Smurfit-Stone's Virginia region mills utilize a web-based chip quality management system to minimize chip variation and gain control over the chip pile

Chip Quality Measurement and Analysis Produces Better Downstream Operations

By **SANDY SMITH** and **DAN DERBY**

Bill Jordan observes that every mill has a sweet spot. He's speaking of that point where a mill's equipment, raw material supplies, and customer requirements come together to produce the right product for the right price at the right time.

In this impossibly complex technical and economic equation that is a pulp mill, existing contracts, current capacity, and spot market discounting must be balanced with input costs, availability, and quality; not to mention the challenge of competing in a global market with aging equipment and huge pressures on headcount.

Finding the optimum balance point is what Jordan calls the "sweet spot" of a mill, and it varies not only from mill to mill but within a given mill over time, sometimes day to day. The need is to break the "volume focus" and understand the whole process.

A past plant manager of both Champion International and International Paper mills in Alabama and Minnesota, Jordan is now an industry consultant headquartered in Decatur, Ala. With hands-on experience making mills work, Jordan is used to chasing this sweet spot. He observes that the biggest challenge has always been "knowing what was going on." He has used everything from matrix analysis to the classic Monday morning meeting to find the source of the problems.

The historical challenge is the time it takes for information to "trickle down" the system, particularly when something is out of balance and the root cause is a changing factor itself, such as chip quality. "It can take weeks, even months of Monday meetings to find out that you have a problem that the guy out at the chipper caused without having a clue what he was doing to the digesters," Jordan says.

Finding and hitting that balance—a dynamic, constantly changing target in a world of globalization, reduced headcounts, aging plants, plant closings, Sustainable Forestry Initiative (SFI) certification, multiple vendors, customer pressures—is the mill manager's nearly impossible job. To manage the sweet spot, a mill's managers must know what's going on quickly.

Jordan recently assessed a technology called The Virtual Chip Doctor (TVCD) that deals with managing the chip quality issue. "It's remarkable that we're just now getting around to close management of the input (wood chips) of this complex, multivariable system," Jordan says. "Historically, a mill would have six to eight major wood suppliers, and it would take weeks or even months to know if one supplier had a problem.

"The challenge was that the guy in the chip mill was measured on only the simplest of terms," Jordan continues. "He didn't have a clue what he might be doing to the digesters. Worse, it took days or even weeks or months for the plant manger to learn what was happening." In that time, typical bottleneck processes, such as recovery boiler limits, become critical. Digester optimization becomes impossible when the materials going into them are close to worst case.

Measurement, analysis, and control of wood chips has typically been ignored or viewed in the simplest terms despite the fact that raw material significantly impacts operations.

The Whole System

Jordan's sweet spot observation—a systems view of the whole value—is not totally unique. Other observers with very different backgrounds reached the same pragmatic conclusions. And they, too, thought about the importance of managing the critical raw material of these impossible

TABLE 1.

