Improve Paper Quality by Combining Cross Direction (CD) Profile Measurements with Process Measurements

WHITE PAPER BY TRIMBLE

ABSTRACT

Profile measurements are typically monitored visually with 2D-profile maps. 2D-profile maps are usually designed for viewing purposes and it is difficult to extract useful detailed information from those. Process measurements cannot be studied together with profile maps, so it is not possible to perform root-cause analysis to find the origin of profile quality disruptions. There is a need for a flexible profile data handling system with an online connection to process data.

With an advanced data analytics system like Wedge, profile data can be handled similarly to other process measurements.

You can freely select a time frame for study and clear outlier data points from the data set. The analysis can be focused on certain time periods, i.e., grade runs or jumbo rolls, etc. Profile variations can be characterized with calculated indices that pinpoint problems in the profile measurements. The profile variation indices can be compared with process measurements to find those process changes that cause changes in Cross Direction (CD) profiles. This methodology ensures the uniform and high-quality CD profile of the produced paper.

wedgesales@trimble.com

wedge.trimble.com

INTRODUCTION

This paper presents a new technique for combining the analysis of Cross Direction (CD) profiles and process measurements. A brief example calculation and the analysis methodology are given.

BACKGROUND ON PROFILE MEASUREMENTS

Uniform paper quality is a very important factor in keeping the paper production profitable. Good and uniform paper quality enables paper producers to run their processes in a more predictable way and keep their promises to their customers. This way paper producers can avoid paper price reductions in a highly competitive market and keep the production profitable.

A typical way to monitor the quality of paper is to use the visual 2D-profile maps of the paper web (Figure 1). However, only the most significant quality problems can be seen on these maps. Slow long-term changes cannot be recognized through visual monitoring at all.

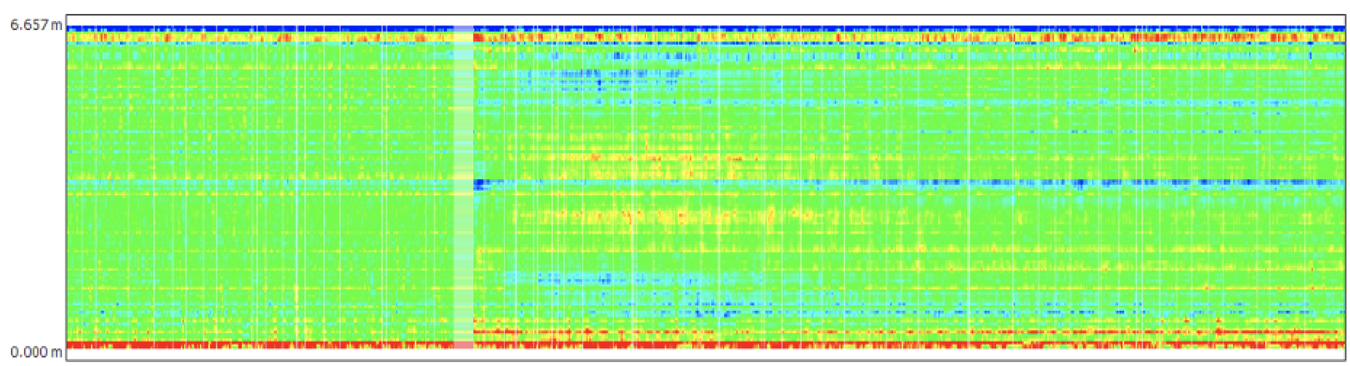

Figure 1. 2-D paper profile map

From an analysis point of view, the problem is that it is not possible to connect the profile maps to the process measurements. Therefore, it is sometimes impossible to find the root cause of the profile problem. It would be useful to have methods to handle long-term history data and to learn how different changes in the process affect the stability of profile maps.

Process data handling tools have developed significantly during the past few decades. It is now possible to handle a lot of data with these systems and analyze what is happening in the process. Profile data handling systems have been developed as well, but these are separate systems. Obviously, there is a need for a flexible profile data handling system with a seamless connection to on-line process data. It must be possible, for example, to freely select any time interval in history and study process measurements at the same time. With this type of system, the user could efficiently study profile problems and troubleshoot the problem to fix it as fast as possible. Remarkably better quality could be achieved with this type of profile handling system.

There are several types of profile problems. Ideally, all numerical values in one individual scan are exactly the same. In practice, there is always some variation in the values. The best situation that can be achieved is that the values are normally distributed around the set-point and the variation is small. The user should notice immediately if the profile differs from this type of situation.

There are two main categories of profile changes:

- Changes in the shape of scan vectors
- Changes in the distribution of scan values

In figure 2, there are four examples of changes in the shapes of individual profile scans. The scan at the top is tilted, the left side is at a lower level and the values increase constantly toward the right side. The other examples are the U-shape, the S-shape, and the W-shape.

