide them with better instructions and perhaps some additional training. Special attention is paid to documentation since maintenance history data can be useful in developing roll maintenance.

Operators observe roll performance and document its impact on the process. All additional information makes it possible to better understand what kinds of disturbances occur on the machine and for what reasons rolls come out of the machine. Based on this information, measures can be taken to extend roll lifetime and thus increase the operational hours of the machine.

Thousands of papermakers have attended Valmet's Roll Maintenance School (**Figure 4**) since it was established in 1990. This course is designed for mill maintenance and operations personnel. Also, it is an ideal opportunity for anyone needing an increase in his or her knowledge of rolls. The unique course offering provides interactive classroom instruction conducted by experienced adult educators involving hands-on learning opportunities and classroom problem-solving exercises.

Figure 4. More than 2400 papermakers have attended Valmet's Roll Maintenance School since its inception.

Added value is demonstrated in efficiency

Roll maintenance generates costs regardless of who is responsible for it. The benefit to the paper mill lies in the added value that comes from better paper machine efficiency through increased roll reliability, control changes, better doctoring or energy savings, among others. Learning new things, in turn, adds to the staff's motivation, their willingness to develop themselves, and their ability to observe roll performance better. This all leads to more efficient operations, eliminates online risks and reveals improvement needs.

Good results from around the world

Valmet's committed specialists in a global network of over 20 roll service centers are easy to reach and eager to help. By working together, the right solution for each customer's specific needs will be found. Entering cooperation is easy and flexible; no major background work or investments are needed. The 360°Rolls approach has been successfully applied to production equipment maintenance at several paper mills around the world – with good results.

Improving roll performance with the latest technology

Valmet's roll technology adds value to mill operations by improving roll performance with the latest roll technology. This positively impacts revenue, lifecycle costs, assets and risks.

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During the last 50 years, Valmet has delivered thousands of rolls to the paper industry worldwide. Valmet makes over 2000 new rolls annually. This vast experience is utilized in roll dimensioning and material selection. As a result, we are able to offer highly reliable and long-lasting rolls for your needs.

As a supplier of complete papermaking lines, Valmet has a thorough understanding of papermaking processes. This know-how is used in designing rolls that provide maximal process performance, such as forming section suction rolls whose construction and shell drilling pattern have been optimized for powerful water removal.

Figure 5. Due to a number of mergers and acquisitions, Valmet has access to a vast library of original roll manufacturing drawings.

Fully compatible spare rolls

Many paper machine manufacturers have over time merged with or been acquired by Valmet, or Valmet has purchased their intellectual property rights (**Figure 5**). Valmet therefore has access to a vast library of original roll manufacturers' drawings.

The dimensions of new spare rolls are verified utilizing these original drawings or by taking roll measurements at the mill. This way we are able to make compatible spare rolls for any machine, regardless of the original machine/roll supplier.

High manufacturing quality

Valmet's rolls are manufactured to the tight tolerance requirements of new high-speed machines. They consequently provide excellent runnability with a low level of vibration under all operating conditions.

As an example, our high-precision tube rolls utilize advanced center balancing technology. These rolls provide high balancing accuracy and low level of vibration on their whole operating speed area (balancing class G1.0).

In the case of suction roll shells, high manufacturing quality means a precise shell drilling pattern and high hole surface smoothness, both of which reduce the risk of corrosion fatigue cracks and thus increase shell lifetimes.

Roll technology based on strong R&D

Valmet actively develops its roll technology to meet the growing demands of the papermaking industry. Pilot paper machine trials can also be utilized as part of this development work (for verifying the process performance of a new suction roll shell drilling pattern, for example).

The common goals underlying all of this development work are better process performance, improved runnability, higher roll reliability, and reduced need for maintenance. Here are a few examples of these roll technology innovations (**Figure 6**):

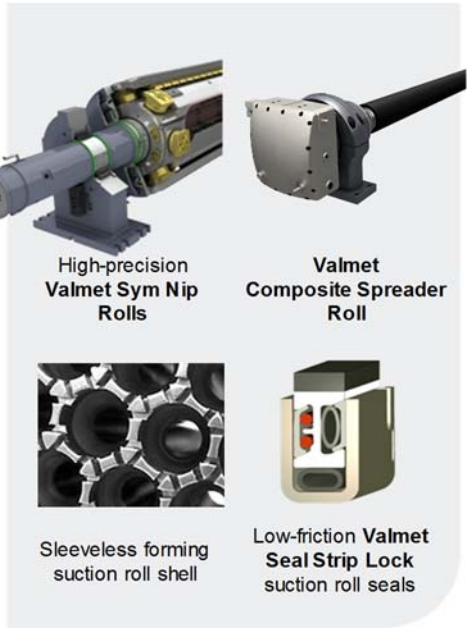

Figure 6. Valmet's roll technology relies on continuous research and development.

- High-precision deflection-compensated rolls incorporating slide bearing support instead of conventional roller bearings. For deflection-compensated rolls, we have also developed active vibration dampening systems that reduce nip vibration and barring.
- Valmet Composite Spreader Roll with a shell made of advanced carbon fiber composites.
- Grooved drilling patterns for forming suction rolls. Additional grooves even out the flow of water from the web to the suction holes and thus improve sheet quality (reducing hole shadow marking and hole defects in paper). With certain grades this pattern eliminates the need for a shrink sleeve (=savings in maintenance costs).
- Non-contacting Valmet Seal Strip Lock suction roll seals. Because of low seal wear we have seen suction rolls exceeding two-year maintenance intervals. The seal also reduces drive power consumption and suction roll noise.
- Ceramic press center roll coatings with high durability and excellent sheet release properties

Roll solutions for every need

Valmet can offer different roll options depending on a mill's particular needs, whether a spare roll, an improved spare roll or a roll upgrade.

A **spare roll** may be a complete replica of an existing roll. Fully compatible and common spare parts can be used for both rolls. As an example, a lead roll could have a spare roll like this. Valmet has also made some spare rolls for old Beloit/Mitsubishi-technology rolls (such as CC-rolls, Bel-Run and Pocket ventilation (PV) rolls).

Valmet can also make an **improved spare roll** that is externally fully interchangeable with the original roll but internally based on our latest roll technology and improved materials. This type of a roll is easy to install in the machine and it offers many of the benefits of the latest technology, such as improved process performance, better runnability and reduced need for maintenance. A typical example of an improved spare roll would be a suction roll with higher-strength shell materials, an optimized drilling pattern, non-contacting axial seals and a powerful internal cleaning shower.

