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By PAUL GOSS

Mills have created the tools to improve effectiveness, but it can be taken further by analyzing the data effectively

## UNDERSTAND DATA; IMPROVE PROFITABILITY

**D**ata handling and storage technology is one of the fastest developing technologies in the industry. Only five years ago our focus was on how to save megabytes, we now don't even think twice about storing giga- or even terabytes.

What we have to think about though, is the reason for collecting and storing data if we do not put it to use. The more data that we are confronted with, the more difficult it becomes to make this data work for us. The papermaker of today needs to benefit from the knowledge of his process that data can bring him. He does not want to spend hours analyzing data; he needs the help of easy to manage tools that do the data analysis job for him and then provide him with clear criteria to make the right decisions.

It is well recognized in the industry that any optimization of our processes is usually accompanied by collecting, storing and analyzing data. As a result of this, the automation landscape surrounding paper machines has become extensive. Fewer than 40 years ago an average paper machine was equipped with 10 or 20 local controllers, controlling for instance the main steam flow, headbox pressure and stock flow. The paper machine of today is very much a highly sophisticated process that cannot be run without the help of an extensive distributed control system (DCS). Initially the DCS system was more an assistant that, if necessary, could be left out. Systems in the likeness of distributed control, quality control (QCS) and web inspection (WIS) have now become essential in running the papermaking process. Without these systems we have to conclude that in most cases the process will grind to a halt.

These systems combine and control information to-and-from hundreds, or in some cases thousands, of instruments located in and around the paper machine. The simple numbers make it impossible for the operator of today to manage the process of papermaking without some computerized form of help.

We could ask ourselves the question: why have we let it get so far that we cannot make paper anymore without the help of the computer? In many mills we often hear how papermakers of the past could make paper without the help of the modern day "digital buddy". The truth most likely is, that the professional of the past could make paper without the modern day assistant; however, it would be of the same quality and at the same costs as many years ago. It is also a fact that the former level of quality and efficiency is not good enough to survive in today's world. The reason

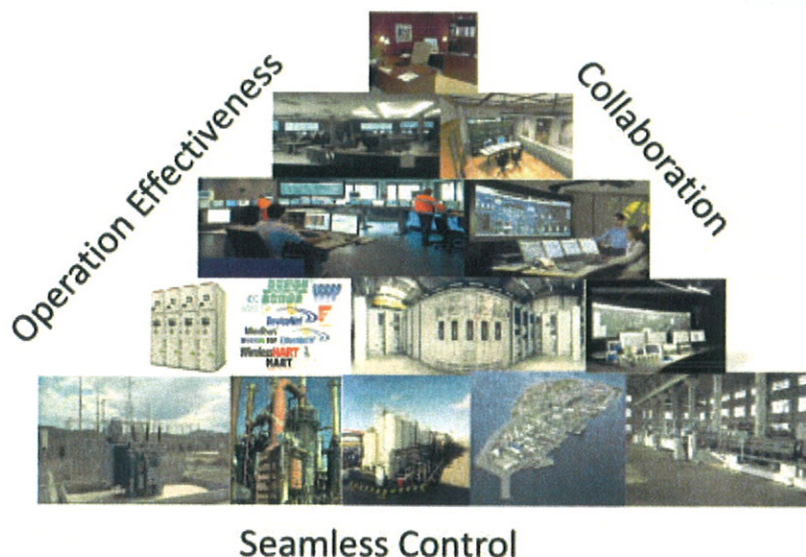


Fig. 1 - Integrated operation requires all three components named above



we have so much reliance on our "digital buddy" to make paper, is that we need to make a high quality product in the most optimized way.

We have come a long way in the last 20 years; however, there is still room to improve. We can learn a huge amount on how to do this from our daily life; take for instance our most common form of transport, the automobile. The combustion engine of today still has the same basis Nicolaus Otto used in 1876, but when it comes to performance and efficiency the modern combustion engine cannot be compared with Otto's early designs. Until the 1970s, optimization of the combustion engine was mainly achieved by improvements on the mechanical engineering side, but since the 1980s combustion engines have been more and more digitalized. The combustion engine is equipped with sensors, electronic actuators all controlled by the famous motor management. With the focus on the environment and cost optimization increasing, the combustion engine would have been banned without this digital evolution.

