Statistical process control and its application in a chemi-thermomechanical pulp mill

Christer D. Henriksson and Tony Ho

KEYWORDS: Control systems, process control, statistical methods, chemi-thermomechanical pulps, pulp mills, quality, computers, information systems, personnel, charts, homogeneity.

Slave Lake Pulp Corp. started up its greenfield bleached chemi-thermomechanical pulp mill in December 1990. Prior to startup, the implementation of statistical process control (SPC) commenced with training for all 75 employees. This training included not only basic SPC methodology but also other aspects such as team skills, which were considered essential for successful implementation of the program. After startup, control charts were developed to enable the operators to determine if a process was "out of control."

The SPC package used in the mill was supplied by MoDo Chemetics and runs on its Millwide Optimization System (MOPS). This information system acquires data from different systems in the mill and makes it available to a number of users. The types of data can be anything from a flow meter reading to a laboratory input. The SPC tools are then applied to these data for monitoring.

This paper discusses the conceptual and practical use of SPC techniques. Mill experience with statistical control of two key pulp properties is detailed, along with the hurdles overcome to make the system successful.

Results and discussion

The two key pulp qualities controlled by the operators are freeness and brightness. These parameters are measures of the ability of pulp to drain and the visual appearance of pulp. We decided these two parameters should be controlled using SPC techniques. The operators measure these two parameters once every hour and input the data into MOPS, which stores the values in a database.

A new control chart is generated every time there is a new input. Having entered the last measurement, the operator checks the control chart to see if the process is "in control" before taking any further action.

Figure 1 illustrates the use of moving range control charts for controlling pulp brightness. The x-chart is displayed in the top window; the moving range chart is in the bottom window. Fixed control limits were calculated for a sample size of 2 and a subgroup size of 24. A standard deviation of 3 sigma was used in the calculation, but tighter control limits can be achieved if sigma is reduced. The benefit from a smaller sigma is quicker response to out-of-control situations. The drawback is an increase in the number of out-of-control points.

The moving range control charts for pulp freeness are displayed in **Fig. 2**. The subgroup size was changed to 42, and the time span covered was over 2 days. The moving limit option was selected for this case, as shown by the steplike functions of the control limits. The moving limit is calculated from past samples by shifting samples, one at a time.

One limit alarm was encountered in the moving range chart; a run of seven consecutive points below the average range limit was detected from subgroup no. 7 to subgroup no. 15 (count from the left-hand side). This alarm could indicate that a shift may be occurring in the direction of the process. The process was analyzed but found to be in control.

