Upgrade Considerations for "Older" Lightweight Paper Machines

Increasing an older machine's speed and efficiency may be just an upgrade away.

By Craig Shaver

The 1970's and 1980's were a booming time in the paper industry, with many lightweight paper machines being commissioned in the 330" wire width range, and designed to run up to about 3500 FPM. Machines being commissioned today to make the same paper grades are designed to run significantly faster, with increased wire width, and have a number of design enhancements compared to the older machines. To remain cost-competitive, owners of the older machines are faced with the task of trying to increase productivity and improve quality to a level that is comparable with the modern machines.

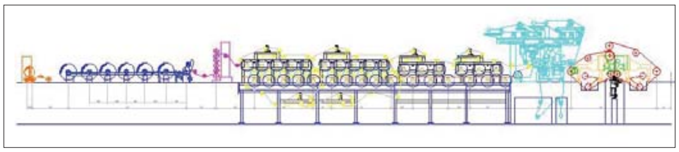

Figure 1. 1970's – 1980's Lightweight Paper Machine

Increased productivity can be achieved by running a machine at higher speed, higher efficiency, or a combination of both. Many of these older lightweight paper machines are capable of operating at speeds 30-40% greater than the original machine design, through implementation of available upgrades. The remainder of this discussion will focus on some of the most attractive upgrade possibilities for the older lightweight paper machines.

HEADBOX

Higher machine speed translates into increased Headbox operating pressure and sometimes more flow to the former. The first thing to review is the condition of the existing Headbox—for instance, checking for signs of damage and leakage. Many older vintage Headboxes used mild steel ribbing to back up the stainless steel in the flow areas and the condition of this mild steel is critical to the structure. The ribbing and the fasteners holding the joints together need to be reviewed for condition, as well as structural capacity for the higher pressure. All other structural components, such as slice jacks, must also be checked for condition and capacity for the elevated pressures at which the Headbox will be operated.

The slice and apron lip areas are critical for delivering a uniform jet to the former, in the proper location, and therefore should be inspected for good condition. All jacks and pivots must be reviewed to insure that operating adjustments can be made for the expected new conditions.

Although most speed increases also require some increase in the hydraulic capacity, many times this does not require major Headbox changes. The drainage capacity of the former will determine the hydraulic needs of the Headbox. Many older Headboxes were oversized by today's standards, so each should be evaluated on an individual basis. As a general rule, many Hydraulic Headboxes may be pushed up in flow, with some capable of being fitted with inserts in the header to increase the pressure drop for better flow distribution.

As the pressure in the slice increases, the force on the slice lip should be checked. The hydraulic force increase is sometimes enough to lift the lip, or make it bow outward between jacks. If this is an issue, installing a stiffer slice lip, heavier springs on the lip fingers, or narrower spacing on the slice control fingers may be warranted. When jacks are changed to narrower spacing, the "jack-to-jack" bend limits will be affected, as well as the sizing of the adjustment jacks. In conjunction with automatic slice adjustment control, cross direction control of basis weight may be significantly improved.

If the Headbox has a separate air pad device such as an attenuator, the ability to operate at higher future pressure must be checked. Many of these devices are "Coded Pressure Vessels," and if the combined speed increase and pressure drop pushes the pressure vessel beyond the rated capacity, the "coded" portion of this device may well need replacement.

The Headbox recirculation valve operates with some differential pressure corresponding to the flow through the valve. The performance of this device at increased machine speed should be estimated, and if cavitation is predicted, an additional pressure drop element can be placed in the recirculation line.

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FORMER

The Former's drainage capacity will become the limiting factor of the wire section as machine speed increases. Typical upgrades to the forming section to increase drainage capacity, improve sheet quality (filler distribution and formation), and improve machine runnability include:

- **Installing opposing blades.** The greatest benefit of opposing blades is an improvement in sheet formation. The location of the opposed blades in the forming process is critical to obtain the optimum benefit. The opposed blades also increase drainage capacity.