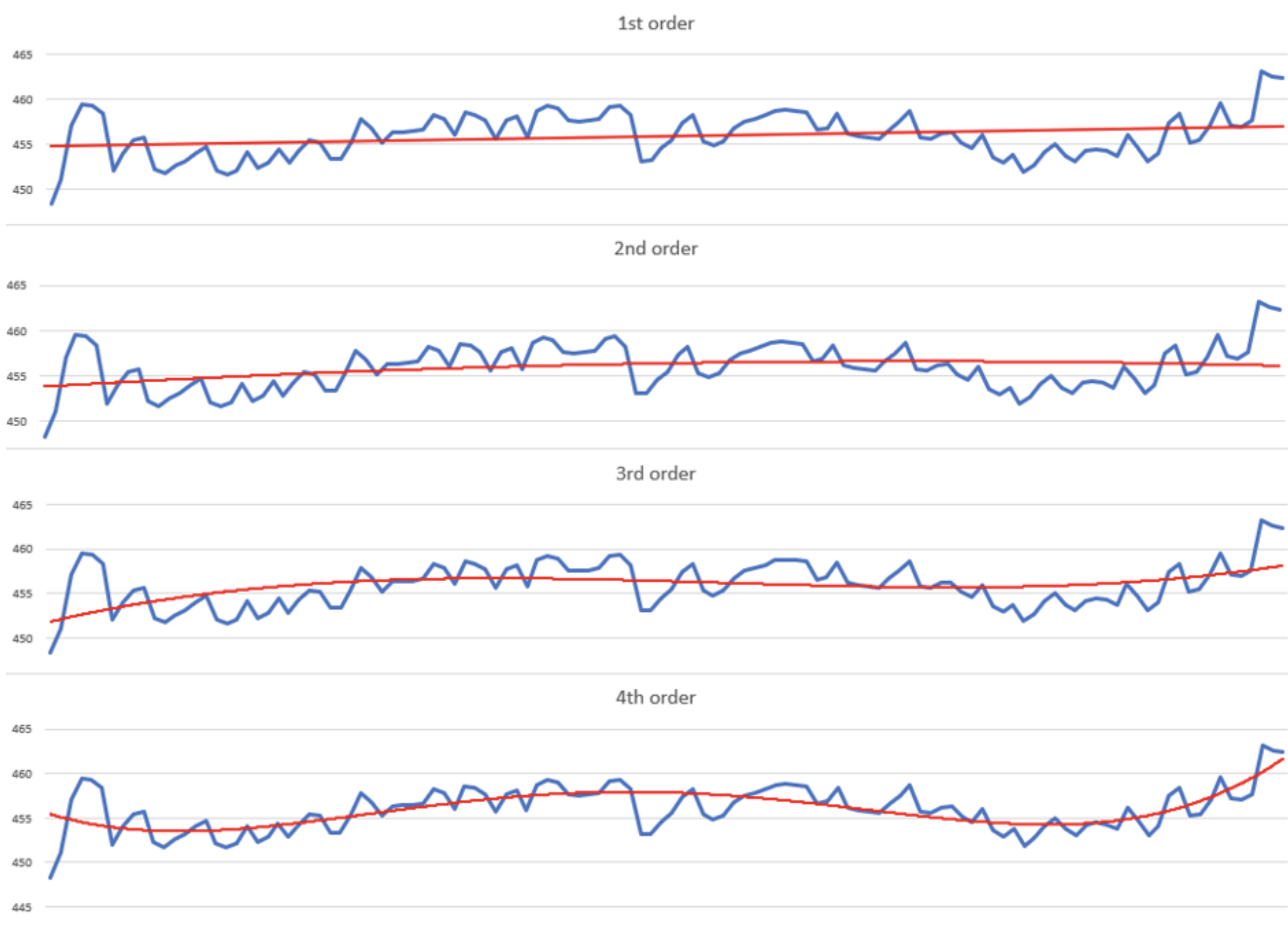

Figure 2. Different shapes of individual profile scans

The other problem type is that the distribution of scan values differs from a normal distribution. These changes are described with mathematical momentum calculations. The momentums are:

1. average of scan values
2. standard deviation of scan values
3. skewness indicating symmetry of distribution
4. kurtosis indicating shape of distribution

In figure 3, there are examples of momentum values.