In the case of a **roll upgrade**, old rolls are replaced with rolls based on the latest technology. This option offers the highest performance and best runnability. Increased nip loads, higher machine speeds or better control of sheet profiles could also be targets for a roll upgrade. A roll upgrade is a more expensive option because it may require the purchase of several rolls at the same time and changes in the machine frame, roll hydraulics and automation system. A couple of examples are: a ceramic-coated center roll to replace an old granite roll, and a zone-controlled deflection-compensated roll to replace an old swimming roll.

Potential roll improvements are virtually unlimited, depending on the section and results desired.

Here are some examples, section-by-section walking down the machine line:

- Forming section
  - Center supported roll to replace curved spreader roll ⇒ higher reliability reduced need for maintenance
  - Grooved forming roll shell ⇒ reduced need for maintenance due to elimination of shrink sleeve (board, newsprint), ⇒ better sheet quality and possible production increase (with shrink sleeve) SC, fine
  - Straight through drilled couch suction roll shell to improve sheet dewatering
- Press section
  - New nip roll(s) to enable higher nip loads & higher sheet dryness (e.g. ceramic center roll, zone controlled rolls, new suction roll or stronger shell).

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- Ceramic center roll to replace granite roll ⇒ higher loading, higher speed, better release
- Deflection compensated roll technology upgrade (swimming roll / CC-roll ⇒ Valmet Sym Nip Roll or CC-roll / swimming / Valmet Sym Nip Roll ⇒ Valmet SymZS Nip Roll) ⇒ less power consumption & vibration, better profilability, more load

- Dryer section
  - Replacement of steel lead rolls with bigger steel rolls or same size composite rolls ⇒ enables higher machine speed
- Sizer & Coater
  - Curved spreader roll replaced by Valmet Composite Spreader Roll ⇒ less maintenance, even spreading
  - New high precision coater backing roll ⇒ better coating quality
- Calenders
  - Supercalender 3-sectional fly roll replaced by Valmet Composite Fly Roll ⇒ better spreading, less need for maintenance
  - Curved spreader roll replaced by Valmet Composite Spreader Roll ⇒ less maintenance, even spreading
  - Supercalender filled paper roll replaced with polymer roll ⇒ longer grinding interval, less speed and load limitations
  - Valmet Thermo HT Roll for calenders ⇒ higher surface temperature, less barring, energy savings
  - Deflection compensated roll technology upgrade (swimming roll ⇒ Valmet Sym Nip Roll, CC-roll / Valmet Sym Nip Roll ⇒ Valmet SymZS Nip Roll) ⇒ less power consumption & vibration, better profilability, more load

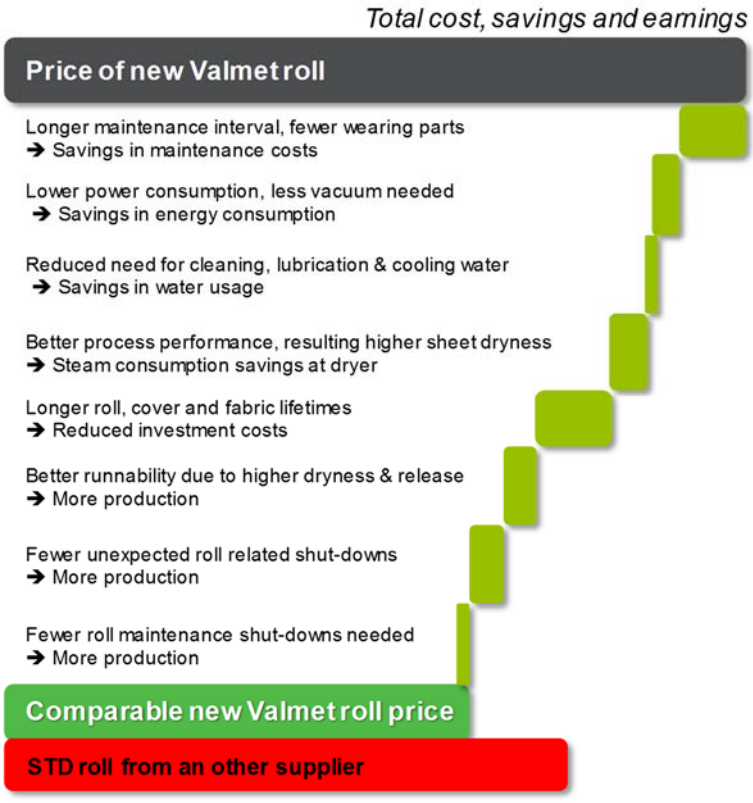

Figure 7. Valmet's state-of-the-art roll technology provides better total reduced lifecycle cost.

- Reel
  - New heavy duty reel spools with quick change heads ⇒ less bottom waste, easier to repair
  - Curved spreader roll replaced by BowMaster composite spreader roll ⇒ less maintenance, even spreading
  - New reel drum with soft roll cover ⇒ better reels
- Winder
  - New winder drums with soft roll cover -> better winding results

Improving roll performance with the right solution

Roll-related challenges can be overcome with 360°Rolls agreement-based cooperation, which offers the highest added value to your process. Examples of these challenges are shown in **Table 1** and described further in this section.

Roll-related challenges (examples)
Poor suction roll cleanliness
Poor roll / cylinder cleanliness
Poor center roll release
Unexpected roll cover failure
Short regrinding intervals due to barring in calendering

Table 1. Examples of roll-related challenges that are addressed by 360°Rolls

Example: Poor suction roll cleanliness

A clogged suction roll shell or cover will reduce sheet dewatering. Poor sheet pickup will lead to poor runnability. Localized clogging will mark the sheet, which can be seen as streaks in the sheet. If a nipped roll gets clogged up, water will make a pond before the nip and cause micro-crushing of the sheet.

Caused by

Clogging can be caused chemically or physically. If the retention agent is not distributed well, or there is not enough of it, the chemical balance of the stock is disturbed and this will lead to pH level fluctuation. Another chemical reason is the type of fresh water available at the mill site. If water contains a lot of lime, it will clog up especially press suction roll shell holes. In some areas the fresh water used in showers causes shower nozzle and suction hole clogging, normally with white lime. In some cases suction box openings are designed in a way that causes shell clogging in localized areas.