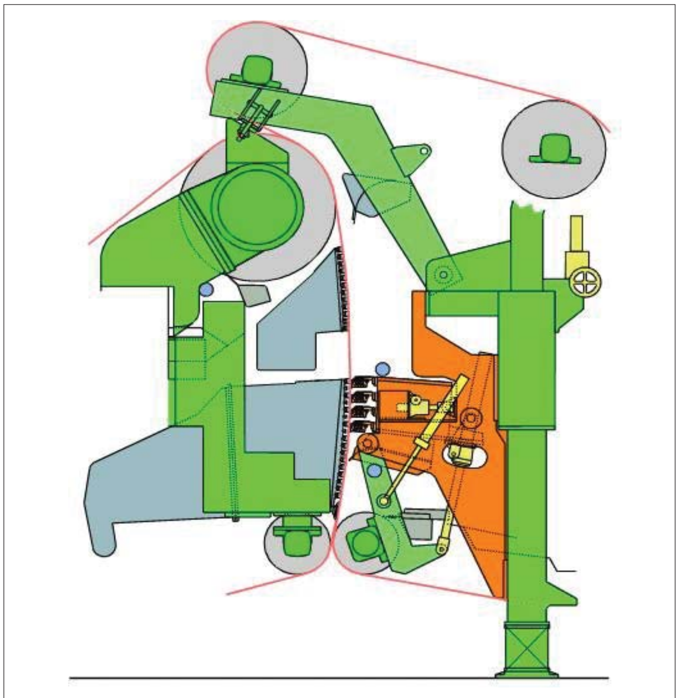

Figure 2. Opposing Blade Installation

- **Installing a new pre-couch vacuum box.** The pre-couch vacuum box is a tool used to improve sheet symmetry. This box also eliminates water throw over the couch roll (typical issue with increasing speeds on certain twin wire formers).
- **Re-configured forming zone ceramics.** The forming zone ceramic blade design and spacing can be altered to improve sheet quality.
- **Installing a couch double doctor.** A double doctor on the couch roll will reduce rewet and increase solids off the former. This will result in better wet end runnability.
- **Installing a new post-couch high vacuum box.** A high vacuum flat box will increase sheet solids off the former by 1.0-3.0%. This results in better press operation and improved felt life. Reduction in wet end breaks will also be realized. The installed drive capacity of the former needs to be reviewed to accommodate the higher drag load.
- **Removal of twin wire bowed rolls.** The evolution or advancement in wire technology has resulted in the ability to operate twin wire formers without the bowed rolls in either wire. This eliminates a maintenance item for the mill.
- **Mist Elimination System.** As machine speed increases, cleanliness becomes a critical factor to achieve efficient machine operation. Upgrading the existing mist elimination system must be considered.

PRESS

Most of the machines installed during the 1970's and 80's contained a three nip no draw press. These were very efficient and do lend themselves to rebuilding for higher machine speeds. However, one must review the press section for the possibility of increased vibration, loss of sheet dryness, and efficiency.

To achieve target sheet dryness out of the press at increased speeds, the nip pressure will generally have to be operated as high as possible.

Often, the felt rolls in the press section will need to be replaced with larger diameter/stiffer rolls to stay below the critical speed (natural frequency) of the rolls. The press framework is very susceptible to vibration as speed increases, due to the high nip loading and high center of gravity of the press section. Finite element analysis can be performed to determine the framework's natural frequencies. This will determine if stiffening of the framework is recommended for increasing the machine speed. Another area of concern for vibration in the press is doctor backs and often these will need to be replaced to accommodate higher speed operation.