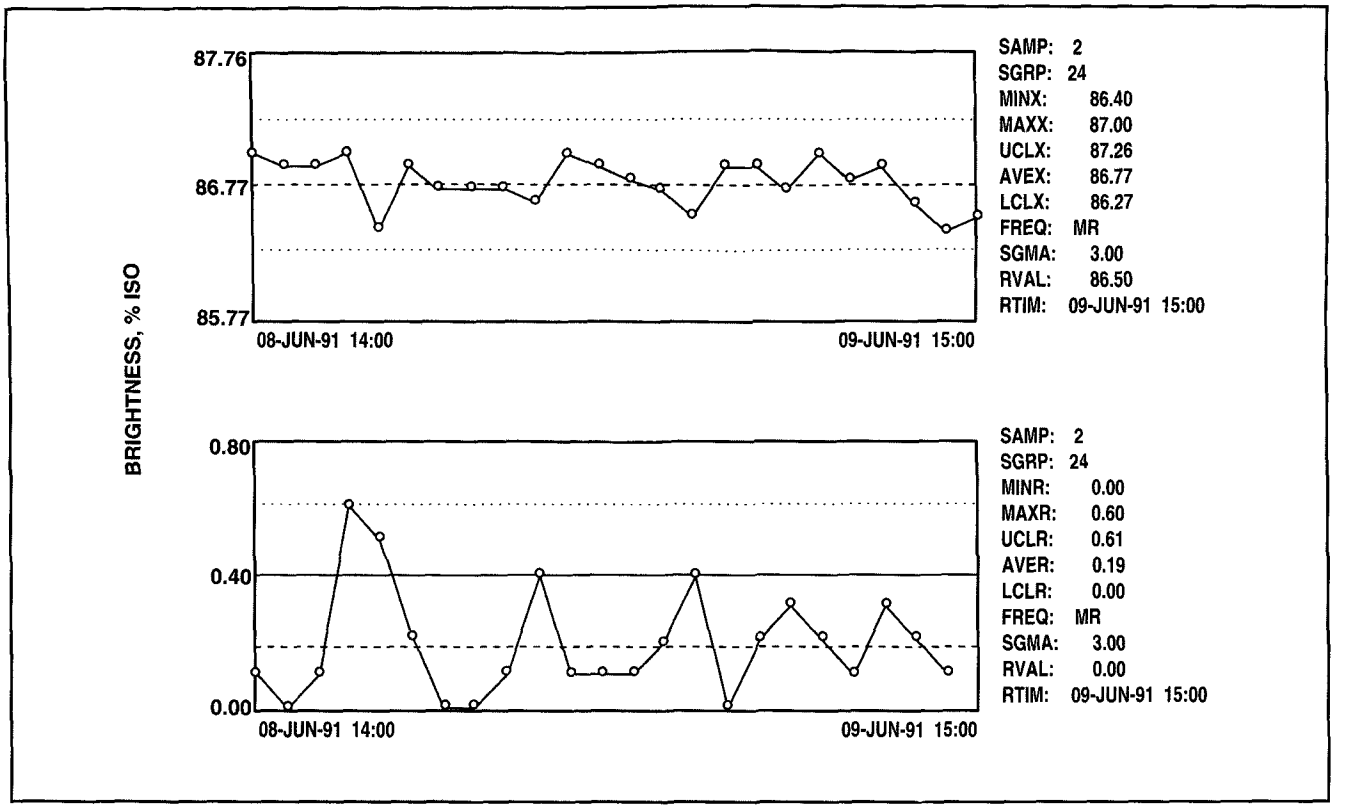
Figure 3 indicates an out-of-control situation. The last freeness was measured to be 321 mL CSF. When this occurred, the operators used the tools they had learned in earlier SPC courses. With the help of troubleshooting techniques, the problem was solved. The proper adjustment was made to the refiner, and the freeness was brought under control.

In the same figure, there is also an earlier occurrence of two consecutive relatively low freenesses: 338 mL and 329 mL. At the time, the operator made no change to the process since the SPC chart indicates the points are in control. The following measurements were on target. In this case, the SPC chart prevented a possible overadjustment.