Solutions

- If internal roll showers are not used appropriately, they will not clean the roll shell (**Figure 8**).
- Seal lubrication water alone is normally not enough to keep shell holes clean. According to OEM recommendations, shell cleaning showers should also be used when the sheet is not on but the roll is turning. As centrifugal force pushes water out of the roll, it will flush the shell holes.

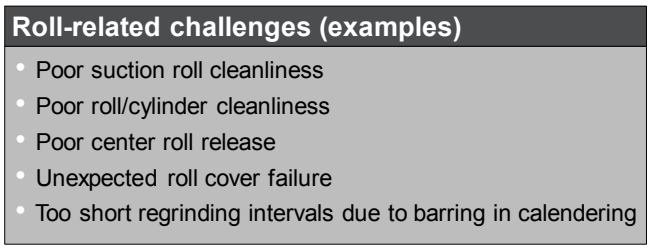

Figure 8. Possible solutions for poor suction roll cleanliness

- If a roll does not have a modern flow-thru shower, it can be equipped with one. The shower design allows mill personnel to flush the shower header line by operating a three-way valve at the end of the loop line.
- If the suction box design causes a clogging problem, the roll needs an additional internal shower to keep the suction box clean.
- In some cases, the suction box needs to be modified to minimize the sticking of stock to its walls. This is typically an issue when the mill is adding more recycled fiber to the stock mix.

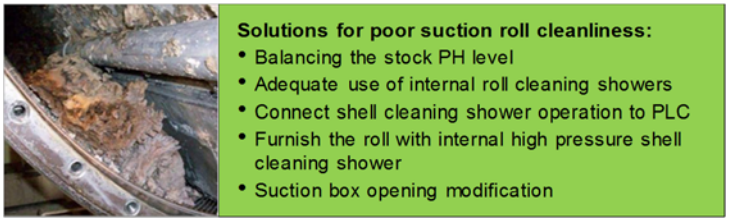

Figure 9. Cleanliness is a particular challenge in certain roll positions.

Example: Poor roll / cylinder cleanliness

A dirty roll / cylinder reduces the cylinder temperatures and drying capacity. It also increases sheet picking and dusting, resulting in an increased number of sheet breaks. Additionally, this lack of cleanliness produces uneven moisture profiles and corroded roll surfaces, and eventually roll cover damage.

Caused by

Several factors influence dryer cylinder cleanliness, including poor sheet release and a contaminated roll / cylinder surface. Moisture and chemicals may be causing corrosion and there may be insufficient corrosion protection. Doctoring and cleaning may be ineffective. The incorrect cover may have been chosen for the roll or cylinder.

Solutions

- Coating with proper cleanliness and release properties
- Optimized doctoring, efficient roll cleaning showers and improved cleaning of fabrics
- Use of release chemicals
- Process optimization (e.g. steam system and cylinder temperature controls)

Example: Poor center roll release

Draw between the press and dryer section increases with poor center roll release, as do fiber picking, sheet breaks and pass-throughs. Poor center roll release also generates tail threading and doctoring problems, and shortens the roll regrinding interval.

Caused by

A contaminated roll surface is a major cause of poor center roll release, including process-based substances such as pitch, binders, fines, fibers and fillers. Changes in process chemistry such as pH, charge and temperature, or changes in raw materials will also detrimentally affect release. Finally, non- or malfunctioning doctoring due to poor or incorrect equipment or parameters will negatively affect release.

Solutions

- Correct cover selection with grade-specific surface properties
- Optimized doctoring: blade type, load
- Shower water parameters: coverage, positioning, temperature, pH, filtration
- Root cause analysis and process optimization (chemical stability, broke flow, retention)
- Use of release chemicals

Example: Unexpected roll cover failure

Roll cover failures increase roll vibration levels, produce marking or holes in the end product, and cause sheet breaks. The result is decreased runnability with unexpected downtime due to roll changes.

Caused by

Poor nip loading or crowning, or roll misalignment cause cover failure, as do ineffective showers and inadequate roll cooling. Ineffective or incorrect showering and doctoring, and a contaminated roll surface or unknown object in the nip are also common causes of unexpected roll cover failure. (For more examples of causes and damage, see Valmet's "***Improving Cover Life***" white paper.)

Solutions

- Correct cover selection for each application
- Process and nip calculations to minimize risks

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- Preventive maintenance and roll cover condition monitoring
- Optimized doctoring and showers
- Maintenance and upgrades for loading and cooling systems and steambox
- Well-functioning web break monitoring system
- Roll cover patching service (even on-machine in some minor cases)

Example: Too short regrinding intervals due to barring in calender

In the special case of calender barring, an unacceptable vibration level from viscoelastic cover deformation and cover wear leads to paper marking and excessive noise.

Caused by

Synchronized nip vibration can occur for several reasons. There may be synchronized deformation of other rolls in the stack. Excitations such as gear vibration may be the cause. The roll cover may have been poorly ground. The vibration may be paper-initiated from nip to nip. The calender may be operating too close to resonance speed.

Solutions

- Avoid roll excitations, i.e. any vibrations in the calender, for example from gears.
- Optimize doctoring.
- Balance the rolls.
- Use a wear and deformation resistant cover, such as CalJaguar H.
- Use the Valmet fly roll / polymer roll offset device.
- Use the Valmet dampening system (for soft calenders).
- Exercise sufficient grinding: in the case of a barred cover, grind off enough to remove any 'memory'.
- Install a vibration monitoring system to predict shutdowns and optimize operating intervals.

Improving roll performance by optimizing maintenance

Roll performance is maintained by a combination of scheduled maintenance, roll reconditioning and roll modernization as shown in **Figure 10**. Roll maintenance impacts revenue in multiple ways: with improved roll performance through roll recondition or modernization, the removal of speed limitations due to the mechanical condition of rolls, and maximizing roll availability.

The longer roll lifetime positively affects the mill assets. Valmet can take responsibility for less frequent maintenance tasks requiring special expertise. There is no need to invest in expensive special equipment.

