

Integrated roll quality/roll tracking systems

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Hundreds of paper mills worldwide have installed computer-based roll tracking systems (RTS). Many have also installed independent quality tracking systems (QTS). Only when these systems are tightly integrated can the full benefits of each be realized by the mill.

"Computer Integrated Manufacturing" (CIM) in the paper industry means different things to different people. A good working definition is that the computer is so much an integral part of the production operation that the operation cannot function without it. The objective of a CIM system can be viewed as helping the mill to:

- Get the right roll (pallet or bale)
- To the right customer
- At the right time
- At the right quality
- At the right cost.

Paper mill CIM functions

Major functions performed by integrated RTS/QTS systems include:

- Order entry
- Block scheduling
- Run quality planning
- Trim optimization
- Paper machine data acquisition
- Lab operations
- Supercalender operations support
- Winder operations support
- Roll quality measurement
- Wrap line control
- Materials handling control
- Warehouse and shipping management
- Customer service support
- Production MIS.

An example of an existing system covering most of these areas in a modern mill is shown in **Fig. 1**. The major functional areas are discussed in the following paragraphs.

Order entry

Computer-based order entry systems invariably use customer master tables containing such information as addresses, billing information, customary sizes, core and wrapper requirements, etc.

In integrated RTS/QTS systems, the customer files also include quality requirements. In several mills, quality tolerances are first established by the grade ordered. These tolerances can be overridden automatically for a particular customer, which in turn can be overridden by an individual order for that customer.

Block scheduling

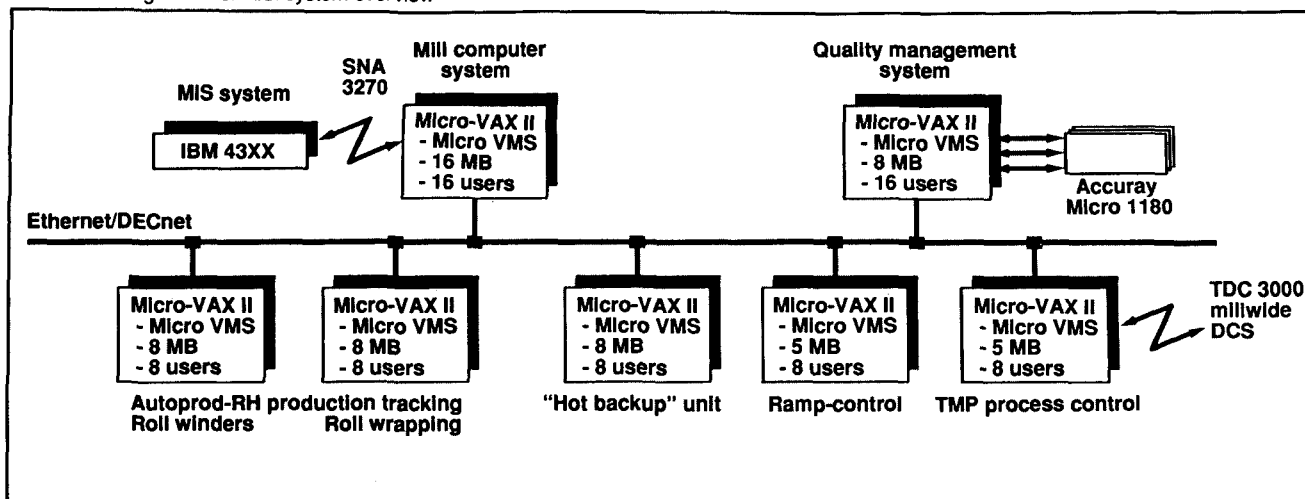
This term refers to the scheduling of blocks of time ("runs") on the paper machine and the assignment of orders to those runs. In a pure roll tracking system, the run is specified simply by a grade number, a start time, a stop time, and a list of orders whose tonnage is consistent with the total time allotted. The mill production schedule is generally responsible for setting up the run scheduler, which is available on dozens of computer terminals throughout the mill and of which dozens of hard copies are made as well. These copies can be found on virtually every supervisor's desk.

Run quality planning

In a modern mill with integrated RTS/QTS systems, the production scheduler and the technical department work hand in hand. In such a mill, the run is not considered scheduled until run quality standards for it have been entered into the computer. These standards are considered as important as the time and tonnage data in the run schedule. By linking them together, when a grade change occurs, the central planning computer can download new setpoints to the distributed control system (DCS) in the pulp mill, the paper machine DCS, and the paper machine measurement systems; the computer can also release testing criteria to the labs. There have been numerous

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1. Norske Skogindustrier A.S. system overview



instances where using manual systems resulted in the use of out-of-date specs, omission of tests, setting up incorrect setpoints, and so on.