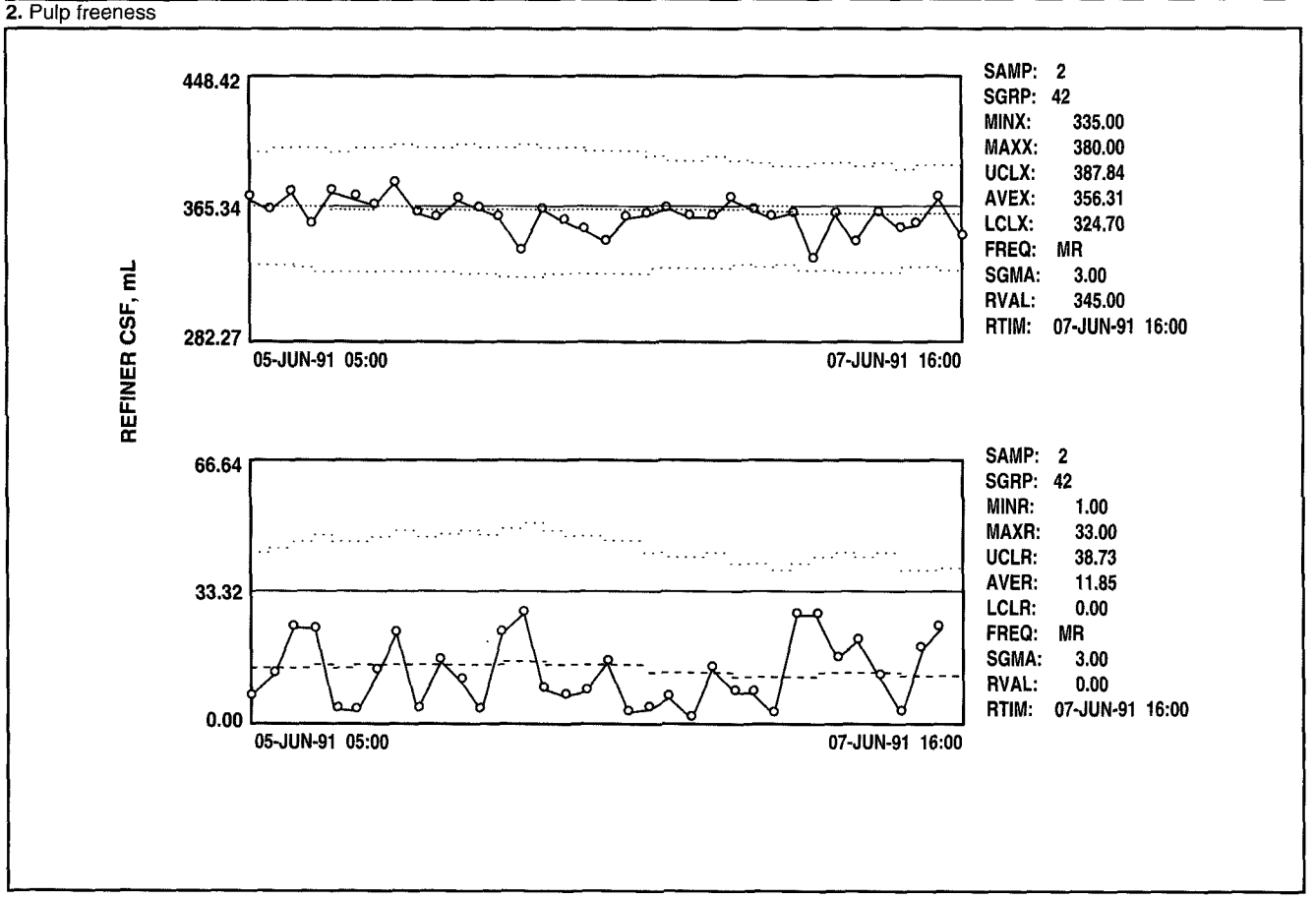
Despite consistent operator training, individual learned experience in the mill environment is somewhat variable, resulting in some variability in operator response to problems. Some operators make a process change the moment a number seems a little bit odd, while others decide to wait for more measurements before making the same change.