The modernization of the combustion engine is a true example of starting with measuring the process, analyzing the data and then using the results to optimize and improve, in many cases in real time closed loop control. The process of collecting and analyzing data of the combustion engineering has led to efficiency improvements of over 100% in day-to-day use.

If we compare the evolution of the combustion engine with the papermaking process, we can conclude that we are only part of the way. Most paper machines are equipped with automation systems like the DCS, QCS, WIS, web monitoring systems and modern drive systems. Thousands of gigabytes of information are collected from many data points, an average of 500 control loops (or more in some cases) on a paper machine is today's standard. We can conclude that the paper industry has this part well under control, we know where and how we want to equip the paper machine with measurements and controls. The question is: are we using this expertise to its full potential?

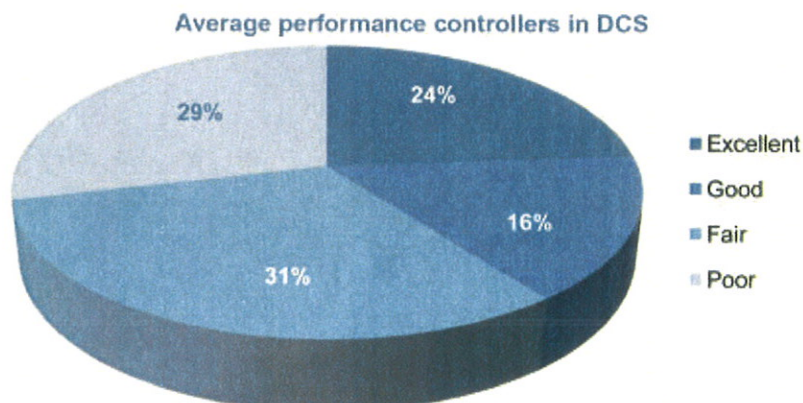
#### INCREASING COMPLEXITY

The answer to this question lies in the success of the systems; the extensive implementation and sheer size of the systems have outgrown our ability to oversee. The vast number of input/output signals and associated controls makes it impossible to see the full picture. It is exactly the success of distributed control and the ease of implementation that has led to the excessive numbers of control loops and information, making it impossible to optimize and monitor all of these.

The simple amount of the control loops prevents us from analyzing and optimizing on system implementation or initial machine startup. In nine out of 10 cases the loops are not revisited or optimized after the implementation. Careful analysis of a number of running paper machines, controlled by systems from different origin, shows the potential clearly; less than 50% of the implemented loops in improvement potential of 50% or more.

Like Otto's combustion engine, the actual process of making paper was not changed, but the process has been optimized and fine tuned in many areas, increasing complexity and making it difficult to analyze without the help of the data. To take the next step in making the paper process more efficient it is important that we use the data that we are collecting on a day-to-day basis to optimize and improve efficiency. Here are some ideas on how we could do this:

- Using data to analyze frequency of failures and defects;



Source: ABB analysis multiple independent DCS systems in P&P industry

Less than 50% of the data is performing for us.....

Fig. 2 - Effect of collecting the data



- Using data to check and improve the health of the controls;
- Using data to check the quality of the end product;
- Using data to reduce indirect maintenance.

Let's explain the background of these in more detail:

**Using data to determine frequency of failures and defects:** A standard function of control systems is reporting alarms, as such nothing special, however if we look into how we handle alarms we immediately see the improvement potential. Due to the large number of data points the systems are managing, a common result is a large number of alarms showing up on the monitors, creating the situation where operators develop a blindness to alarms, missing the

critical ones or not recognizing repeating alarms. This results in unwanted process upsets or, not uncommonly, failure situations that last for years and years. If we analyze alarm data we can address and remove dominant and unwanted situations, thus improving the process efficiency. Would it not be highly beneficial if we could analyze for instance:

