Practical Applications of Automation for Vacuum Web Coating

Acronyms have come and gone as applied to manufacturing automation and software. When MRP didn't work it was called MRP2. The new ERP is really a repackaging MRP2 with Financial and Human Resource software packages. The key to utilising these systems is not the initial cost and set-up but the vast amount of data that must be entered and maintained. The ideal system would feed this information automatically to the system. There is often untapped information on the shop floor in the way of PLC's (Programmable Logic Controllers) and HMI's (Human Machine Interfaces).

Many manufacturers use computers for design and product planning. These work instructions are then printed with the shop router. For operators with automated equipment the opportunity is lost to provide real time feedback on process and production information that can update inventory and provide order status for shipping.

Automation should be deliberately approached with clear objectives and targets for the system. Suppliers may dazzle and impress with graphics and fancy screens but the functionality should match the company's objectives and plans. A customised solution may not be expensive, if off-the-shelf software requires a large amount of changes to match the manufacturer's requirements.

Benefits of Automation

Many benefits can be derived from automation. Quality can be improved by displaying timely and accurate information. This can be acted on by the operator, co-ordinator or CEO to ensure products are produced at the desired quality, cost effectively and in a timely manner. Good system design ensures delivery of the information where it is needed. Generally any productivity measurements, such as speed or runtime monitoring result in 10 to 15 % increase in productivity. Operators that see these numbers displayed have a quantifiable measurement of how well their shift is going. It is advisable to address operator concerns and suggestions on equipment improvement when implementing a new production monitoring system otherwise productivity falls back to original levels, as operators attribute loss of productivity to be management's fault.

Two benefits of automation appear to conflict with one another. These are flexibility versus enforcement of procedures and guidelines. An automation system provides only one way to receive information and process material. Operators receiving the production schedule via a screen cannot just be verbally told to run something else. Even priority jobs must be entered on the system. This ensures operators have the correct set-up instructions and can download recipe information directly to the controllers. It also ensures production reporting information is attributed to the correct order. Scheduling personnel get immediate feedback on the impact of inserting the priority order. Operators are also restricted and cannot just run whatever material is on the floor. They have to follow the schedule, which ensures timely delivery of product. A system like this has

been implemented and in use for over 14 years in a wire and cable plant. Flexibility comes from being able to upgrade and refine the system with minimal effort. Conceptually a complete machine could be re-programmed to produce a different product with each order downloaded into the machine. Practically, things easily downloaded like tension, optical density and speed setpoints are sent to the controllers while physical machine adjustments, such as tooling or number of boats are displayed for selection by the operator. This flexibility allows better response to customer needs and supports the drive toward mass customisation. Ideally, a customer could design a product on the Internet then request quotes and deliveries from various suppliers. An integrated, automated factory is the one best suited to accepting and delivering an electronic order like this, since customised instructions could be directly transmitted to the shop floor.

Another benefit of automation is knowledge capture. The practices of your best operators should be captured in the machine recipes to provide repeatable process for various products. Operator experience in machine adjustments can be programmed as automated algorithms within the machine to assist less experienced operators.

Information adds value. Generic product is undifferentiated. The fact that you can deliver a specific product by Tuesday by 4 p.m. has more value than a product that has a nebulous 2 to 4 week delivery. Many manufacturers feel disillusioned by the bureaucratic procedures required for ISO 9000 certification. Those that have been successful with the process find added value in improved quality, lower scrap and better information that can be transmitted to customers.