We are trying to establish a continuity in the way the

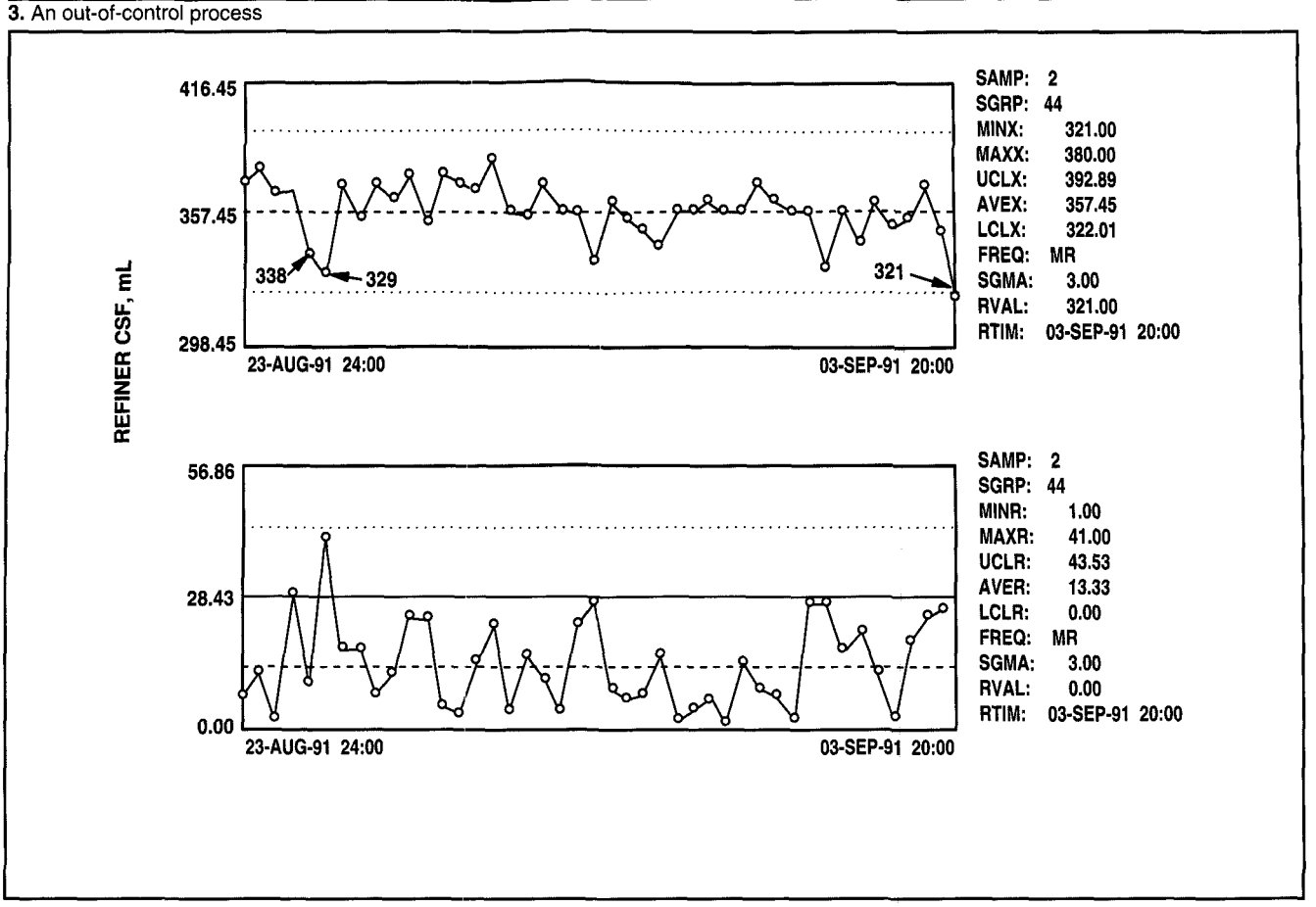
1. Pulp brightness



2. Pulp freeness



3. An out-of-control process



mill is run to ensure a consistent pulp quality. SPC and control charts have allowed us to do this.

Since the operators started using SPC, the product uniformity of our final brightness and freeness have been improved by 60% and 26%, respectively.

The concept of SPC and control chart monitoring does not progress by itself. Constant monitoring and nurturing by upper management are required, along with a commitment by all employees to make it successful.

Continuous retraining is essential for the SPC program to stay alive. At Slave Lake Pulp Corp. we have already had one retraining session that emphasized the concept of teamwork. There also has been individual training for each operator on how to use the control charts.

Despite the fact that Slave Lake has a lean organization, follow-up has been emphasized to ensure that interest and success are maintained.

We have used control charts on a daily basis since April 1991. We are still in a SPC startup phase and are slowly expanding it to include more variables and more people. So far, it has been accepted as an excellent tool for controlling and monitoring the process. The general rule is: If a process is in control, do not make a change. This has allowed us to decrease our process variability and improve our final quality.

Conclusions

Implementation of SPC at Slave Lake Pulp Corp. has resulted in 60% and 26% improvement in product uniformity of brightness and freeness, respectively. The SPC program has total operator acceptance. With the success of the program, additional parameters will be monitored to realize further improvements in product uniformity and effluent quality. ◧

Received for review Sept. 23, 1991.

Accepted March 5, 1992.

Henriksson is a process engineer for Slave Lake Pulp Corp., P. O. Box 1790, Slave Lake, AB, Canada T0G 2A0. Ho is a project engineer for Chemetics International Co., MoDo Chemetics Division, 1818 Cornwall Ave., Vancouver, BC, Canada V6J 1C7.