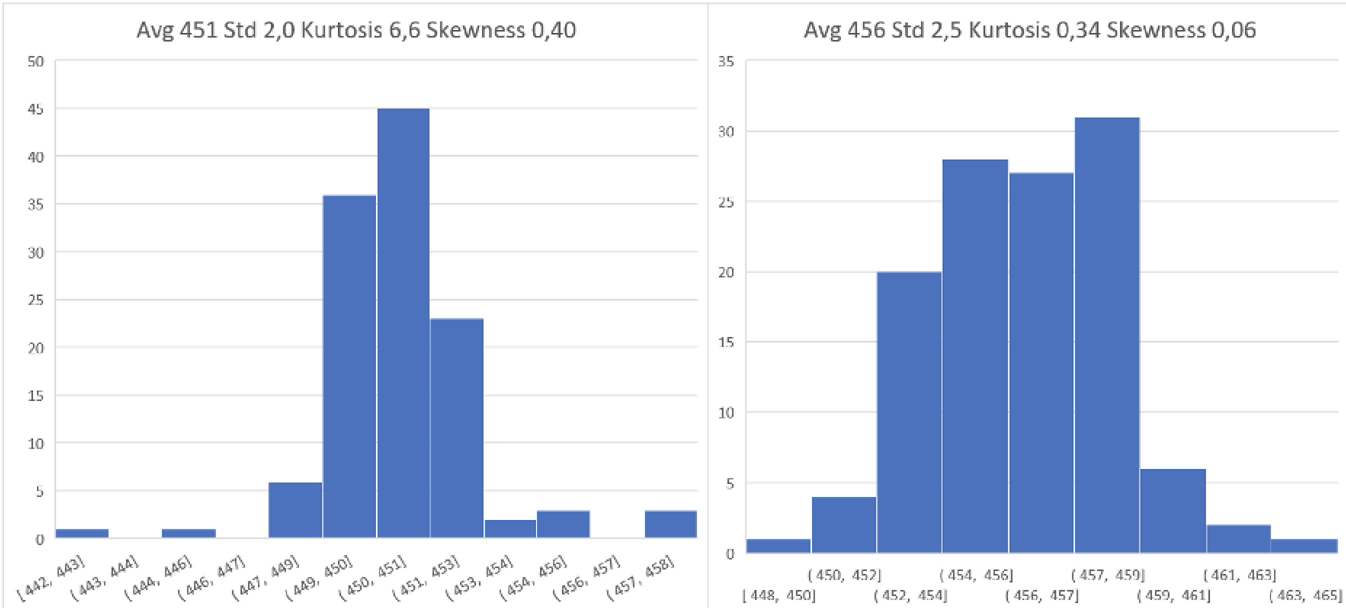

Figure 3. Two different momentum values of a profile scan; spikes in a scan indicate that the distribution differs from normal distribution

COMBINING PROFILE AND PROCESS MEASUREMENTS

We must be able to combine the information hidden in profile maps with the process data of a profile variation index. Different types of indices indicate when certain types of profile problems occur. These index values can be monitored as trends and can, therefore, be studied together with process measurements. When the profile map information is converted into trend format, it can be handled like other process measurements, and it is possible to use process diagnostics methods to find the root cause of profile changes.

The calculated profile indices also enable the efficient study of long-term changes in the uniformity of paper profiles. The time span here can be several months or even years.

In the Wedge system, profile data can be handled similarly to any other process measurement. The user can freely select any time frame to study, for example, one day or data for a certain paper grade over the previous month, etc.

The profile indices are calculated continuously into the database and the user can study those indices together with profile maps or other process measurements.

When a certain profile index indicates that there are changes in the paper profiles, the user can focus the root-cause analysis on those time intervals where the biggest problems are.

In figure 4, the index indicates that the profile is W-shaped. You can check this by clicking the same time point on the profile map.