Trim optimization

Since the late 1960s, there have been good packages available for computer development of winder cutting patterns to minimize trim loss. The better packages also take into account order priorities, vehicle loading, and other logistical factors. The only consideration of roll quality requirements has been indirect, by allowing the scheduler to flag certain orders not to be placed at the edge of the sheet, for example. It has also been possible to do dynamic retrimming of the balance of a run to make up losses or recognize problems with making the planned deckle, etc.

For example, there is one mill in which a computer at the winder, in real time, compares the cutting pattern developed earlier by the scheduler with the quality profile of the reel being wound. The result is to swap rolls within the pattern from zones of inadequate quality to those adequate for each roll's order. This is an emerging area with potentially great benefit to the mills.

In addition, state-of-the-art mills prepare integrated plans in which the winder trim schedule is coupled with a warehouse or loading schedule that ensures that rolls arrive "just in time" at their destination.

Paper machine data acquisition

Modern measurement and control systems generate a constant stream of data: speeds, flows, profiles, trends, streaks, holes, footages, break times, and so on. It is not uncommon for a new paper machine measurement system alone to generate 20 or more profiles—per scan—with 480 data points per scan.

A traditional roll tracking system doesn't begin its tracking until the winder—and consequently does not contain these data. Modern systems begin tracking at the reel and marry the quality data generated by the tracking systems with the logistics related to the physical reel.

One new mill in Great Britain utilizes metal barcode tags attached to each reel spool. A laser barcode reader at the reel reads this tag at turn up. This allows the system

to associate the spool I.D. number with the stream of quality data that has been coming to it over the past 45 minutes as the spool builds up. At each subsequent station, additional barcode readers identify the spool and hence the paper wound on it. Visible defects, breaks, splices, and other information are entered by operators into computer terminals in the control room.

Lab operations

Many labs have replaced the traditional two-foot wide data recording pad with computers of one sort or another—generally PCs. In a modern integrated system, a terminal instead gives access to a database which shows, on the same screen, the run quality requirements established earlier, DCS data, and measurement system data for the current reel being tested as well as previous reels. The lab test data are entered into the same database. A number of mills have Robotest, or other Lorentzen and Wettre automated testing machines whose data go directly, automatically, into the quality database.

One major benefit of a common quality database is that it allows immediate correlation of on-line sensor and lab data. Likewise, troubleshooting from one database can utilize DCS data, measurement system data, lab data, and roll inspection data.

Supercalender operations support

There are several mills where the supercalender operator has access to the measurement system profiles of the reel currently being calendered or about to be calendered. One mill in the upper Midwest provides the operator a composite profile trend, sometimes referred to as a "waterfall chart" due to its appearance. This is a graphic display or printout of the composite profiles for a number of reels, in sequence, having the appearance of a contour map. Internal contour maps for individual reels—made up of scan-by-scan data—are available, but not generally used.

One mill in Europe has available a sort of "before and after" display where one line shows the average caliper (or moisture or basis weight) foot by foot through the reel as it emerges from the paper machine. A second line in a different color is overlaid on the first, showing the same

variable as the paper emerges from the supercalender.

These kinds of displays are only possible through integration of the quality system, which has information about the quality of each reel, and the roll tracking system, which tracks the reel currently at the calender.

Winder operations

The winder represents a critical control point in the process, for it is here that in a roll (as opposed to sheeting) the final product of that mill—a shipping roll—is created. It is at this point that the “accept, reject, hold” decision takes place. In a modern integrated mill, that decision is computer assisted.

Furthermore, in many mills the winder knives are set not by operators but by the roll tracking system, operating through some mechanism on the winder. Quality data, specifically profile data, are useful in determining which roll to cut out of which position. As the article discussed earlier, that decision can be automated.

The quality database is also updated by the operator’s visual inspection—that the roll was telescoped, for example, or damaged in breaking apart the set.

At this point rolls are barcoded for further tracking.