To achieve target sheet dryness out of the press at increased speeds, the nip pressure will generally have to be operated as high as possible. This can be achieved by utilizing extra load potential of the existing equipment or through installation of new press rolls and/or new loading equipment. Cooling capacity of existing hydraulic systems is frequently inadequate for higher speed operation of the press and replacement of the hydraulic unit should be considered. Sheet rewet potential should be looked for and minimized, specifically eliminating excess felt wrap on exit from the press, and relocating showers on some of the rolls like the suction roll.

If additional dryness is required, one or more of the presses can be replaced by a shoe press. Mini shoe presses designed for up to 2500 PLI can easily be installed to achieve up to 2% improvement in dryness. With somewhat more installation effort, such presses designed for up to 6000 PLI can achieve up to a 5% improvement in press dryness.

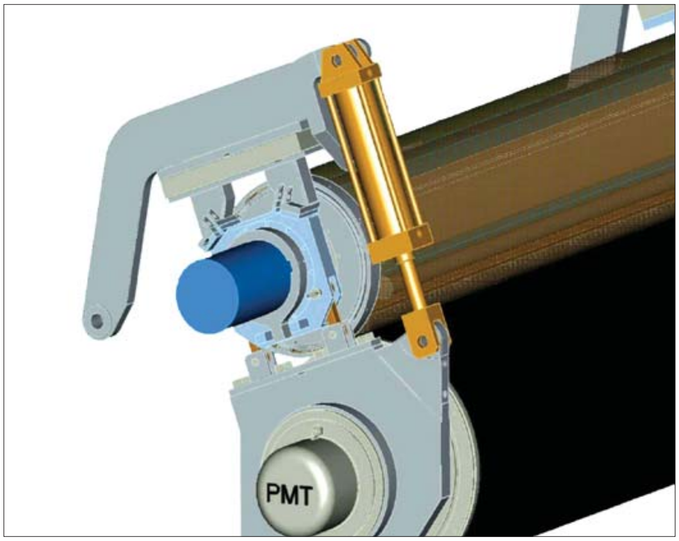

Figure 3. Smarnip Mini Shoe Press

Runnability can often be improved in the press section of these older machines by closing up transfers. Of particular concern is the transfer between the press and the dryer section. A typical upgrade in this area involves addition of a vacuum transfer roll to transfer the sheet positively to the dryer felt, and then a vacuum box to hold the sheet to the felt until it gets to the dryer can.

One more upgrade to be considered in the press section is to place a double doctor on the suction roll. The benefit of this upgrade will be similar to adding a double doctor on the couch roll—more water removal with more CD uniformity.

DRYERS

The dryer section vibration potential should be considered when increasing machine speed 30-40% over original machine design. Similar concerns arise in the dryer section as were noted in the press section. Often the felt rolls will need replacing in order to keep the operating speed below the critical speed. Stiffeners may also need to be added strategically to the dryer framework to reduce vibration potential.

Several upgrades are available to dramatically improve runnability in the early dryer sections, allowing higher speed operation.

Sheet runnability in the early stages of the dryer section is always of concern because the sheet is still more water than fiber and prone to breaks. Several upgrades are available to dramatically improve runnability in the early dryer sections, allowing higher speed operation. Current technology is to single felt the first one or two dryer sections and to use grooved and drilled rolls in the bottom dryer can positions in the single felted sections. Vacuum applied to Vented Dryer Transfer Rolls (VDTR) will help stabilize the sheet on the felt and to assist with tail threading. Blow boxes would typically be installed in the dryer pockets to help stabilize the sheet in the early dryer sections. Dryer pocket felt rolls are often relocated slightly toward the wet end to provide increased sheet support as the sheet leaves contact with the dryer cans. All of these features allow operation at much higher machine speeds.

Operation at higher machine speeds results in more moisture being evaporated in the dryer section and needing to be carried away by the dryer hood air system. Common upgrades to the hood air system include:

- new supply and exhaust fans with greater flow capacity
- larger ductwork
- new dampers
- new supply air heating coils
- new pocket ventilation equipment with sheet stabilization features.