Combined fiber savings

Period ending	% Chip within desired fractions	Total % chips screened to fuel	% Chips remanining	Pulp yield above baseline	Onsite screened out fiber $/ton	Total screened out fiber $/ton	Digester pulp fiber $/ton	Fiber value gain from chip quality	Onsite monthly screened out fiber	Mill monthly screened out fiber	Total monthly screened out fiber	Digester monthly pulp yield gain	Total monthly fiber value gain	Cumulative fiber savings
Baseline	65.0%	11.7%	88.4%											
Annualized	67.8%	9.8%	90.2%	0.00%					$2,642	$464,302	$466,945	$445,121	$912,066	$912,066
Target	73.0%	4.0%	96.0%	6.65%	$1.95	$3.27	$1.09	$4.36	$934,915	$634,284	$1,569,199	$524,046	$2,093,245	$2,093,245
January	65.6%	10.1%	89.8%	3.77%	$0.11	$0.67	$0.33	$1.00	$4,510	$24,052	$28,562	$13,858	$42,420	$42,420
February	64.9%	11.7%	88.3%	3.72%	$0.69	$0.04	$0.45	$0.41	$25,019	$23,535	$1,484	$16,144	$14,660	$57,080
March	60.5%	16.2%	83.8%	3.39%	$2.95	$2.29	$0.47	$1.82	$129,163	$28,665	$100,498	$20,613	$79,886	$22,806
April	67.9%	10.0%	90.0%	4.88%	$0.13	$0.77	$0.85	$1.61	$5,156	$35,651	$30,495	$33,526	$64,021	$41,215
May	69.8%	8.5%	91.5%	5.23%	$0.51	$1.52	$1.10	$2.62	$26,050	$52,055	$78,104	$56,461	$134,565	$175,781
June	72.7%	7.3%	92.7%	5.69%	$1.08	$2.21	$1.18	$3.39	$46,321	$47,981	$94,302	$50,611	$144,913	$320,694
July	74.8%	7.0%	93.0%	5.56%	$1.13	$2.33	$1.34	$3.67	$50,182	$53,593	$103,775	$59,510	$163,285	$483,979
August	74.4%	6.7%	93.3%	5.73%	$1.09	$2.28	$1.36	$3.63	$44,446	$48,410	$92,856	$55,261	$148,117	$632,096
September	71.0%	9.2%	90.8%	5.59%	$0.02	$1.22	$1.28	$2.49	$772	$46,737	$45,966	$48,223	$94,189	$726,285
October	64.4%	10.0%	90.0%	4.28%	$0.05	$0.79	$0.76	$1.55	$2,765	$45,839	$43,075	$41,695	$84,769	$811,054
November	64.4%	9.9%	90.1%	4.03%	$0.02	$0.83	$0.64	$1.48	$767	$37,246	$38,013	$29,407	$67,420	$879,474
December	62.7%	10.5%	89.5%	3.68%	$0.22	$0.46	$0.66	$1.12	$6,759	$20,539	$13,780	$19,813	$33,592	$912,066

complexprocesses.

In 1996, Dr. Ingemar Croon wrote an article on this very subject from the point of view of an independent industry technical consultant. Croon, a TAPPI fellow since 1990, pointed out the disjointed nature of managing such a complex value chain in an article titled, "Paper Companies Need to Balance Unit Management with Integrated Outlook," published in *Pulp & Paper* and written along with associate Anik Bose.

Croon reiterated something Jordan learned hands on: You have to look at the entire value chain and particularly at the boundaries between organizations. Croon quotes a case study of a "major mill in North America" where product quality and frequent breakdowns were traced to the quality of fiber feeding the fiber line. With 25 sawmills feeding its line and "little or no control over the quality of…incoming raw materials," it was no wonder that there were control issues.

What Croon had insightfully pointed out was something other industries (such as Toyota and Wal-Mart) have known for some time. To be competitive, a company must increasingly manage not only its own operations but control those of its suppliers. Wal-Mart is legendary for fierce control over its own value chain, and Toyota's awesome quality is, in part, due to the working partnerships it has built over the years with its suppliers.

A year later, Croon published another article with a resonant theme. In "Kraft Pulping: The Next Leap," he spoke to the issue of the industry's aging mills and the need to find new strategies to keep them competitive. Published in August 1997 in PIMA's *Papermaker*, the article spoke of the need to find new competitiveadvantages for these aging mills.

In the case of U.S. production capacity, this is particularly relevant. Among discussions of two-stage continuous kraft cooking, oxygen delignification, and ECF/TCF costs was his observation that "the wood raw material area is often badly neglected by the pulp industry, resulting in a substantial loss of income." Emphasizing this he said, "No other industry feeds a complex raw material into the manufacturing system without proper control of its quality and composition."

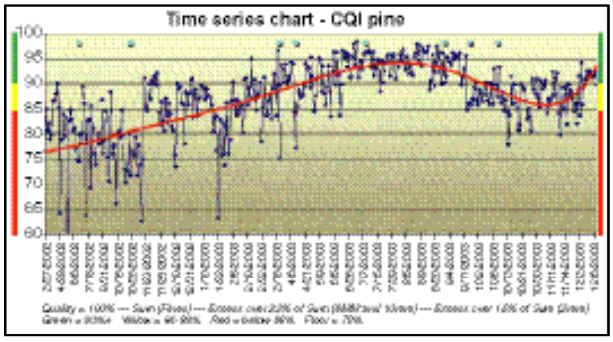
It was Croon's hope that "new analytical tools that instantly measure the chemical and physical characteristics of wood" would become available and "for the first time, it will be possible for mills to carry out advanced fiber management and to know the real quality of the wood entering the digester." Croon's position, it turns out, was corroborated by a completely independent industry group.