- The number of active, unacknowledged, hidden, and/or shelved alarms;
- The alarm rates and average, maximum number of alarms per hour;
- The average time to acknowledge alarms;
- The percentages of alarms above acceptability level (user defined);
- The percentages of alarms above intense level (user defined);

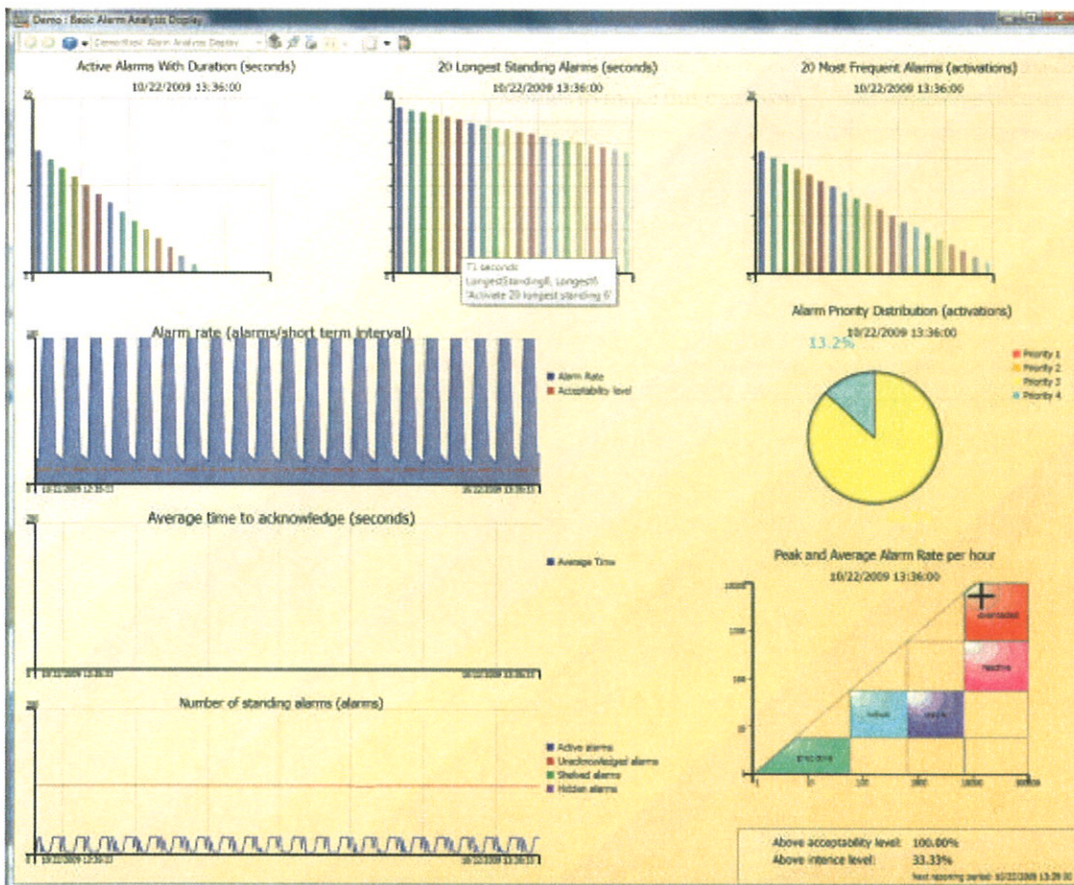


Fig. 3 - Alarm analysis operation: The alarm analyses function delivers KPIs for the alarm handling configured in the control system



- The most frequent alarms;
- The alarms that were active for the longest time;
- The still active alarms that were active for the longest time.

Based on a detailed analysis of alarms it is possible to address and remove long term or reoccurring process upsets, allowing operators to focus on things that are of real importance.