Individual roll quality measurement

There are several technical issues to consider when integrating measurement system profile data with winder set up data to determine quality by roll. In the cross-machine direction (CD), the profile at many mills is specified by as few as 60 values (i.e., 60 “data boxes”) for each variable (basis weight, caliper, moisture, etc.). In the machine direction (MD), the individual scans, perhaps 40–60 of them, are averaged by the measurement system to provide a single “composite profile” for the reel. Thus, in the simplest (and most common) method, roll quality is determined by taking 60 values, referencing them to distances from the front of the sheet and overlaying the winder knife settings, also referenced to the front of the sheet. For example, on a 200-in. machine, each data box (of 60) would represent 3.33 in. A 30-in. roll cut from the reel between 45 and 75 in. from the front would include paper measured in part of data box 14 (45 divided by 3.33 equals 13.51), all of data boxes 15 through 22, and part of data box 23 (75 divided by 3.33 equals 22.52).

There are two flaws in the above approach. First, state of the art measurement technology, such as that used by the AccuRay First Sight® system, provides not 60 but 480 data boxes of resolution. Where a 1-in. streak would “disappear” in a 3.33-in. data box, it would show clearly in a 0.42-in. (200 in. divided by 480) data box.

Second, use of a composite profile averages out MD variations throughout the reel. If the machine has MD stability problems, or if the reel being wound is the first after a grade change, these can be significant.

Thus the most advanced systems (of which there are only a few in the world) store each scan, at the highest practical resolution, as the reel is being built. These data are tagged by the footage into the reel and retained on disk in the computer system until the reel is wound, perhaps many hours later. At this point, the reel is represented by a matrix of perhaps 60 rows—one per scan—and 480 columns—one per data box. Individual cells in this matrix are associated with specific rolls, based on the beginning

and ending footage of the set they were cut from and their position across the set. This technique takes considerably more computer disk storage and processor power and is only justified when the grade, or the mill’s marketing posture, requires a “zero defects” approach to roll inspection.

Wrap line control

Modern roll wrappers are programmable logic controller (PLC) driven at the least and, in some cases, function as robotic subsystems to the roll tracking system. In the subsystem case, the wrapper manufacturer provides a laser scanner, a positioner for it, a scale, a roll width and diameter verification device, a label printer, and an automatic label applicator. In other cases, the tracking system vendor provides and integrates many of these functions. A barcoded shipping label is placed on each roll in either case.

Materials handling control

At one advanced mill in Norway, the mill planning computer, the roll tracking computer, a quality tracking computer, and a roll ramp/conveyor control computer are all connected to a single mill data network. In this mill, the scheduler enters a warehouse destination for each roll into the planning computer when he prepares a run schedule. When the roll tracking computer determines that a specific roll has been wrapped and is of shippable quality (based on data from the quality tracking computer), it transmits a message to the roll ramp/conveyor control computer saying, in essence, “Here comes roll 12345, put it in bay T102.” When a roll arrives at the input to the sort deck, its barcode is read and the roll ramp/conveyor control computer directs it to the proper lane. Later that lane is offloaded onto one of six conveyor tracks and taken automatically to the proper area of the warehouse.

Warehouse and shipping management

Even if all systems (human and computer based) have performed perfectly up to this point, and the right roll is wrapped properly and has the right label on it, it can still be loaded into the wrong vehicle, or not loaded at all. The best technology to control this is the use of radio-linked terminals on the lift trucks. To the computer, these terminals behave just as if they were hard wired to it, but in fact they communicate on a radio link. Many mills in North America and some in Europe have proven this technology. First the lift truck operator keys in the lot or order he is to load, then the computer tells him to go to “bay T102 and get roll 12345.” Once he has the roll, he either keys in the roll number or a check digit, or uses a hand-held laser to scan its barcode. If he has the wrong roll, the computer generates an alarm message. When he loads the roll, he can scan a barcode attached to the entrance of the vehicle. If he is loading it into the wrong vehicle, again an alarm is produced.

Customer service

It is in customer service that an integrated roll tracking/roll quality database can make an immediate impression on the customer. Given a complaint about a roll, customer service can type the roll number into the computer and

immediately retrieve the date and time that it was wound, its position in the set, the profile of the reel (or as noted above, possibly the true profile of the individual roll), the running conditions of the machine, and so on. If indeed the roll was defective, it can be determined if any other similar rolls were sent to the customer and he can be warned not to run them.

Production MIS

One of the hot topics in paper manufacturing in recent years has been that of the "single window" or "single window on the process." An integrated RTS/QTS can be a key element in such a system, given the right networking and data presentation technologies. By itself, the integrated RTS/QTS can provide production management with consistent information from the paper machine to the

shipping dock that deals with both quantity and quality of production. The same terminal can display production efficiency, measurement system and lab data.

Summary

As the paper industry employs more and more computer automation in its operations, it will achieve the greatest benefit not through "islands of automation" but through integrated systems that help us manage the critical elements of our business in harmony. □

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