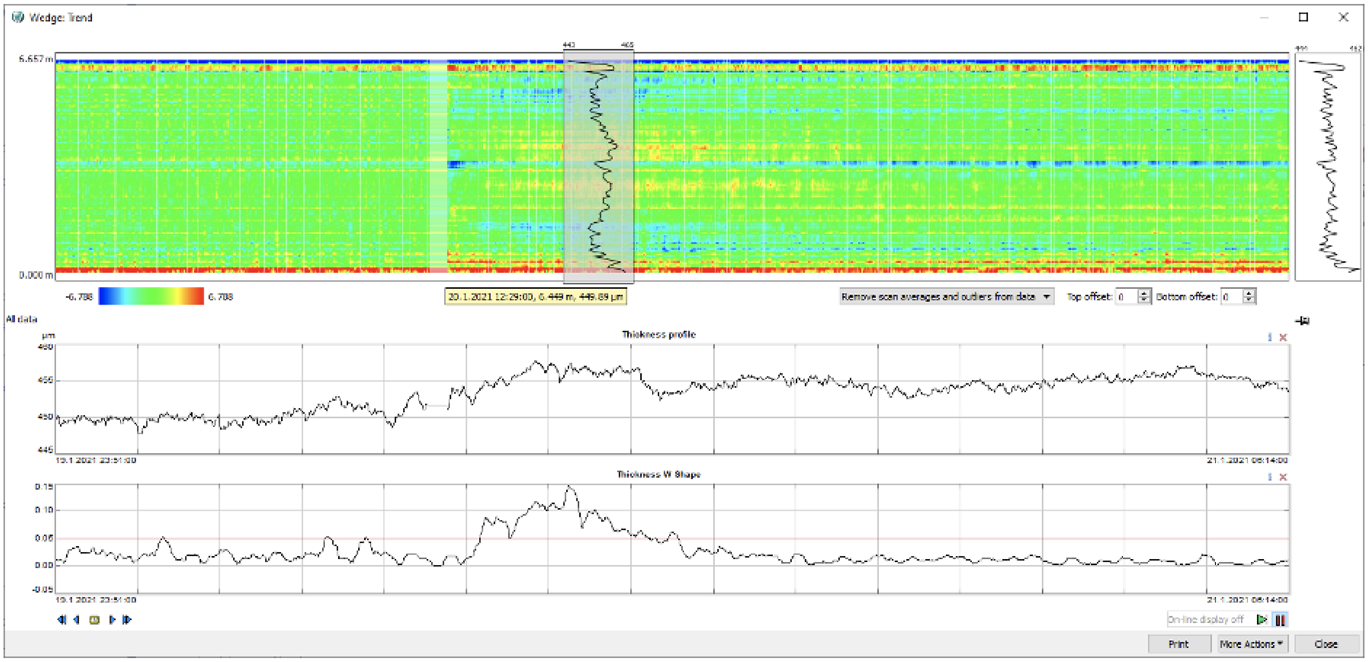

Figure 4. W-shaped profile variation index compared with process measurements to find those process changes that cause changes in the CD profile

In figure 5, the root cause of the W-shape of the profile is diagnosed with the pattern recognition method. Wedge can go through all other measurements and find the ones that have a similar or mirror pattern at the same time or before the W-shape changes. As a result, Wedge lists root cause candidates for the quality issue.

As a Wedge user, you don't have to worry about possible process delays, since the pattern-recognition tool compensates for them automatically.

Figure 5 shows which process measurements correlate best with the W-shaped index.

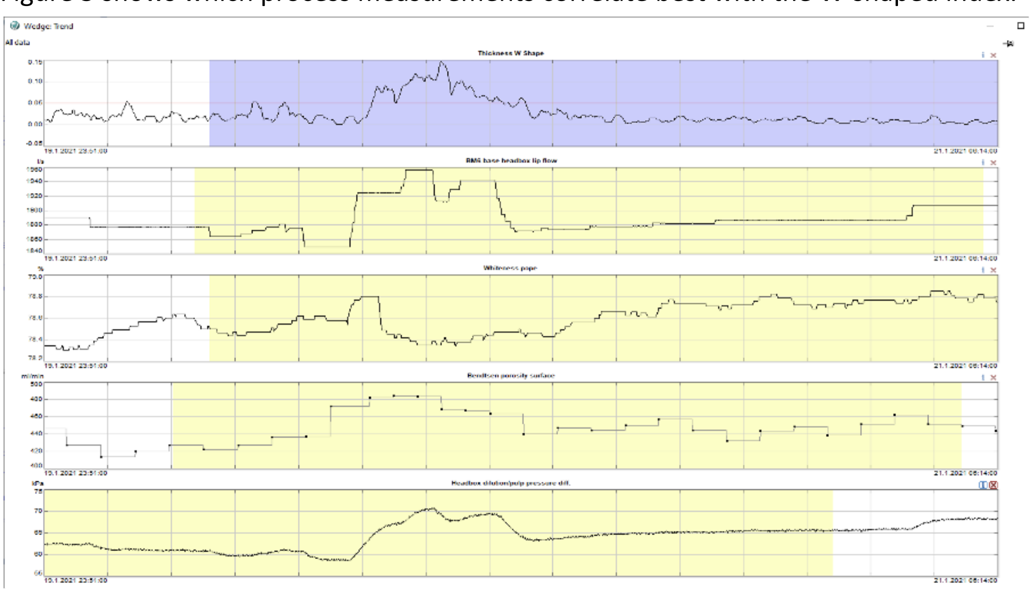

Figure 5. Process measurements that best correlate with the W-shaped index by waveform identification technique

CONCLUSIONS

This methodology helps the user quickly find the root cause of the profile problem and ensure the uniform and high-quality CD profile of the produced paper. The analysis methodology and procedure are reliable, fast, and user-friendly, so the results are also reliable and obtained fast. This is of extreme importance, as otherwise the analysis is neglected because of the high workload or because the analysis results may be faulty.