Lifecycle costs are reduced through optimized roll maintenance intervals, energy savings as a result of roll modernizations, and the

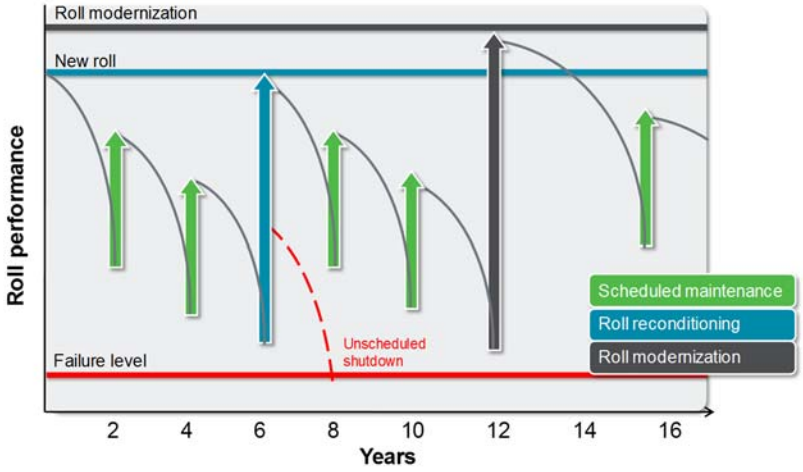

Figure 10. Roll performance is maintained by a combination of scheduled maintenance, roll reconditioning and roll modernization.

subsequent lower number of roll failures in the machine.

Optimizing roll maintenance reduces risk by using preventive maintenance planning. Spare parts are available during roll overhauls. A maintenance history supports preventive actions to remove known risks.

The 360°Rolls optimized maintenance program provides service for all roll types, makes and models. The maintenance services include - in addition to scheduled maintenance, reconditioning and modernizing - grinding, balancing, component repairs, dynamic performance analysis, service agreements and onsite inspections and services.

Adding value with roll covers

The choice of roll cover is critical, requiring in-depth product and process knowledge, and varies with every location on the machine and each mill's unique needs. The choice of roll cover affects revenue in several ways, for example: optimizing press dewatering through the latest materials and surface design, improving runnability with clean press and dryer roll surfaces, achieving higher quality sizing and coating, and reducing the vibration and planned roll changes at the calender. These goals are all achievable with Valmet roll covers (**Figure 11**).

From an asset perspective, cover monitoring and documentation by Valmet helps you know the condition

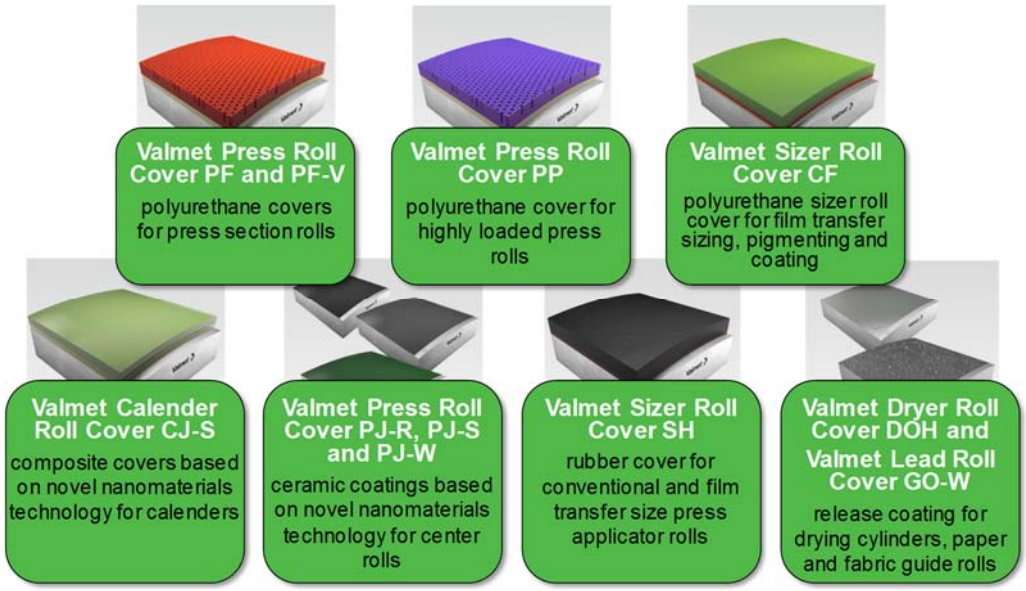

Figure 11. The correct roll cover is available from Valmet, optimized for your process conditions.

of your rolls. The roll covering and grinding history documentation help to plan and optimize the use of your grinding machine.

Valmet roll covers reduce lifecycle costs by extending cover life, resulting in less spending on roll covers. Optimizing roll running periods provides fewer roll changes and less maintenance grinding. Additionally, energy savings are achieved in pressing, drying and calendering.

Valmet expertise helps you select the most appropriate cover for each application and position. Unexpected corrosion-caused failures are eliminated. Comprehensive monitoring and documentation accurately predicts the regrinding and recovering intervals, thus avoiding unexpected roll failures.

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You are assured of benefiting from advanced technological know-how when choosing a Valmet roll cover. We use a full range of materials from ultra-soft rubber and polyurethane to ultra-hard carbides and ceramics. We develop cover products and use suitable production methods in all primary material groups for use throughout the paper machine. Our experience with all modern materials used for papermaking roll cover applications is extensive, including composites, polyurethanes, rubber, carbides, ceramics and chromium. Our global R&D network utilizes laboratories and testing equipment, including pilot machines for paper, board and tissue testing. Valmet's roll cover R&D is driven by the development goals of economy, reliability and reduced maintenance needs, producing the most optimal covers for all process conditions.

The 360°Rolls program takes care of your roll cover investment with specialized services. These Valmet services are backed by our materials knowledge, global benchmarking and R&D network. They include: service agreements; cover condition monitoring; nip and press simulations; process analysis services; onsite coating, inspections and services; troubleshooting and patching.

Improving the mill's bottom line with agreement-based cooperation

A roll service agreement with Valmet is an efficient way to minimize lifecycle costs. The agreement typically includes:

- optimizing the scope of overhauls so that targeted running times can be achieved,
- monitoring the condition of rolls in the paper or board machine to decide on the optimal time for roll changes, and
- ensuring proper maintenance and warehousing conditions to prevent mishaps.

Revenue is enhanced by optimizing roll performance with joint targets and efforts. The latest technology is brought into your process for optimum performance. Roll availability is maximized.