**Using data to check and improve the health of the controls:** As mentioned, the success of the automation system is the extended functionality that is packed into it; this however is most likely also one of its biggest downfalls. We cannot oversee, optimize

and monitor all this functionality without adapting the way we do it. We try and optimize such a complex system in the same way we use for a single loop controller, working on the one loop that seems to be causing an upset and often forgetting that this loop is part of many integrated and dependent loops. To oversee these complex systems of controls we need to let modern technology work for us. It is a small step from data collection, already implemented in DCS systems, to analyzing the performance of the controls. The control performance in its turn can then be translated into easy to understand results, indicating to us where we should focus our efforts. Based on calculated control loop and final control element (control valve) performance indices we can then easily categorize for instance the "Top 10" badly performing control loops or control elements. Plantwide disturbance analysis can be determined by looking for the root cause when groups of loops are performing poorly.

Loop performance analysis tools are provided with concrete guidelines on where to focus our efforts in optimizing the process, eliminating hidden disturbances and helping us to get to the root cause. It would not be the first time that a control loop is working hard on eliminating a problem introduced by another control loop.

**Using data to check the quality of the end product:** Another source of process data that is not used to its full potential is the variance partition analysis, also known as VPA reports. Generated by the QCS, these are mostly known as reel or grade reports, showing the 2-sigma values. These 2-sigma values are commonly used by paper mills to determine and report the quality of the paper that is being produced and if it is within specification. However, the VPA has significant potential to improve the efficiency of the process and the quality of the end product that is seldom used.

VPA reports give an excellent summary of the product that is being produced and can be a great help when analyzing possible improvement potential and where this potential can be found. The VPA in principle provides a snap shot of the produced product in four areas: short-term variation and long-term variation in machine direction, variation in cross direction and the total sum of these. By comparing and

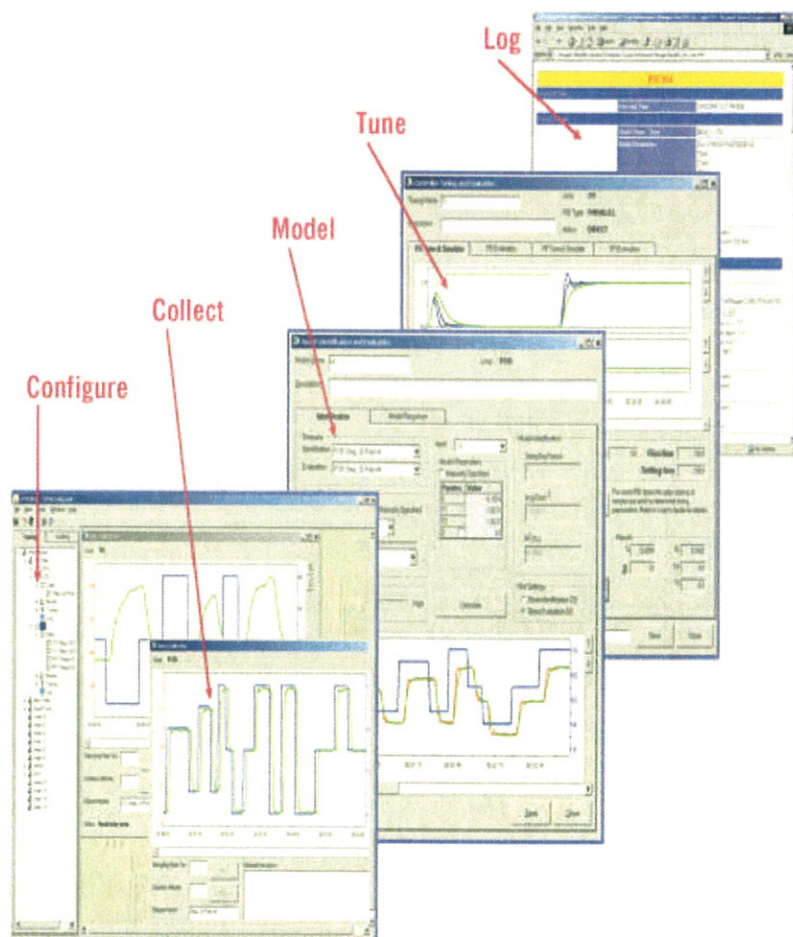


Fig. 4 - Optimizing with data control loop diagnostics: Loop Performance Manager (LPM) is a standard PID loop performance diagnostics tool that consists of three main components