Requirements for New Equipment

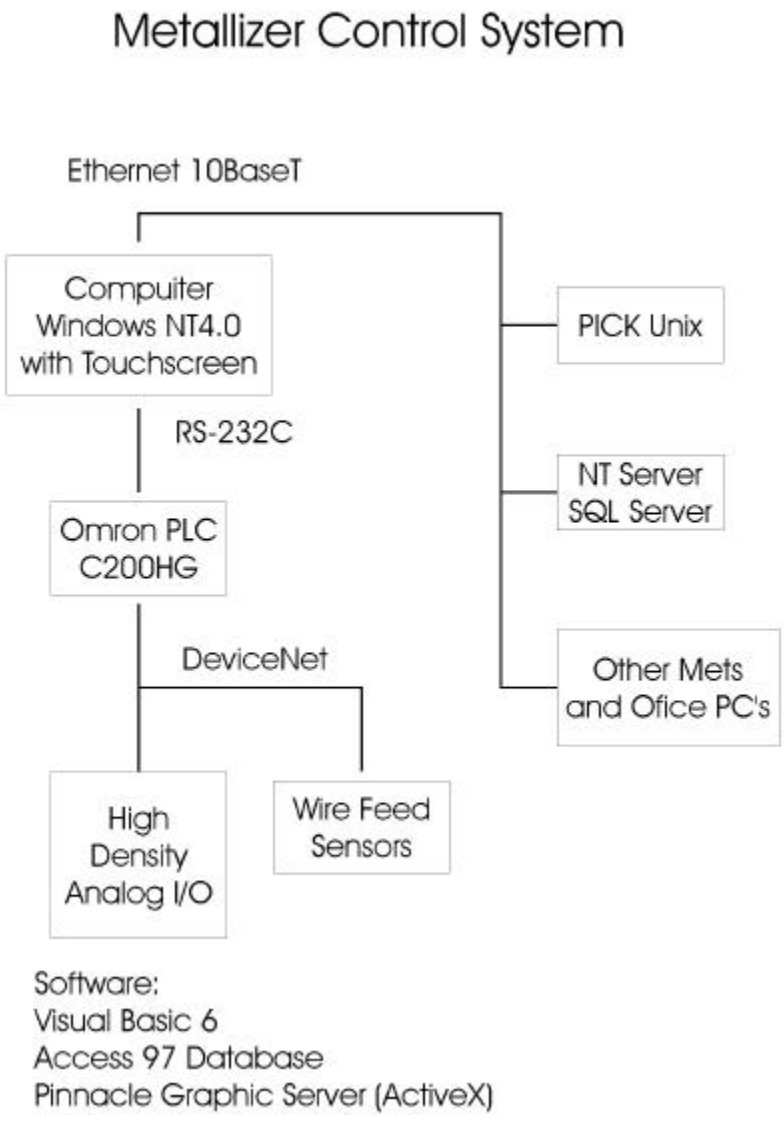
When buying or specifying new equipment consider the usability of operator screens, reports and functionality. Also consider the following aspects of the information system:

- Open system components. Does it have a standard PLC and I/O card system, such as Allen Bradley, Omron, Eurotherm or Siemens? How many items are from single source suppliers?
- Does it use a standard database for data logging, such as Oracle, MS Access, Sybase or SQL Server? (Any database with ODBC or ADO connectivity.)
- Network connectivity via Ethernet. Database, NETDDE or specific IP port access implemented in the software is desirable.
- Standardised software. This could be a package such as Wonderware or Intellution iFix. It could also be a standard development environment, such as Visual Basic, Visual C++ or Java. Plan to buy a development copy of the software with equipment capital.
- Source code availability. Access to the source code is desirable. In many cases this is the only way to customise it for your plant environment, for example, connection to your plant scheduling system.
- Failure Modes. Can the system operate without the screen or PC? What are the recovery procedures for the computer?