Your assets are protected with longer lifetimes of rolls and covers. Valmet can take the responsibility for frequent maintenance tasks. Your investment needs are minimized.

Optimized roll maintenance intervals improve your lifecycle costs. Valmet shares our best practices with you, related to roll covers and maintenance. The number of roll failures in the machine is reduced.

360°Rolls preventive maintenance planning minimizes your risk, including availability of spare parts and a comprehensive maintenance history.

The scope of a 360°Rolls agreement varies depending on mill goals (**Figure 12**). At the simplest level, an agreement will maintain roll availability. At the next level, the agreement also targets improved efficiency. The highest agreement level further optimizes performance.

At the Maintain level, the main purpose is to maintain the machinery. This agreement is based on fixed prices and scopes. The Improve level adds development aspects. In addition, there is a commitment to certain performance level and flat pricing per month. The

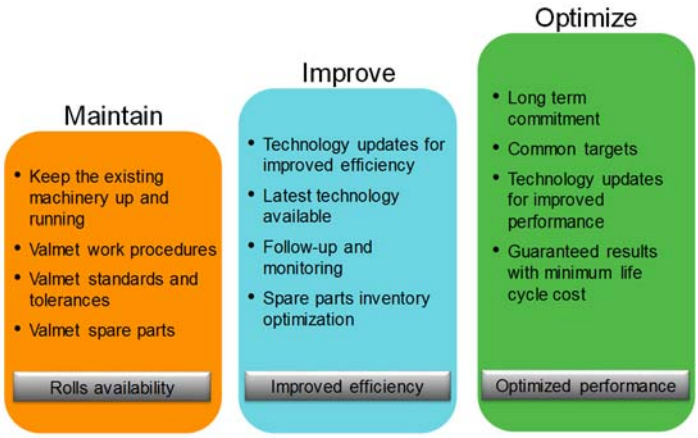

Figure 12. The 360°Rolls agreement level is based each mill's needs.

specific elements of each 360°Rolls agreement level are shown in **Figure 13**, but are customizable to each mill situation.

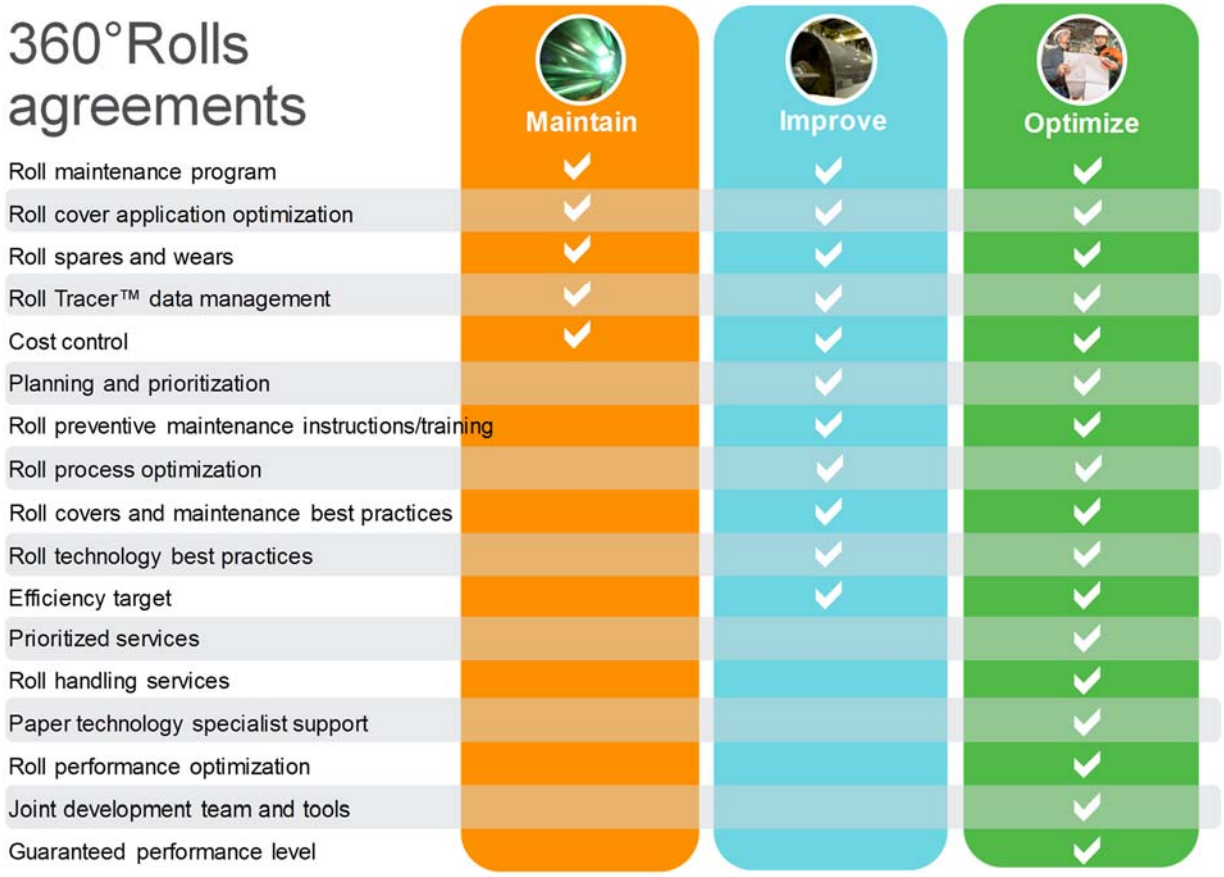

Figure 13. The components of each 360°Rolls service agreement

Depending on the level of roll maintenance management required, the 360°Rolls agreement can assume three models: mill workshop, Valmet service center or Valmet maintenance center at the mill. This is illustrated in **Figure 14** (next page).

Results achieved with the 360ºRolls program

The elements that make up the 360°Rolls concept have been in use for several years as separate services or agreements. They are now brought together in one comprehensive, tailored offering to mills worldwide. The following brief case studies illustrate results that have been achieved by mills around the world with various elements of what is now the 360°Rolls program.

Minimized unscheduled roll-related shutdowns with roll maintenance agreement

Roll maintenance agreements, as mentioned previously, do not have to be totally performed by Valmet. At the Holmen Paper, Hallsta paper mill a mixed maintenance model was chosen to start with. (They have since awarded Valmet the full responsibility for their roll services.)