It's important to note that while pulp and paper mills have generally recognized the need for improved data acquisition and availability, taking advantage of those opportunities is lagging other investments. In an article from the June 2004 issue of *Pulp & Paper* by Janssen et al, the authors report that a major survey of North American mills on the use of IT revealed that while "mills have recognized the benefits of IMS (information management systems)...the potential value of IMS has not been fully exploited."

In particular, the authors point out, "the potential for using IMS for business process analysis and supply chain manage- ➤

FIGURE 1.

Multi-month trend chart of chip sampling data



ment is generally undervalued, or in some cases, still unrecognized." Based on a survey of Canadian and U.S. mills, the article clearly shows that the industry thinks there are still significant opportunities to broaden the impact of information technology to meet an increasingly competitive environment.

Gaining Control Over The Chip Pile

Steve Simmons, forester in the Forest Resources group of Smurfit-Stone Container Corp.'s (SSCC) West Point and Hopewell, Va., pulp and paper mills, holds responsibility as the head of SSCC's Virginia Region Chip Quality program. As a member of SSCC's Forest Resources Division Chip Quality SOP (Standard Operating Procedures) and protocols, he has helped shepherd the current generation of quality programs aimed at the chip piles feeding SSCC's pulp mills. Simmons' understanding of SSCC's processes, goals, and business culture is impressive.

The West Point and Hopewell facilities make up the Virginia region of SSCC. These mills make white top linerboard, kraft linerboard, and corrugated medium for customers around the world. While SSCC has historically been very circumspect about its internal operations, in the case of chip quality they agreed to make Simmons available to discuss its history in the Virginia region.

The Virginia region has had chip quality programs in the past. Those early efforts were run by staff foresters and went through a number of incarnations as the mill ownership changed through the years (Chesapeake Corp. to St. Laurent Paperboard and finally SSCC). Asked how they knew chip quality programs would help, Simmons admits that their optimism "was probably just instinctual. We didn't have any hard data. It was just kind of natural to know that if you improve the quality of chips and don't lose as much through the waste stream then you've got to improve your processes."

When the programs were restarted under SSCC, additional expertise was added in the form of New Hampshire-based "The Chip Doctor" on the recommendation of Forest Resources Division upper management. This technology, designed and developed by Biomass Resources Inc. and Sunbury Software, is hosted by Fiber-M Technologies Inc., an independent application service provider (ASP) for the pulp and paper industry.

This technology turned out to make a real difference as the outside consultant added both technical expertise in chip quality technology and a systematic software program for data

chip quality measurement

The Doctor is In

The system used by Smurfit-Stone's Virginia region is a compromise between sophisticated modeling and established approaches. It builds on existing in-house sampling to feed chip measurement data into a common database and analytical tool called "The Virtual Chip Doctor" (TVCD).

Chip quality data are input into the TVCD program in several ways. The program has been designed to accept uploads from either the Gradex or Rader chip classifying machines, as well as inputs directly into the program via a manual data-entry screen (available in both English and French).

Using trend analysis techniques, the application provides the mill management team, technical staff, and their suppliers with chip quality information in formats custom suited to the mill's style of operation. These customizable reports enable early detection of quality problems that go beyond traditional accepts and rejects limit yardsticks.

While this isn't a "Six-Sigma" program, it is a first step in putting the chip pile under modern statistical quality control. This is a "web-enabled" system (i.e., it runs remotely on dedicated servers with continuous staffing), so it doesn't put serious demands on the mill's internal information technology staff.

To date, Smurfit-Stone has used onsite technical consultants to identify and correct chip problems identified by the new analysis and reporting. However, the TVCD system has a "Recommended Corrective Action" feature (Figure 2). This series of viewers and maintenance checklists is designed to identify solutions to the root cause of chip problems. This should be effective since it includes specific "how-to" instructions going down to individual equipment setup and maintenance.