While attempting to increase machine speed on these older machines, drying rate of the dryer section frequently becomes a primary limitation. One way to overcome this limitation is to increase steam pressure in some of the dryers. If additional header pressure is already available, and the dryer cans are rated for higher pressure, then the solution is simply to increase pressure setpoints. Other options might include installation of thermocompressors to boost steam pressure, or modification of the dryer drainage system to enable operation at higher pressure.

CALENDER

When considering machine speed increases, the calender can be looked at similarly to the press. Both involve nipped rolls, variable crown rolls, hydraulic units, flexible rolls, and framework. All the calender rolls should be checked for critical speed compared to the desired design speed. For large speed increases, many of the calender rolls may need to be replaced. The hydraulic unit cooling capacity may be marginal for higher speed operation and it too may need to be replaced.

Temperature control systems on most of these calender stacks were designed to maintain the roll surface temperature at nominally the same value as the sheet to minimize temperature induced non-uniformity in nip pressure at the sheet edges. As machine speed increases, the amount of heat transfer required to accomplish this goal also increases. The existing calender heat transfer machines typically are not up to the task and should be considered for replacement or upgrade.

Another calender upgrade consideration for lightweight paper machines furnished in the 1970's and 80's is the drive location on the calender. Many of these older machines were supplied with the drive input on the second roll from the bottom, commonly referred to as the queen roll. This was a common design because it worked for one thing, and also because the bottom roll was generally a variable crown design roll which made driving a little more difficult. Something that has been found as lightweight paper machine operation has pushed through the 4000 FPM level is that the calender operation will be noticeably more efficient if the drive is placed on the bottom roll. One way to understand this is to note that the bottom roll is usually the biggest roll and has the highest drive load. So it is better to drive that roll directly rather than through the sheet in the bottom nip.

REEL

Many components of the reel on these older machines are original equipment, having served their purpose well, but now being ready for repair and upgrading. Efficiency of the entire paper machine can be improved if larger reels can be made. Larger reels mean fewer turn-up attempts and therefore fewer missed turn-ups. Larger reels also translate into fewer reel changes at the winder unwind.

Efficiency of the entire paper machine can be improved if larger reels can be made.

The first equipment upgrade consideration when moving to larger reels is the reel spool. They may need to be upgraded due to physical load limitations or they may need upgrading to keep paper stresses within currently acceptable guidelines to minimize paper defects such as crepe wrinkles and bursts. Regardless of whether the reel spools are replaced, rubber or polyurethane covers should be considered. Covers help in several ways, such as more uniform nip distribution, better turn-up efficiency, and less damage to the reel drum.

When considering the upgrade to larger diameter reels, one should also look at the spacing between reels on any extended rails plus the spacing between reels and the floor. There are OSHA guidelines for minimum spacing if operations personnel will have access to the moving reels, potentially requiring increased spacing along the extended rails and raising of the entire reel.

The primary arms and secondary arms of the reel are potential candidates for upgrading, particularly if the reel spools will be changing in size. Even when the existing spools continue to be used, the existing primary and secondary arms are commonly worn out to the point where spool alignment cannot be maintained adequately during the turn-up process. When replacing the primary and secondary arms, a common upgrade is to convert to hydraulic loading from pneumatic loading. Hydraulic control and operation has matured since these older machines were installed, such that it can now be justified on high speed lightweight paper machines in spite of slightly greater initial cost. Hydraulic operation provides for smoother operation of the primary and secondary arms, and better nip control capability.