The initial roll maintenance agreement with Valmet dates back to September of 2011, and included regrinding, scheduled maintenance and reconditioning, with Valmet personnel onsite. The mill made SC, MF journal and book paper grades, producing 670,000 metric tons per year on three papermachines.

Daniel Peltonen, the mill technical manager talks about the Holmen-Valmet mutual objectives: "We were faced with having to decide whether to upgrade our grinding machines to the latest standard and invest in new equipment. We calculated that the best course of action from a financial perspective would actually be to send the rolls to Valmet."

Mr. Peltonen goes further in explaining the background behind Holmen Paper's decision: "We have exceptionally high expectations for this agreement and I'm not just talking about the quality of roll grinding and improved maintenance. We also hope it will have positive effects on productivity. Through this agreement, we expect to be able to increase the availability of the paper machines by minimizing unscheduled roll-related shutdowns. The agreement is also designed to give us access to expert resources and the latest developments in paper machine maintenance."

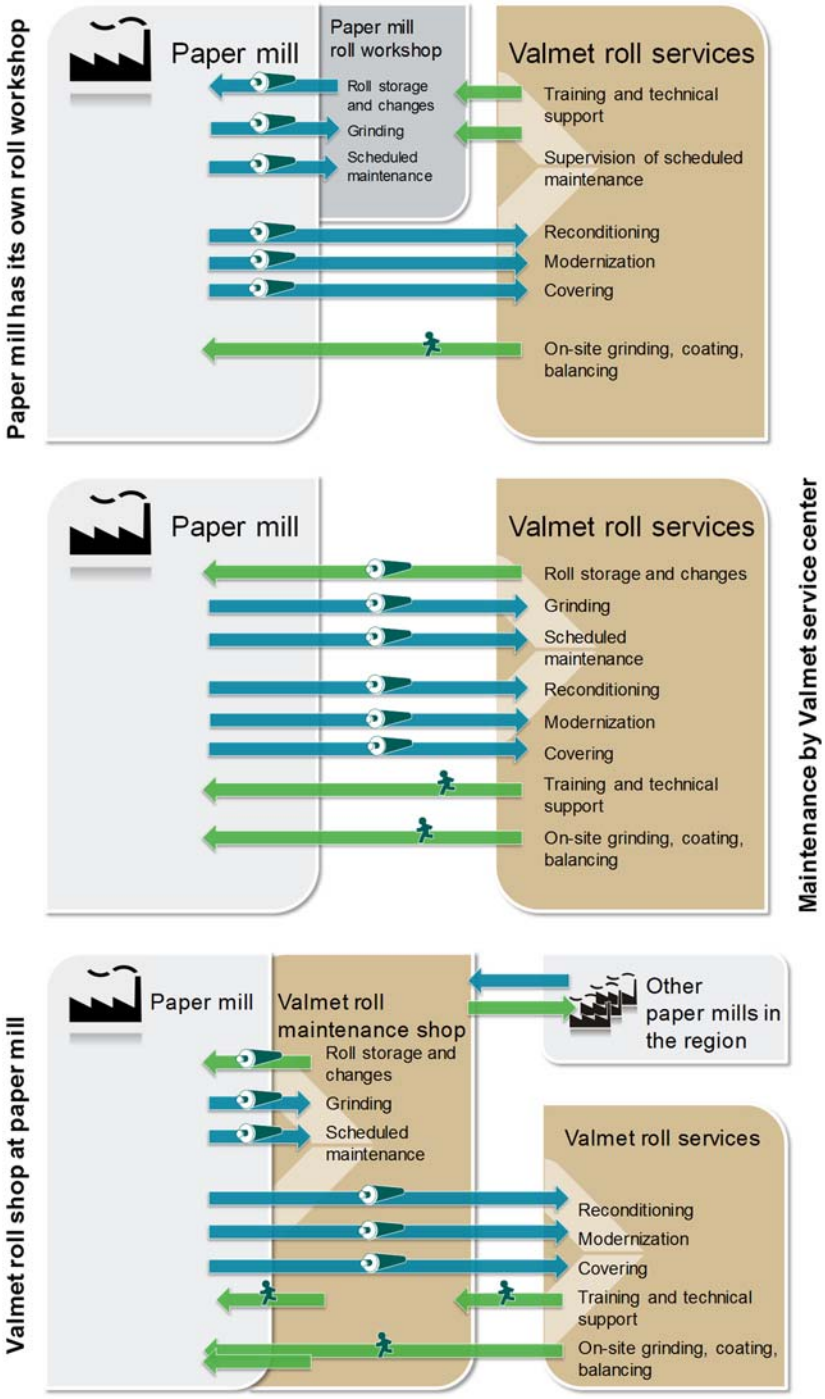

Figure 14. Maintenance management varies in a 360°Rolls agreement based on each mill's needs, equipment and expertise.

Regarding staffing, Mr. Peltonen states: "… as we have been forced to reduce staffing levels at the mill, the remaining workforce needs to be organized as efficiently as possible. This cooperation agreement is one way of meeting staff requirements."

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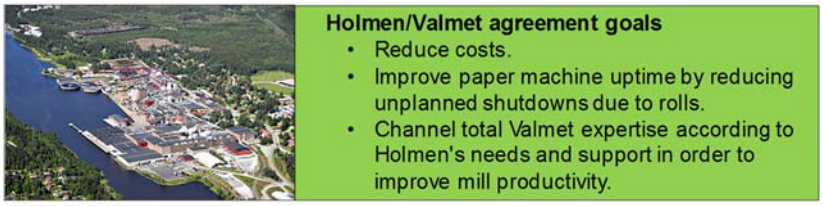

Figure 15. Main goals of Holmen/Valmet roll maintenance agreement

The quality of roll grinding, as it relates to equipment and expertise, was also another key factor in choosing Valmet. "So far, we've taken care of all roll grinding at our own roll workshop, but as things stand today the machinery needs to be modernized," continues Daniel Peltonen. "To run a roll workshop successfully, it must be cost-efficient and have a sufficient volume of work. So we were faced with having to decide whether to upgrade the grinding machines to the latest standard and invest in new equipment, or whether to find other solutions. We calculated that the best course of action from a financial perspective would actually be to send the rolls to Valmet's roll service workshop […], where they have the latest technology to perform 4-point measurements and 3D grinding. For us, the most important consideration when improving roll servicing is to improve the quality of the grinding work."

