Developing the fastest corrugating medium machine

Menasha and its suppliers breathe new life into a 30-year-old paper machine.

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Four years ago, Menasha Paperboard Division began a project to convert a 26-year-old machine in Otsego, MI, into the world's fastest corrugating medium machine. Menasha achieved this feat by relying on the creativity of the Otsego mill's employees and on the engineering expertise provided by Menasha's suppliers.

The Otsego experience shows the benefits of a close working relationship between a supplier and customer. It demonstrates the trust necessary for both sides to take risks. Furthermore, it shows the results papermakers can achieve when they take full advantage of their suppliers' resources.

The goal: 3000 ft/min

Paper machine No. 1 at Otsego dates from 1965 and, as recently as 1990, it was running steam limited at about 2100 ft/min on its main 26 lb/MSF grade. When Menasha decided to rebuild the machine in 1990, the goal of the upgrade was to attain a speed of 3000 ft/min. This was not intended to be a maximum theoretical speed, but rather an achievable operating speed. This represented a roughly 43% increase in speed—and it would make PM No. 1 at Otsego the world's fastest medium-producing machine. With the then-fastest corrugating medium machines averaging a top speed of about 2600 ft/min, this goal represented a challenge for Menasha.

The process changes needed to provide dewatering muscle, sheet stability, and the highest finished product quality were pushing the boundaries of design knowledge. There were some consultants and suppliers who doubted that 3000 ft/min could be achieved using current fourdrinier technology.

Compared to industry giants, Menasha's papermaking operations are relatively small, and Otsego is the only paperboard mill operated by Menasha. As a result, the Otsego mill had to rely exclusively on the vision and expertise of its in-house engineers and operators for the rebuild. However, engineering self-reliance had long been a trait at Otsego, and it had greatly affected the mill's attitude toward its suppliers. According to John Bonham, Otsego's general manager, "We're a hard mill for suppliers to break into, because we're not interested in low-cost offers. Instead, we want suppliers that will offer us more, those that we can rely on for advice and assistance. We're not too proud to learn from others. We listen to our suppliers, and we act on their advice."

New approaches to reach a higher speed

When finished, the rebuild amounted to a comprehensive US$ 55 million update of PM No. 1 and its support systems. From stock washing and secondary fiber cleaning to roll wrapping and waste treatment, every capability was substantially upgraded. (See the accompanying sidebar for a list of components added in the rebuild.) In fact, all of the new equipment was sized to accommodate 3500-ft/min operation.

Within the scope of the rebuild, one area that received particular attention was the fourdrinier. The mill was concerned about forming and dewatering a high-quality medium sheet at 3000 ft/min. As a result, the staff at Otsego relied extensively on the assistance of two suppliers: AES Engineered Systems and the Appleton Wire Division of Albany International.

These suppliers were familiar with the Otsego mill—and to each other. Menasha had been using AES products at Otsego for many years, and Appleton Wire forming fabrics had been on PM No. 1 for over ten years. AES had been a part of Albany International until 1993, and since then has maintained a close alliance with Appleton Wire. Consulted frequently during the planning, construction, and startup phases, both AES and Appleton Wire made several important recommendations that helped shape the design of the forming section.

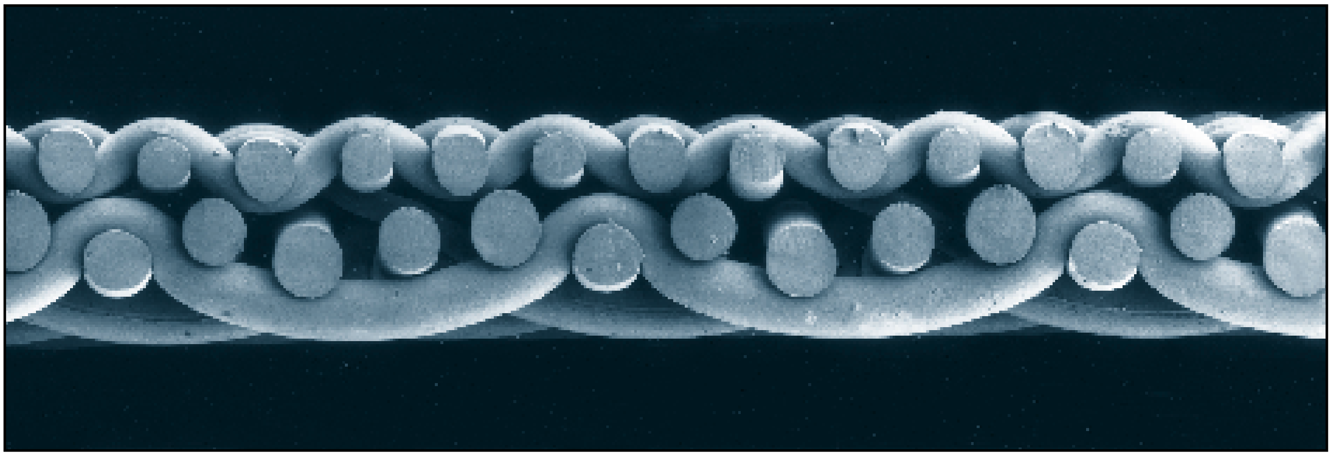
The most notable change was extending the fourdrinier 15 ft from its previous 50-ft length, making it one of the longest fourdriniers in use on a medium machine. (See **Fig. 1.**) Two operational factors made this length extension necessary: the higher operating speed (which reduced dwell time per foot on the forming table) and a reduction in headbox consistency from 1.2% to as low as 0.9%. This combination of higher

