Beyond process control to process diagnosis

Pulp and papermakers normally deal with equipment wear, some occasional failures and process instabilities. The analyses, diagnostics and problem visualization functions built into modern DCS and QCS systems help to solve these problems for mill teams of operators, maintenance specialists and engineers. The result is better process efficiency and product quality.

When pulp and paper processes are running smoothly you might get the impression they are on auto-pilot. However, when the sheet breaks, a machine fabric is lost, something changes unexpectedly or fails the operators must react quickly to return to some state of relative stability. It's not smooth sailing all the time.

Mechanical components wear continuously or break occasionally, valves deteriorate or malfunction and process unit operations don't work as they should for various uncontrolled or unexpected reasons. That's the reality, regardless of the degree of automation. It's true that automatic controls stay on course during upsets, but any notions of an auto-piloted process must be dismissed quickly when operators are faced with mechanical problems, disturbances and pulsations from process equipment or abnormal chemical reactions in the pulp mill. There are always problems to work out. These upsets, interruptions or outright failures result in lower productivity and sometimes costly downtime. Worker safety can be compromised as well.

Information is good; diagnosis is better

However, there are remedies to these problems in modern automaton systems. Quality control and distributed control systems have opened up a vital stream of information about the process, the machinery condition and product quality for a more transparent and consolidated view by mill staff. While information is good, diagnosis is even better. That is why analytical and problem visualization tools are now proving their worth by helping mill staff to resolve and avoid the re-occurrence of mechanical, process stability and quality problems. The extensive use of these problem-solving tools underlines the old engineering adage – if you can define a problem you can usually solve it.

Modern automation systems have opened up the process for a more transparent view by mill staff - including operators, maintenance technicians and engineers. Today, many planned or impromptu meetings to solve problems take place in the control room.

In this regard, DCS and QCS systems have evolved to become much more helpful to operators, process engineers and maintenance staff working as a team. It's a long way from the times when pulp and paper mills dutifully stored printed production summaries that were seldom used and just gathered dust. Today's information and diagnostic functions are active, visible and developing as the discussions go on.

With the integration of many more measurements, analyses, diagnoses and problem visualization functions it is now possible to determine the root causes of mechanical, process and quality problems. Moreover, with the essential input of human interpretive skills, it is more likely to prevent them from recurring. By looking out for telltale signs of instabilities or imminent failure and by keeping track of key performance indicators, mills can prepare for necessary corrective actions, nip problems in the bud and therefore ensure high process efficiency.

Problem visualization

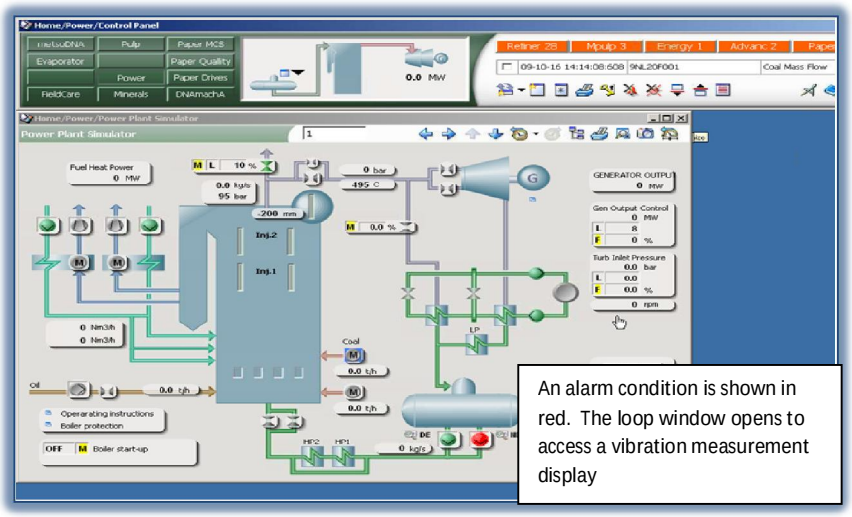
The process of problem visualization started in the 1990s with the integration of machinery controls and interlocks in the DCS system. By displaying the previously hidden logic functions, the causes of halts and startup problems are diagnosed and solved quickly- sometimes by the operators - thereby helping them to start up their processes in a prompt and orderly way.

More recently, machinery condition monitoring has been added to the diagnostic capabilities of DCS systems[1], allowing operators to see if a particular machine component or bearing is vibrating too much or showing signs of wear. Operators don't need to know the intricate details of vibration analysis; they just need to know that something is abnormal. Then a maintenance technician with specialized vibration analysis skills can be brought in to see if it is serious enough to fix right away or if it's possible to wait until the next shutdown. Some problems - like polymer roll hot spots - need immediate attention, since a failure can come quickly.

Reliability is operator driven

The integration of condition monitoring in the DCS environment comes at a time when maintenance and production departments in pulp and paper mills are developing programs to coordinate their efforts for predicting and planning maintenance activities. The embedded condition analysis function will help mill staff to target maximum process availability and cost-effective operations.