FIGURE 2:
A sample of a corrective action instruction screen

This combination of continuous, integrated, and widely shared information, built-in corrective action instructions, and the "Fiber Model" mill impact forecasting seem to have real potential for managing the chip pile. In Smurfit-Stone's Virginia region ,it has enabled reductions in production costs, equipment maintenance, chemical, and other expenses.

fiber savings

Typical Mill Benefits

In general, the establishment of a chip management system with a fully implemented information management system can yield the results shown in Table 2. Benefits include:

- Real-time reporting in dollars allows mill to account for savings (less wood purchased or more pulp produced for the same ton of chips)
- Annual real-dollar savings that can be measured and tracked real time (Figure 3)
- Facilitates statistical process control over the wood room and purchased chips
- Provides data to manage wood purchasing processes
- Supports measurement of total value chain performance
- Improves communication and problem solving throughout the mill by a shift to "facts-based decision processes using common information."

Note: Real-world data on the impact of TVCD's customers is confidential and proprietary information. TVCD has aggregated some "typicals" based on multiple customer experiences.

TABLE 2.

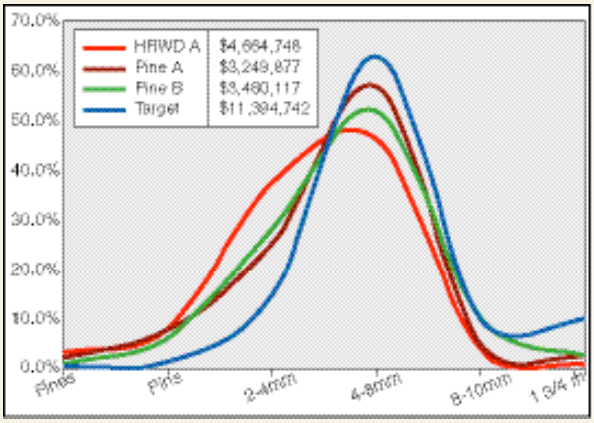
Typical results from a chip management system.

Item	Multiple Customer Results
Cost/return	$0.02. Cost of installation and operation of software divided by the quantified value of fiber savings.
ROI	$49.03/dollar invested (i.e., annual ROI)
Fiber utilization	Increases of 2% to 5% and higher on an ongoing basis
Chip quality ("accepts")	92% to 96% "accepts" pre-screened
Fiber value gain: screened out chips	$3 to $4/ton
Fiber value gain: digester pulp yield (fiber only)	$1 to $2/ton
Fiber value gain: total from chip quality distribution	$3 to $6/ton
Fiber yield savings (typical)	$5/ton*

*Example: Pulp mill green use of 1 million tons will yield savings of $5 million/year—fiber only, does not include other savings in chemicals, energy, etc.

FIGURE 3.

A sample of the Fiber Model savings impact.



acquisition, analysis, and remediation. This paralleled SSCC's own CustomerOne business philosophy of "Measure, Analyze, and Corrective Action."

According to Simmons, management then challenged this renewed program with the question, "Can we move chip quality by the way we set up chippers, particularly with the major contributors of our fiber supply?" For Simmons, that question raised immediate issues. "How would we know if we have been successful in changing chip quality?" Simmons says he had wondered. He concluded, "We had to start from the very beginning, again."

As they began, Simmons said they had to reestablish a sampling program (Figure 1). There were basic measures, such as percent accepts, but more was needed. The team also needed to understand what The Virtual Chip Doctor program meant and then establish complementary measurements.

Interestingly, Jordan's review of the technology was similar. "You have to have a sampling program to get this to work," he says. In his mind, the TVCD system is "just like a plant management system, and it allows you to be not only proactive but to get everyone on the same page. The slow trickle down of information typical of a mill ceases, and the guy supplying the chip pile often will know he has a problem before you do." Increasingly, Jordan feels such an information system will break down the walls between forest resources and the mill.

In the SSCC experience, once sampling and measures were in place, Simmons says his team "started working with the chippers again to move chip quality in the direction we thought we wanted to go. We accomplished that, and ever since then, it's been a learning experience."