According to Valmet's service center manager for that region, Valmet has three men based at the Hallsta mill, creating opportunities to work more closely with the mill, and enabling Valmet to quickly identify any problems the mill is having. The Valmet maintenance engineer serves as an important link between Valmet and Hallsta, providing support for the mill's own maintenance personnel. Valmet's workforce also includes two maintenance technicians, whose main duties are to take care of on-site mechanical roll maintenance.

This approach is the best solution in terms of optimizing costs and avoiding unnecessary roll transportation. However, larger service jobs and basic maintenance are carried out at Valmet's regional roll workshop, where all necessary resources are available.

The service agreement remains in effect today, with the Mill Manager approving of the service level provided by Valmet at the mill site.

Increased production and improved efficiency

Green Bay Packaging contracted with Valmet to perform roll services over a five-year period from 2006 to 2011. The services were provided to their containerboard mill in Morrilton, Arkansas encompassing two papermachines.

The results for the first three years of this agreement were spectacular, with a 35% cost savings from roll lifecycle improvements ($1,220,682) and a 10% production increase resulting in margin improvement (net) of $5,220,000. According to the mill's production manager, "Green Bay Packaging reported an increase of 10% in production on the heavy weight grades. Later, there was also an increase on light-weight grades which assisted the mill in setting record machine speeds on all grades."

The mill has since given Valmet's regional service center their "Outstanding Supplier Award" for services rendered during the agreement. The agreement has been extended and may be expanded to another mill.

Documented high impact cost savings

In another Valmet onsite service agreement at a confidential mill similar significant results were achieved. This mill's three-year service agreement ran from 2006 to 2009. The agreement covered seven mills and eleven paper machines, of which ten were of Valmet manufacture.

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The documented results for the three-year contract include a 40% cost savings due to longer roll lifecycles ($2,560,500) and a margin improvement (net) from continuous improvement projects of $3,001,098. The mill renewed the contract for a second term after achieving such good results.

Since that time the mill has been purchased by another company, which has negotiated a new contract for all their mills. The range of cost savings due to the Valmet service agreement approaches 90% at some of these mills.

Excellent return on investment

Ponderay Newsprint was making newsprint with a wire width of 9.17m at a production speed of 1430 m/min on PM1 at its Usk, Washington mill. They modernized their rolls with Valmet Seal Strip Lock, hoping to reduce energy consumption.

The results proved the capabilities of Valmet Seal Strip Lock to deliver an excellent return on investment. The cumulative power savings on the suction press roll, suction couch roll and suction forming roll on PM1 were 550 kW. In addition, the suction rolls' noise level was reduced.

The mill planned to further modernize other suction rolls with Valmet assistance. According to the PM1 papermachine manager, "We intend to keep moving with it since we see the value."

Modernized roll	Power savings	Savings per year*
Suction press roll	185 kW	98,000 EUR
Suction couch roll	240 kW	127,000 EUR
Suction forming roll	125 kW	66,000 EUR
Total	**550 kW**	**291,000 EUR**

* 350 production days, 90% machine efficiency, cost of electricity .07 EUR/kWh

Table 2. Compact LocSeal, just one of dozens of roll modernizations, has helped Ponderay Newsprint to significantly reduce energy consumption on PM1.

Improved dewatering with press suction roll

The Stora Enso Sachsen Papier mill in Eilenburg, Germany is one of the world's top newsprint machines and has had a cooperation agreement with Valmet since startup for PM1. One common target has been to continuously improve the performance of PM1. The agreement includes four to five joint meetings each year, with targets of continuous production improvement, identification of bottlenecks, expert visits to address any problems, and minor investments.

The mill makes newsprint grade (100% DIP), with an average daily production of 890 tons, basis weight 40-52 g/m^2. The machine has a wire width of 10m and design speed of 1700 m/min.

The machine reached its limits in 2001. The key bottleneck limiting the speed of the machine was the draw required from the press center roll. The dewatering capacity of the first two press nips was insufficient. The production speed had to be reduced when running the heaviest 48.8 g/m^2 and 52 g/m^2 newsprint grades. Basically, there was too much water in the nip, which acted like "glue" and finally caused the sheet to break.

The mill, together with Valmet, targeted a minor rebuild to reduce the number of breaks and shorten break times. The mill also desired to increase press niploads while increasing dewatering capacity.

Press section analysis showed that a nip load increase at the press section was the solution needed. The desired outcome was confirmed with short test runs using increased nip loads in the 1st and 2nd press nips. The solution comprised a new press suction roll shell capable of carrying higher nip loads, with a new grooved and blind-drilled polyurethane cover. The cover had a larger open area as compared to the hard coating being replaced – 40.9% compared to the previous 18.5%.

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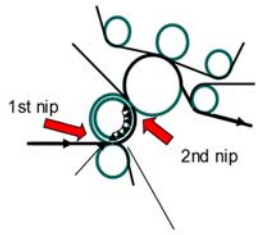
This solution made it possible to reach the desired nip load levels without a major press rebuild. The nip loads increased (1st nip by 13 kN/m, 25 kN/m in the 2nd nip). The suction roll vacuum level also increased by +5 kPa (**Figure 16**).

	Before	After	Difference
Press load in 1st nip	87 kN/m	100 kN/m	13 kN/m
Press load in 2nd nip	95 kN/m	120 kN/m	25 kN/m
Vacuum level in press suction roll	40 kPa	45 kPa	5 kPa

Suction roll installation



Press suction roll with a new shell

Figure 16. The new suction roll and poly cover at Sachsen Papier allowed for increased nip loads and vacuum level.

The results within one month of installation are shown in **Table 3**. They included improved press section water removal with all grades and speed increases due to higher sheet dry content. And all while maintaining good levels of machine efficiency, draw and steam consumption. There were no negative changes to paper quality (bulk and porosity actually improved) or felt lifetimes. Therefore, there was no need to change the press section felt types.

Newsprint Grade (g/m²)	Previous max. speed (m/min)	New max. speed (m/min)	Speed increase (m/min)	Addition production (tons/day)
45	1650	1700	50	26
48	1600	1690	90	50
52	1540	1690	150	90

Table 3. The improved press section water removal enabled higher speeds and corresponding increases in production at Sachsen Papier.