Rather than being in the corner of the control room or in the maintenance shop, the condition monitoring visual displays are right in the center of action and immediately within the reach of the operators. Christer Idhammar of Idcon Inc. emphasizes the importance of involving the operators in the recognition of potential problems [2]. He says, “To include operators in essential care of equipment including preventive maintenance inspections is one of the reliability and maintenance improvement initiatives that can yield the best return on investment. The investment is low and results in increased reliability and lower maintenance costs can be substantial.” This is a major change in operating philosophy which is often called operator driven reliability (ODR)



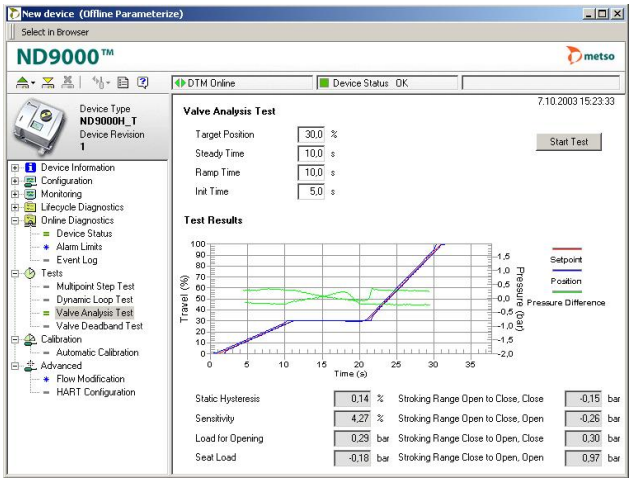
A machinery condition alarm generates a visible alert on a typical DCS process display. When this alarm is activated by a mouse click a detailed vibration analysis window opens as shown below.

When a vibration alarm is acknowledged and activated by a mouse click on the combined process display a pop-up window reveals the details of the vibration patterns in the process element. From here, a precise diagnosis can be made.

Detecting small problems before they are big

Embedded analysis in a DCS also extends to process valves and field instrumentation. The performance of valves can be followed closely, impending problems with their response can be flagged and maintenance can be scheduled proactively before process stability or uptime is affected. The cost of maintenance is lower since repairs are done only when indicated.

E&I maintenance staffs now follow real, just-developing valve problems before they become big ones.[3] For instance, small diaphragm holes can be detected by excessive travel deviations, and these small warning signs can be detected while the process is running before the diaphragm breaks and causes valve failure. Machine shutdowns have thus been avoided.



Remotely-initiated tests like this, as well as the continuing online diagnostics, determine the health of a valve and when to make necessary repairs.

Process detective work

With advanced spectral analysis, QCS systems analyze the variability of product quality measured online and relate it to process instabilities. In many cases, this detective work by mill engineers can lead to better quality and higher process efficiency. Operators are also presented with two and three-dimension representations of online paper quality so corrective actions on the machine can be followed in real time. These color-coded displays alert operators to out-of-spec areas and encourage them to keep quality in the green zone.

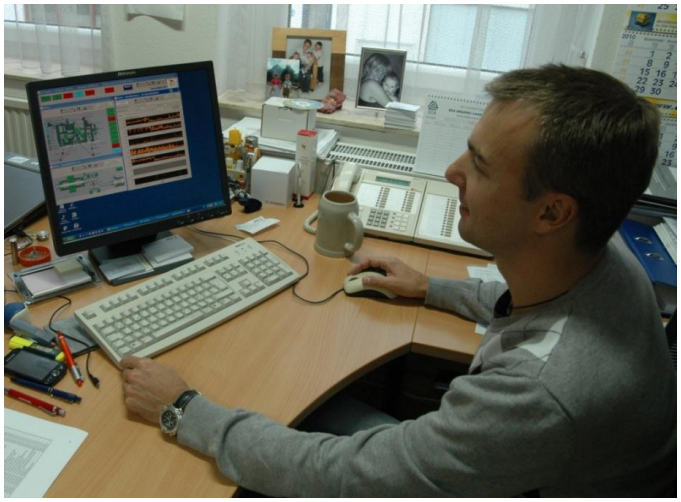
Variability Detection - Basis Weight

Online variability analysis in a QCS analyzes characteristic patterns of quality variability measured by online sensors and relates them to mechanical or process conditions. In this case, a 12 Hz variation in a coated sheet basis weight (and associated harmonics) was traced back to a coater backing roll vibration.

In the pulp mill, where instabilities are often related to raw materials and varying chemical reaction rates, fuzzy logic is used to deduce the common sources of process problems and the corrective actions based on experience. One experienced operator at a Finnish mill said that the indicators of good or bad chip column movement and other performance statistics help the production team to devise new digester operating strategies to continuously improve their operation.

Meeting where the action is

Many of these diagnostic tools are also available on desktop computers where more detailed analysis can be done remotely - away from the hustle and bustle of the control room. However, while individual analyses and discoveries at a desktop computer often shed light on a papermaking or pulping problem, lasting solutions are most often worked out and implemented by a team effort. This involves meetings and discussions - either planned or impromptu -where the action is happening and where the diagnostic information is readily available. The best place is often right in the control room.



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Stora Enso is one company who recognized the value of this problem-solving collaboration when they set out to design the control room for the PM12 production line at the Kvarnsveden, Sweden mill.[4] This central meeting point is where mill employees of various job functions and suppliers can get together and look at the real-time data and solve current problems. The success of this concept relies on readily available information from the control room user interfaces - the operators' windows on the process. The need for this purpose-designed meeting point is by no means unique to this mill. In fact, all mills should consider how meetings are arranged and how the data and diagnoses from automation systems could be - and should be - a central part of the solution process.

When the day comes that automation systems are smart enough to solve problems automatically mills may be on true auto-pilot. But pulp and paper process and quality disruptions today must be solved by human interpretation and collective problem-solving skills. In this regard, the process insight and visualization available in today's automation systems can be a major help.

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