Not without some pride in the results, Simmons now says, "We can measure, set a goal to change, and execute change." The chip quality program has yielded some significant wins, Simmons says, including:

- A major gain in ease and speed needed in identifying chip quality problems and trends
- The ability to "drill down" in the data to identify root causes at the specific fiber supplier level
- The credibility of the forest resources organization with its pulp mill customers.
- Leverage of limited (even declining) staff resources with a systematic internal sampling program mated to the external data analysis program
- A switch from the mode of "just go change something" by having "real data in front of all parties."

"When we've had a supplier who has embraced the recommended changes and maintained them, their chip quality has been steady," Simmons says. He adds that the quality measures "just jump up and then they're steady." There have been some added bonuses. Improvement of supplier chip quality reaches ▶

into the supplier's own operations. "The ones who are on board are getting more chips per tree with the help of the TVCD expertise," Simmons says, adding that, "we've seen a fairly consistent improvement."

Simmons admits that their progress could not have happened without a number of underlying advantages that helped make the SSCC program a winner. Among the more important success factors he sees are:

• An existing Smurfit-Stone operational culture of data-based decisionmaking. In fact, the corporate mantra of "measure/analyze/corrective action/sustainability" seems to have served the chip quality program well.

• The Virginia region's management commitment of mills and forest resources organizations to execute the chip quality program itself. However limited resources might be, chip quality must be someone's job.

• Availability of an off-the-shelf, relatively easy-to-install data acquisition and analysis program. In the case of the TVCD application, it took weeks and months, not the years typical of a start-from-scratch, do-it-yourself system.

• Availability of outside expertise from The Chip Doctor's staff in the technical intricacies of chipping. Educating the staff on how to succeed took more subtle technical knowledge than one might imagine. On the other hand, Simmons did see the same problems repetitively show up as he assigned The Chip Doctor's staff to visit suppliers.

Making An Impact

In all these discussions, one thing became clear. Even if a mill has significant data available, it's hard to know just what impact it is having with a chip quality program. As everyone points out, a mill is a very complex machine fed by a living material.

So what is the overall effect of chip quality improvement? Simmons believes, "Once you answer the question that, yes, you can sample, measure, and change chip quality, everything is open to you. Then you can start analyzing what the different chip quality factors have on the pulp mill and the impact you had." However, he adds, "Once you get to the digesters, there are

so many variables in that process that it gets very complicated. Yes, there's lab data that point to the impact of chip quality, but a mill is just so big and complicated that it's hard to measure the chip quality impact. All the measuring devices are just not in place to gauge and assign the impact on the whole mill's output."

Most corporations in this very competitive environment are not typically open to sharing the data, even if they had it. That makes knowing what the potential impact of chip quality is a challenge. However, as Simmons points out, TVCD's "Fiber Model" analysis tool can overcome this.

The "Fiber Model" was created to deal with this complex problem. This built-in software uses proprietary algorithms to predict the impact of chip profile, for example, against a mill's existing baseline. It can show the impact on mill efficiency and material usage of those adjustments via customizable graphs and tables.

In fact, says Simmons, "you can drill down by species or supplier in essentially real time." Most importantly, this automated model can even indicate the monetary value of potential changes (Table 1). Analysis of baseline, current, and target chip quality allows the prediction of potential savings from chip quality optimization. The impact of all unit managers seeing the same data at the same time in the same format is not to be underestimated.

While TVCD has confidentiality agreements with its clients that preclude publication of customer data, they were willing to aggregate its results from multiple installations and customers (see sidebar , p. 52).

People familiar with the internal operations of paper mills are familiar with the traditional conflict between mills and chip suppliers over chip quality. There is nothing more divisive than the finger pointing of a Monday morning meeting. Simmons says that as much as anything, the TVCD program has shifted those meetings and relationships from the tradition of "just change something" to a "fact-based problem solving" session.

SANDY SMITH *is CEO, Fiber-M Technologies, Bangor, Maine, and* **DAN DERBY** *is a freelance writer on business and technology issues based in Tuftonboro, N.H.*