According to the mill: "Making paper from 100% DIP is very demanding because it is dirty, sticky, elastic and more likely to break. With the nip load increase, the machine's overall runnability has improved and sheet break propensity has decreased." The mill manager continues: "Our expectations have been exceeded. The speed increase due to this rebuild is remarkable!"

Note: The total need for modifications varies case by case. Sometimes more rolls need to be changed to stronger ones or changes to frames and loading systems are needed. Water removal can be improved with nip load increases on grades where loss of bulk is not a problem (such as newsprint).

Reduced bottom waste with Valmet reel spool with quick change head

The Atlantic Packaging mill in Whitby, Ontario makes 100% recycled newsprint on a 7.2m wire width papermachine. The bottom waste was a persistent and serious problem at the mill. Operators regularly overbuilt the reel diameter by a considerable margin, which led to significant dry end losses due to the overloaded reel spools.

As a solution to this problem, Valmet provided new heavy-duty reel spools capable of taking the load of oversized reels. These new reel spools were based on a new Valmet reel spool with quick change head type head design (**Figure 17**).

Figure 17. Valmet reel spool with quick change head

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A comparison of conventional shrink-fit and bolt connected quick change type reel spool head construction is seen in **Figure 18**. A shrink-fit head (on the left) alters the stiffness and bending of the shell at the ends, which results in uneven support for the parent roll. The quick change heads (on the right) allow for more uniform bending of the shell and even support across the full length of the parent roll, thereby reducing bottom waste.

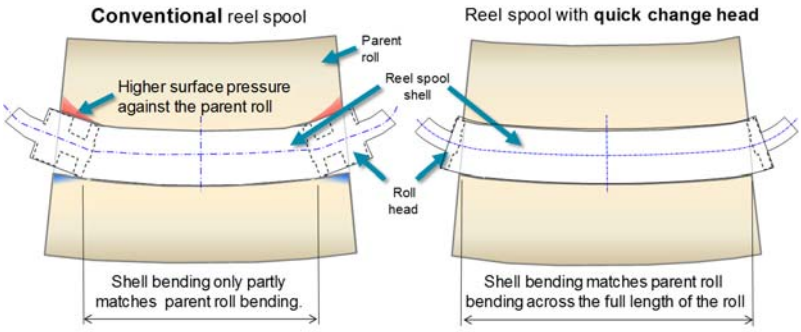

Figure 18. Advantageous shell bending with QuickChange head

Quick change heads bolted to the shell ends lack the stiffening effect of shrink-fitted roll heads. This enables the deflection curves of quick change reel spools to follow the deflection of the parent roll better all the way to the edges, allowing for more even support of the parent roll. More uniform distribution of surface pressure between the reel spool shell and the parent roll decreases the amount of bottom waste. Another advantage of more uniform nip loading during turn-ups is a reduced risk of overloading the cover at the spool ends. Quick change reel spools are nowadays a standard in new Valmet high speed paper machines.

New quick change reel spools eliminated the mill's bottom waste problem. This increased production and provided a good payback time for the customer's investment. According to the Whitby mill manager, "I haven't seen a project that has been such an instant success: Running to zero bottom waste is now a regular procedure and dry end losses have been reduced significantly, providing a good return on investment."

Record results with new roll covers

Sizer roll cover lasts 55 weeks

The M-real Simpele (now Metsä Board) BM3 makes folding boxboard at 600 m/min with a trim width of 4.04m. The roll replacement cycle was far too short. They needed a cover that would better withstand wear and deformation.

The mill chose to go with the Valmet Sizer Roll Cover SH and was very happy with the results. According to the mill service manager, "The potential performance offered by [Valmet Sizer Roll Cover SH] convinced us. It saved us from 10-15 roll pair changes on the sizer during the year."

Figure 19. The Valmet Sizer Roll Cover CF ran for a record 47 weeks, four times longer than the other vendor's polyurethane roll.

Coater roll cover runs 47 weeks

An MWC/LWC mill in Europe was making LWC with 70-115 g/m^2 basis weight, running at 1800 m/min on an 8.5m wide machine grew tired of their current polyurethane roll covers which required short regrinding intervals of 8-10 weeks. They were also concerned about their coating profiles and the stability of the roll surface. The mill was film coating at 15 kN/m, with dry solids content 65%, 5-9 g/m^2.

After switching to the Valmet Sizer Roll Cover CF, the mill reported that the new roll cover ran four times longer, with a record time in machine of 47 weeks. During this time the coating profile remained stable

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and there were no stripes in the coating. There were no scratches on the cover, and its surface roughness remained stable. This represented clear savings for the mill.

Results through ten years of roll grinding cooperation

In March 2011, Shanghai Prosperous Paper Co., Ltd. (SPP) and Valmet renewed their annual roll grinding agreement, this time celebrating its tenth anniversary. The initial cooperation agreement started right after Valmet opened its local regional service center in 2001.

SPP, located in Shanghai City, entered the Chinese newsprint market in 1998 and operates a high-speed 1300 m/min newsprint line with a wire width of 4.8m and an annual capacity of 141,500 metric tons. It has been acknowledged as a leading technology enterprise by the Shanghai Government several times.

The main targets in signing the roll grinding agreement were high production value, production cost savings and better end-product quality. These goals have all been achieved with the initial roll agreement. According to the general manager, "Valmet has introduced important innovations as well as given major support […] shown commitment and enabled [us] to succeed."

Valmet registers and documents all SPP roll grinding data, including the grinding date, the solution implemented and information about any problems or previous damage to the roll. These records help to produce the best possible grinding result for each roll. Valmet also feeds the data into the mill's maintenance information system, which reduces the mill's roll maintenance costs.

"We benefit from the grinding agreement since it improves our working methods and enables us to use [Valmet's] professional help. All this reduces costs and increases reliability," states the mill's vice maintenance manager.

The representatives of SPP and Valmet meet regularly to discuss any potential roll problems and plan roll regrinding schedules in order to avoid unplanned downtime due to rolls and to maintain high efficiency. Troubleshooting and quickly finding optimal solutions to problems are also part of the deal. The service agreement further ensures that roll grinding turnaround times remain short even during vacation and peak production times.

In addition to roll grinding, cooperation between SPP and Valmet also includes roll covers, spare parts and roll maintenance. The general manager continues, "We save a lot of time and costs through the grinding agreement. We intend to strengthen our cooperation with Valmet in a much wider area after having received support from them even in the most difficult times."

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.

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