1. Menasha Corp.'s PM No. 1

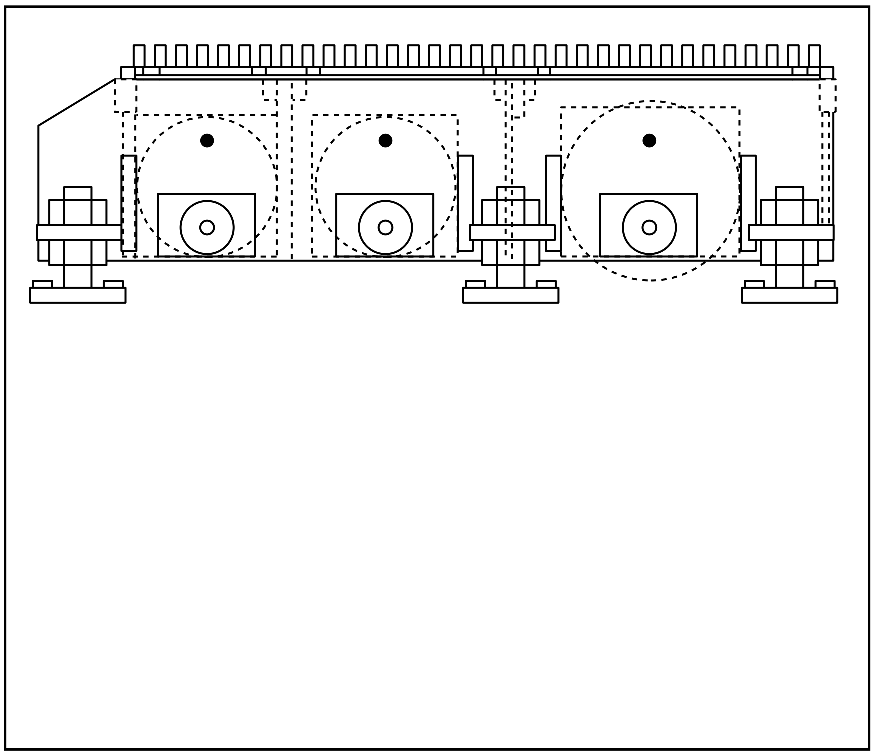
speed, lower consistency, and greater fourdrinier length totally changed drainage and activity characteristics. The definition of medium quality was also changing. Traditionally, flat crush strength (as measured by the Concora test) was a primary quality measure for the medium. As the focus on stacking strength increased in the corrugated marketplace, compressive strength (measured by ring crush or STFI tests) became more critical to customers than flat crush. To maximize compressive strength, the sheet must be formed differently. All of these factors necessitated new approaches to both the forming fabric and the dewatering system.

Appleton Wire—the sole forming fabric supplier on this machine since 1990—had in 1989 upgraded PM No. 1 to a Kraftex 96T triple-layer fabric. The fabric change improved machine production rates and paper strength characteristics. During the Menasha upgrade, Appleton Wire developed a second generation of triple-layer forming fabrics—the Kraftex-SG 99T. (See **Fig. 2.**) This fabric design provides improved dewatering as well as the potential for higher fabric life. Menasha quickly converted the machine to the Kraftex-SG 99T fabric design in 1992. Not only did the new design provide the required incremental speed increase, it helped to double fabric life!