Case Study at CMP

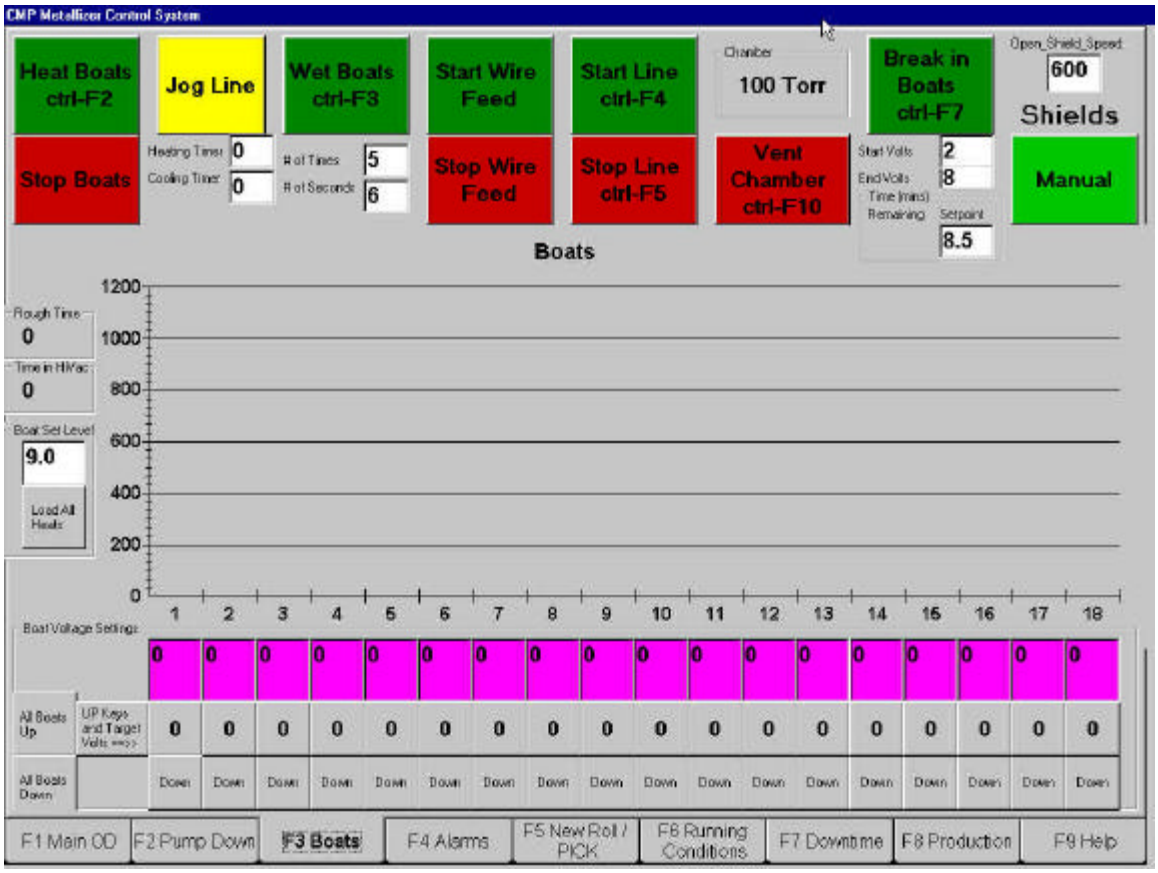
Celplast Metallized Products of Toronto, Ontario, Canada engaged RM Systems Integrators to refit three metallizer machines that had a DOS based system and I/O card rack system that was difficult to maintain since spare parts were not readily available. The mandate was to update the controls, improve reliability and improve fit of the operator controls with the corporate culture. After the initial technical hardware design was done, a development team comprised mainly of operators was established to review the controls and prototype screens. Their input determined the final form and functionality.

The system uses an Omron PLC with a Windows NT based touchscreen. Program code in the PLC is ladder logic. In the NT Workstation, a Visual Basic application communicates with the PLC using a serial link. Initially bar graphs were done using MSChart (part of VB5.0) but were later switched to a commercial ActiveX control called Pinnacle Graphic Server. This provides smoother updating of the displays. Another enhancement includes an exception based tag class that allows only those values that have actually changed to be updated on the screens.



