

OPC communications cost effectively links paper machine's dye skid and color control, Solutions!, Online Exclusives, September 2002

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OPC COMMUNICATIONS COST EFFECTIVELY LINKS PAPER MACHINE'S DYE SKID AND COLOR CONTROL

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The world's leading manufacturer of paperboard for office products upgraded a paper machine to improve color quality and help reduce machine downtime to only 35 minutes when changing colors and grades. It achieved these goals by adding an automated liquid-dye skid linked to a color control system via OPC (Microsoft Object Linking and Embedding [OLE, now Active X] for Process Control.)

FiberMark, Brattleboro, Vt., makes some 200 different colors and grades of paperboard products on a dedicated, multi-layer paper machine. Converter customers turn these products into the report covers, pendant files, 3-ring binders, etc., familiar to every office. Because many customers have switched to just-in-time inventories, FiberMark has had to increasingly accommodate shorter runs of smaller quantities with faster turnaround times. This has resulted in color/grade changeovers rising to as many as two or three a day. The company urgently needed to establish color quickly, and then stay on color.



Photo 1. Portion of the Emerson DeltaV™ controller running the new dye skid at FiberMark, Brattleboro, Vt. Shown (left to right) are the controller's backplane-mounted power supply card, CPU card, and four FOUNDATION™ fieldbus communications cards having two fieldbus segments each. Fieldbus instruments provide almost all analog functionality. The integrated DeltaV digital automation system is a key component of Emerson's PlantWeb® digital plant architecture.

Each changeover took up to two hours and produced excessive scrap when lining out color during restart. The machine has seven head boxes for producing up to a seven-layer web comprised of precisely colored liners on the outside and filler layers between. The liners are generally dyed white pulp, while filler layers are a combination of recycle and pulp that may or may not be dyed. An older Measurex 2002 gauging system monitored basis weight, moisture content, and single-side color. Adjustment of these variables was manual, as was the addition of powder and liquid colorants.

Automation the Answer

To improve operations, FiberMark recently invested in:

- Automated color control to gauge color accuracy and density, calculate the paper machine's speed, stock consistency, and paper dry weight, and then determine the proper dye amounts to create and maintain the correct color, and
- An automated liquid-dye mixing and distribution skid to replace the manual weighing, hand mixing, and manual dumping of dye into pulpers. The skid receives instructions from the color system to meter, mix, and deliver the correct volume of the dye blend.

Color sensing has been removed from the older Measurex equipment (basis weight and moisture content remain) and placed in a new Honeywell-Measurex MX Open monitoring/control system having two-sided color gauging. The gauge on one side serves as the master or reference for color accuracy and density; the gauge on the other side as a slave to match the reference. Although MX Open is not the latest technology, it's adequate to the FiberMark task and substantially less expensive than newer, more sophisticated color control.

The 24-head skid (4 banks of 6 heads), built by Bran+Lubbe, covers the full color wheel and is automated by Emerson Process Management's PlantWeb® digital plant architecture, whose key component is an integrated DeltaV™ digital automation system. FiberMark initially considered adding the skid to an existing Emerson RS3 distributed control system (DCS) running the paper machine's wet end, but opted for standalone control using the more advanced digital plant architecture approach because of its newer and open technology, smaller footprint, lower cost, ease of use, handy tools and diagnostics, and scalability for possible future expansion into a mill-wide control system. The mixed dye is delivered at the correct flow rate to the paper machine at four locations: drain, stuff box, suction side of the fan pumps, and top side/bottom side.

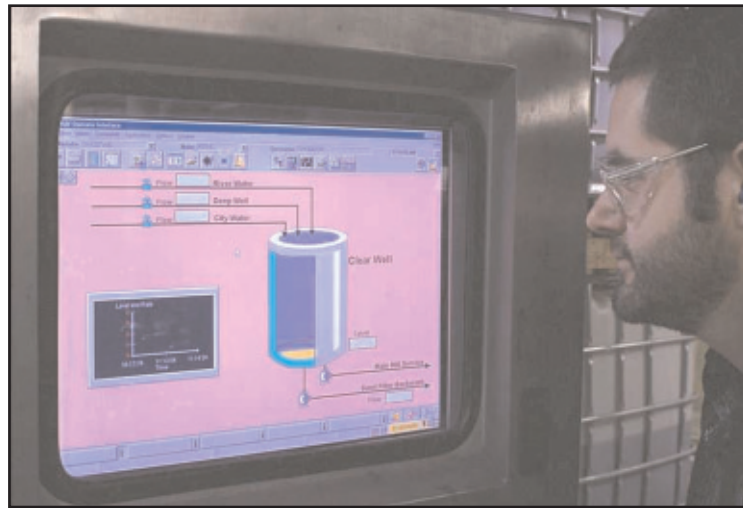
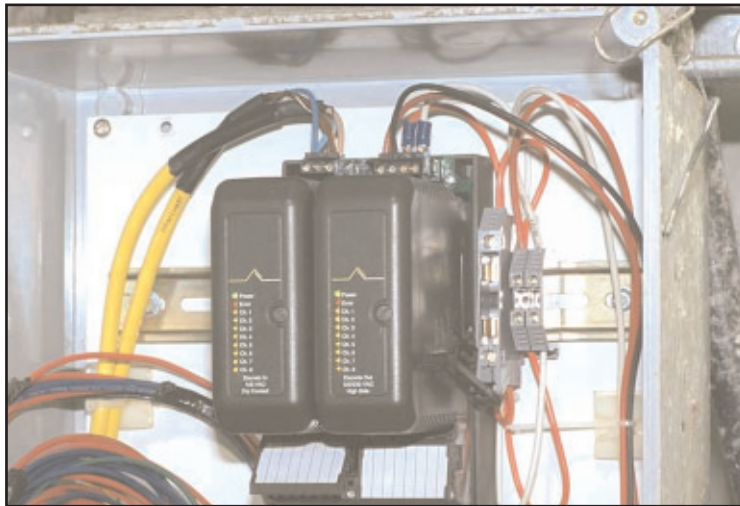