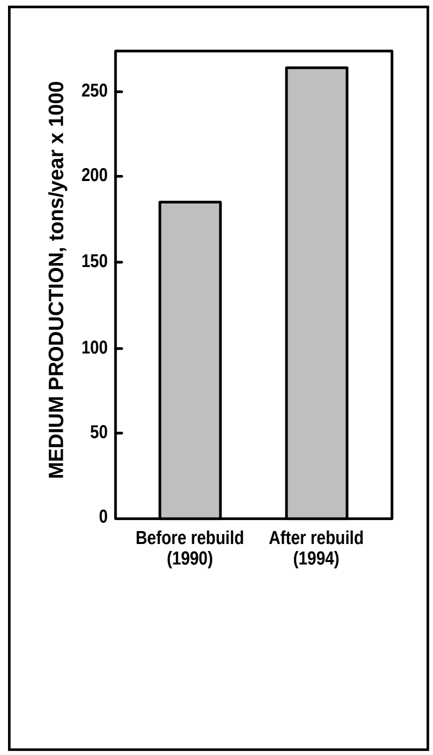
2. Appleton Wire Kraftex-SG 99T forming fabric



3. AES triple-zone high-vacuum box



4. Medium production before and after rebuild



The AES contribution to the forming section included a new forming board, an activity box, gravity foils, and a low-vacuum system. The existing low-vacuum boxes had limited pull due to their short drop legs, so they were converted to a rear-discharge configuration.

The three single high-vacuum boxes were replaced by a single triple-zone high-vacuum box. (See **Fig. 3**) This use of multicompartment boxes has been a growing trend over the last few years. However, the optimum compartment size and slot width for each machine remained elusive. Consequently, AES undertook an extensive development program to optimize the high-vacuum application. This resulted in a computer model that predicts high-vacuum dewatering and its effect on drive load. Based on the information generated by this model, and on AES's extensive field experience with multizone boxes, the supplier recommended and configured a triple-zone box that met PM No. 1's requirements. Since the multicompartment box provides a continual surface to the forming fabric, it also prevents breaks to the atmosphere—an inevitable condition with individual units that increases airflow requirements and reduces dewatering efficiency.

Together, these fourdrinier enhancements allowed the plant to reduce headbox consistency to 1.0%, which led to a subsequent improvement in formation.

By late summer 1991, the rebuild had been completed, and startup was underway. Although there was a considerable learning curve, which was expected with this leading-edge rebuild, by early 1992, the machine was operating well. The operating speed was up to 2700 ft/min—clearly a record for a 26-lb corrugating medium machine. As Bonham points out, “There’s a big difference between running a machine at 2100 and running it at 3000. We all had to learn to do things differently from before.”

For the crew running PM No. 1, the rebuild meant learning how to run a totally different process. To achieve peak performance, it was necessary to develop new process information systems, standardize more centerlines and operating procedures, and focus on a finer level of process detail. There is little forgiveness in a paperboard machine running this quickly. Not only did the crew have to master different techniques (such as a new sheet-threading procedure), they had to change their frames of reference about what is important in running a higher-speed machine.

From project conception forward, the customer’s desires for finished product quality were paramount in design decisions. This included establishing a toll-free 800 number for customers during the startup to ensure that their concerns over product quality and service were immediately addressed. Fortunately, the transition went smoothly.

Trials and tribulations: the optimization process

With operating speeds already surpassing those of any other medium-producing machine, the people at Otsego, Appleton Wire, and AES were heading into uncharted territory. There were no other applications to reference, no other examples to follow. As a result, the only way to optimize the lengthened fourdrinier’s performance was through a series of trials.

The goal of the optimization trials was to retard drainage in the early forming zone to enhance activity and avoid sheet sealing. Then, more dewatering was promoted in the low-vacuum section of the fourdrinier. During the trials and experimentation, vacuum box locations were altered, blades were added, foil blade angles were changed, vacuum levels were tweaked; all the effort was directed to enhancing drainage, improving activity characteristics, and improving sheet formation.

The machine was running smoothly at 2700 ft/min. But when operators tried to gain the additional 300 ft/min, sheet breaks began to occur. Again, the mill and its suppliers jointly studied the problem. They recognized that more attention to detail was required at the higher speeds. Forming board alignment and levelness became more critical, as did general alignment down the fourdrinier. Proper fabric tension control for all sections also became more important. Proper fabric cleaning and conditioning were essential in all machine sections. Finally, the operation of the forming section activity box needed to be more precise.

One factor that helped the optimization process was that Otsego closely monitored all the process variables. According to Bonham, “We kept a close eye on parameters like L/b (the ratio of headbox slice opening to setback). We used digital readouts to track that and other table variables at all times. A slower machine may get by without that degree of control, but not one running at our speeds.”

While some of the trials yielded no improvement in fourdrinier performance, other small changes produced notable improvements. For example, better vacuum control on the activity box improved activity levels, further enhancing drainage and formation. On the whole, it was an incremental process, with each success bringing the machine closer to its targeted performance. By May 1994, PM No. 1 was exceeding 3000 ft/min on an intermittent basis with outstanding board quality. Although it doesn’t yet average 3000 ft/min, the machine has run as fast as 3090 ft/min. Menasha’s operators are certain that reaching the 3000 ft/min average is simply a matter of time. They feel the design goal has been met.