Speaking of nip control, lightweight paper is prone to defects near the spool due in many cases to poor nip control during the turn-up process. One feature available today that wasn't available 30 years ago is primary arm nip relieving. This is a means of countering the weight of the spool as it contributes to nip pressure. A desirable nip pressure for lightweight paper is in the range of 15 PLI, but the weight

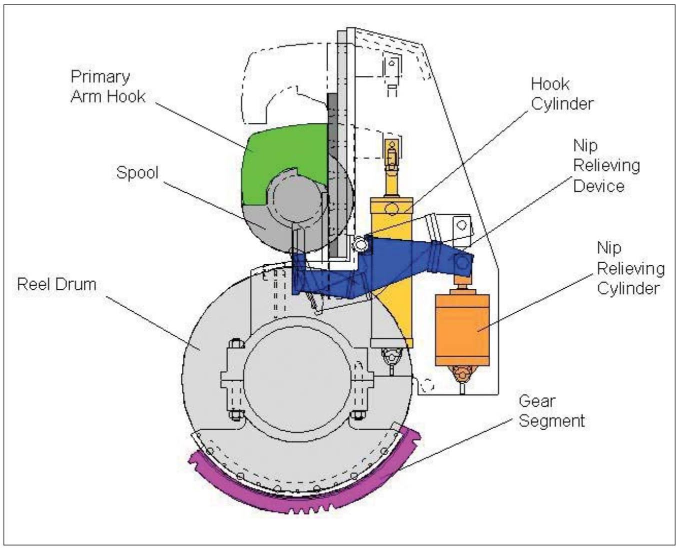

Figure 4. Primary Arm Nip Relieving

of the spool in the turn-up position on many of these 330" wire width machines is about 50 PLI. As the spool weight is offset by the nip relieving mechanism, the nip pressure is also redistributed from heavy on the ends to a more uniform condition. This nip redistribution has been seen to be very beneficial in terms of turn-up efficiency.

Another control feature not furnished on machines in the late 1970's is controlled transfer. This is the transfer of nip from the primary arms to the secondary arms with minimal disruption in the total nip. Without controlled transfer, there would inevitably be some period of double loading, sandwiched on either side by normal loading. This rapid change in nip pressure over very short time would frequently result in paper defects.

One more reel upgrade for improved turn-up efficiency is replacement of the "gooseneck" with a newer design that will better transfer the leading edge of the sheet around the new spool. Typical new design goosenecks will have a shroud that wraps around the spool in the turn-up position, with air nozzles to help the sheet wrap the new spool.

WINDER

The winder, by design, needs to run faster than the paper machine because it is a batch process compared to the continuous paper machine feeding it. As the older lightweight paper machines are upgraded for increased productivity, the winder frequently becomes a bottleneck. Cycle time improvements can be obtained by:

- replacement or modification of slitter positioning systems to reduce set-up time
- installation of parent reel insertion rails and empty spool removal equipment to improve efficiency of the unwind related tasks
- installation of auto set change equipment, including a cut-off knife, core loading system, and slitter/core chuck positioning equipment

Winder operational efficiency on these older machines is often hindered by the existence of obsolete controls, which require frequent maintenance and downtime. Replacement of the obsolete controls can significantly reduce such maintenance.

Winder roll quality can often be improved on these older machines with an upgrade to the rider roll system. Many rider roll relieving programs are still driven with hardware cams, and replacement with recipe driven controls can increase flexibility and repeatability. Replacement of rider roll chain lifting systems with direct acting cylinders can likewise improve roll quality.

SAFETY

When upgrading an older machine for improved productivity and quality, every area of the machine should be examined with an eye on safety. Government agency requirements as well as available safety technology have changed during the last 30 years. Increased equipment automation and improved guarding are valuable compliments to any mill safety program, allowing these upgraded older machines to operate as safe as any new machine. Examples of areas that should be reviewed for compliance are:

- reel and winder fencing
- rider roll safety latches
- nip barriers

CONCLUSION

Lightweight paper markets have never been more competitive than they are today. New machines being supplied are inherently more cost effective than older machines due to efficiencies of scale and speed. The older machines, specifically those furnished in the 1970's and 80's, can in many cases be upgraded to remain competitive with newer machines. The challenge is to identify the most cost effective upgrades. ■

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