Photo 2. DeltaV PC operator workstation mounted on the dye skid. The workstation connects to the controller via an open Ethernet control LAN.

During evaluations leading to the skid's control system specification, PlantWeb automation architecture proved the best for the packaged equipment. The DeltaV system's field-mountable controllers have a form factor resembling PLCs which in the past have been chosen to run skids of all types. The technology additionally relies on open PC workstations, an open Ethernet local area network (LAN) tying controllers and workstations together, and open buses – such as FOUNDATION™ fieldbus – for instrumentation. What's more, the architecture's database is global, object oriented, and requires no controller-to-workstation database mapping. Control development is accomplished through drag-and-drop graphic configuration using pre-engineered control modules.

The architecture helpfully offers a full discrete point capability – either by bus communications or hardwired I/O cards – to handle the many switched devices present on a color skid. FiberMark would have liked to have specified Actuator/Sensor-interface, an open bit-level bus (AS-i) for discretes, but an AS-i communications card, since released, was still in beta testing.



Photos 3 and 4. Normand Raymond, FiberMark Instrumentation Supervisor, checks two DeltaV discrete I/O cards mounted in a cabinet distant from the controller and served by a fieldbus segment running nearby. Although fieldbus is primarily intended for analog devices, DeltaV discrete I/O cards can directly reside on the bus. In FiberMark's case, the fieldbus-remoted I/O cards avoid the need to run a second set of wires and conduit all the way back to the controller.

FiberMark performed configuration of the skid's controls, graphics, and communications with the assistance of the skid maker and the control system's local representative. Logic was written in the IEC 61131.3 Function Block Diagram and Sequential Function Chart languages. Most of the skid's analog instruments reside on fieldbus segments wired back to cards on the skid's single controller. Fieldbus saved much wiring and has made for superior troubleshooting, maintenance, calibration, and alarming.

A few 4-20 mA devices not available in fieldbus were wired to I/O cards on the controller backplane, as were all but two discrete points. Those points, distant from the controller, were picked up by a remoted DeltaV discrete I/O cards directly residing on a nearby fieldbus segment, an arrangement that avoided the need to run a second set of wires and conduit all the way back to the controller. Although fieldbus is primarily used with analog devices, the DeltaV system allows its discrete I/O cards tap into the bus.

How to Integrate the Incompatible Controls?

After the skid automation was chosen, FiberMark was faced with integrating it with the color control. This was no small task because the two systems are not natively interoperable and any link between them would need to carry approximately 250 points of realtime, bi-directional, peer-to-peer data. Further, data exchange between the skid controller and the color control's Application Manager varies greatly in volume – little during steady-state papermaking conditions, very high during startup after a color/grade change. Data includes dye choices, pump setpoints and speeds, routing valve positions, flow meters, etc.



Photo 5. FiberMark is the worlds' leading manufacturer of paperboard used for such familiar office products as report covers, 3-ring binders, day planners, pendant files, etc.

Three communications methods for linking the two systems were looked at: point-to-point hardwiring, an RS-485 serial link, and OPC. Hardwiring was immediately seen as costly and impractical. A 1 Mbps RS-485 connection using the open Modbus communications stack could possibly do the job but might not be fast enough and would require the preparation of custom drivers at both ends. OPC was the best answer because it would allow the incompatible equipment to communicate via faster Ethernet without FiberMark having to prepare or maintain drivers. With OPC, equipment manufacturers prepare proprietary protocol-to-OPC Ethernet drivers for each of their devices. The end user can then transparently plug the devices into his Ethernet network. Both the DeltaV system and MX Open accommodate OPC and Ethernet on any PC running Windows NT.