Again, it is important to stress how the three-way interchange between Otsego, Appleton Wire, and AES contributed to the success of the optimization process. Both of the suppliers

The rebuild: What was involved?

The US$ 55 million rebuild at Otsego was comprehensive. It included the following systems and components:

- 350-tons/day secondary fiber processing system
- Stock preparation cleaning system
- Headbox
- 8500-PLI extended nip second press
- 15-ft extension of forming table
- Silent drives for second, third, and fourth dryer sections
- Rebuilt reel
- Rewinder
- Off-machine roll wrap system
- Brownstock washer
- Waste treatment clarifier and aerators.

had unique knowledge and expertise that was vital to the other. Equally important, the Menasha staff was willing to listen and to experiment. As one of the supplier sales engineers said, "They [Menasha] don't suffer from the 'not invented here' syndrome."

The future: more cooperation for faster speeds?

By any measure, the rebuild at Otsego has been a success. Productivity is up 34% since the rebuild, and in 1994 over 250,000 tons of product left the Menasha mill. (See **Fig. 4.**) But no matter how fast the machine is run, the bottom line for a medium machine is how well its product converts on a corrugator, and what it brings to finished box performance. On both counts, the medium from PM No. 1 is more than acceptable. Through the machine startup and process optimization, customer acceptance has remained strong—Menasha is a preferred or sole supplier for many of its customers.

Even with all this, the Menasha staff is still not satisfied. The optimization program, and the cooperation between Otsego, AES, and Appleton Wire, continues. Because much of the equipment installed on PM No. 1 during its rebuild was sized for 3500 ft/min operation, another phase of upgrades, with accompanying higher operating speeds, is already being considered. When these plans proceed further, it is certain that suppliers like AES and Appleton Wire will be deeply involved. TJ

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A look back at corrugated containers

Tappi Journal readers whose primary interest is corrugated containers may wish to refer back to the 1993 and 1994 issues for information on the following topics:

1993

January: p. 32—Conference report: CorrPak 1992; p. 145—Corrugating medium: alkaline pulping, wheat straw; p. 152— Corrugating machines: rolls, scheduling, simulation; p. 158— Linerboards: regulations; p. 194—Conference reports: Corrugated Containers Conference.
February, p. 49—Board mills: Kentucky, recycling, startup; p. 87—Certification: ISO, quality control, Virginia; p. 157— Corrugated boxes: recycling, refining.
April, p. 207—Corrugated boards: additives (saturation); p. 215—Corrugated boards: printing; p. 219—Costs: corrugated boxes, efficiency, productivity (efficiency).
June, p. 129—Boxes: moisture content.
July, p. 116—Corrugated boxes: additives; p. 122—Compression strength: corrugating machines; p. 130—Physical properties: flutes, single facers; p. 140—Corrugating machines: grinding, precision, rolls.
August, p. 247—Certification: failure, ISO.
October, p. 32A-11—Corrugated boxes: Latin America; p. 32A-13—Company profiles: Corrugated boxes; p. 10:32A-16 —Corrugated boxes: marketing, suppliers; p. 10:32A-19— Linerboards: metals, migration, wash waters; p. 10:32A-26—Boxes: cycles, enviornmental, humidity; p. 10:32A-31— Linerboards: friction factor, recycling, wax.
December, p. 206—Awards: M. Hoysted, G. S. Rennie.

1994

January, p. 51—Forest products industry: paper board industry, paper industry; p. 83—Compression strength: edge crush tests, time, waxing; p. 87—Compression strength: corrugated boxes, creep tests, humidity.
February, p. 163—Basis weight: freeness, linerboards, shock drying (bogus boards); p. 169—Impulse drying: bogus boards, linerboards, multi-ply boards.
April, p. 185—Corrugated boxes: reclaimed fibers, soaking, sodium hydroxide; p. 193—Bonding strength: Corrugated boards, edge crush tests, variables; p. 199—Charts: corrugating machines, rolls, trim waste; p. 207—Corrugated boxes: efficiency, man machine systems, standards; p. 213—Conference report: Corrugated Containers.
July, p. 71—Adhesion: bonding strength, corrugated boards; p. 75—Moisture models, food packaging, fiberboard.
September, p. 32-9—Awards: converting industry, converting plants; p. 32-6—Corrugated boards: marketing, package design, packaging industry; p. 32-13—Corrugating medium: F-flute, food boards, package design; p. 32-17— Specifications: converting plants, ISO, standards; p. 32-25— Corrugating medium: parameters, waste management, waste papers; p. 32-34—Corrugating machines: cutters, dimensions, knives; p. 153—Corrugating medium: bleached pulps, reclaimed fibers, recycling.
December, p. 113—Kenaf: linerboards, chemithermomechanical pulps, substitutes.