The OPC link was developed by FiberMark using both the skid's redundant 10/100 Mbps Ethernet control network and the color system's non-redundant 10 Mbps Ethernet network. (See simplified block diagram.) Emerson designed the DeltaV system for OPC right from its inception; as a result, configuration and operation were smooth and seamless. We stumbled a bit at the color control end because the point capacity of its OPC connections was initially confusing. We eventually established 18 connections in each direction categorized by function – setpoints, remote setpoints, mode, auto, cascade, manual, etc. If we need to add a point or make a change, we know exactly where to go in the logic.

Everything in One Computer

Unlike most OPC applications, where an OPC server serves several OPC clients, the FiberMark application interconnects two OPC servers. Server-to-server communications require an OPC software bridge, in this case the Emerson DeltaV OPC Mirror™. Because of the skid automation's highly developed OPC capability, all OPC functions could be loaded into a DeltaV Application Workstation. Included in this workstation are:

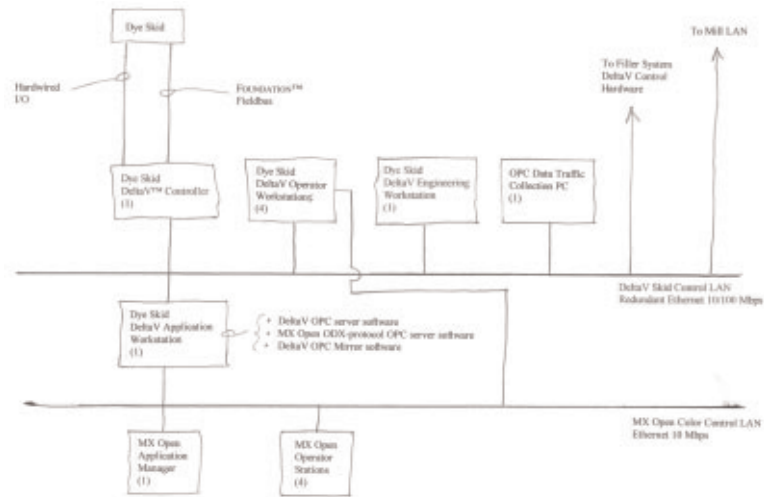
- DeltaV OPC server software,
- MX Open ODX-protocol OPC server software, and
- DeltaV OPC Mirror software.

Not only were hardware costs cut, but also the fastest translations were assured by confining all OPC work in one PC and fitting that 800 MHz Pentium III machine with 512 Mbytes of RAM. The mirror was configured in an Excel spreadsheet, which allowed the 250 points to be quickly listed through copy-and-paste methods.

In a another move to cut costs, floor cabinet space, and system complexity, every operator and engineering workstation assigned to the skid system carries a third Ethernet network interface card (NIC) to allow it to connect to the color control system's LAN and display the color space window. One skid workstation, at the dry end of the machine, is some 330 feet from the color control LAN. To add a colorspace window to that station, an Ethernet fiber optic spoke was run. All other LAN cables, and the fieldbus cables, are copper.

A Little Customization Added

Rounding out the new skid and color control systems are two additional pieces of software prepared by FiberMark and inserted into the skid system's program. One is a simple block in the controller that produces a one-second clock signal – a heartbeat – sent via OPC to the color system and returned. Should the OPC tie fail, the heartbeat will stop and the two systems will alarm and continue to control as last instructed. A heartbeat is necessary because the application used OPC report by exception.”). If the link failed without the heartbeat, no values would change and operators wouldn't know that a communications failure had occurred.



Simplified Block Diagram 1 – FiberMark Color System PlantWeb® Field-Based Automation Architecture

Diagram 1. Simplified block diagram of the skid automation system and its OPC tie to the color control system.

The second piece of software is a visual basic program, featuring an OPC driver, loaded into a dedicated PC. It captures and stores all data traversing the two automation systems. The program allows FiberMark to analyze problems by using sorting software to backtrack through the database. The volume of data points is significant; more than 30,000 were collected over a recent two-day period.

Outstanding Results

The OPC interconnect between the dye skid and the color control is working very well. The only weak point seems to be a bottleneck that occurs occasionally during times of very high data exchange, caused by the color system's LAN being limited to 10 Mbps. Primarily affected are this system's HMIs, which occasionally lose updates for a few seconds because of their lower priority status. To assure that a short loss of visibility causes no production problems, color control is temporarily suspended as last instructed. The higher priority OPC data exchanges with the skid don't appear to be affected.

Paper machine grade/color changeover time has been drastically reduced. The average today is just 35 minutes, compared to up to 2 hours previously. Color accuracy – on both sides of the sheet – has been much improved, and scrap is substantially reduced as well. All of these benefits have been largely generated by the new dye skid and color control. A second, less complicated PlantWeb project that improved filler layer control provided the remainder of the gain.