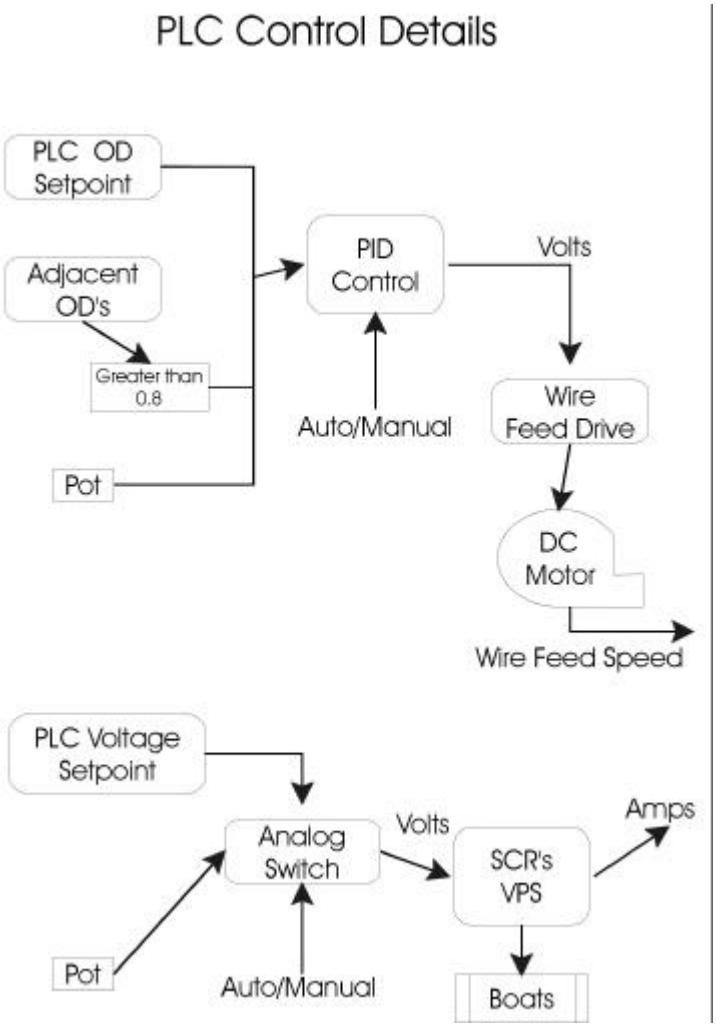
Many benefits are derived from the system. Operators have requested numerous functional enhancements to the system. Since the operators were part of the design process, acceptance and use of the automated controls has been easily achieved.

Some functions that were programmed had existed in the original DOS based application. Many of these are industry standard functions. Some of the new functionality improves original system. The new system allows bumpless transfer from manual to auto and back. The original system would have unpredictable results if switching modes, as relays and analog switches performed this. The addition of the PLC allows complete reboot of the computer if necessary, even while a roll is running, as the PLC maintains process control.



The user interface has improved by using a Windows capacitive touchscreen for direct control. This eliminates the multiple menus present in the original DOS application. Process functions include automatic pump down and vent. Boat heating can be ramped normally or by a slow boat break-in function that is user adjustable. Buttons “light” up with color when the functional interlocks are complete, for example, desired vacuum reached before starting boats. Other controls included, Wire feed start/stop and wet-out, Web start./ stop, Web Jog. When the system was first implemented, it included a “screen scraper” application that would fill in process information on a legacy Unix production reporting application. This proved cumbersome. There are plans are to implement a SQL Server application in the future.

Automatic OD Control



During the course of implementation, an experienced operator was training a new one at the metallizers. Many of their suggestions were incorporated into the system. Conceptually the original control used primarily the wire's matching optic and a percentage of adjacent and second adjacent boats. It became apparent that level plating was only a function of the adjacent OD's. The PID's are used inside the PLC to adjust the wire feed speeds based on 50% of each adjacent boat. If an OD is below 0.8, it assumed to be defective or with no film, so only the valid adjacent reading is used. This allows auto OD control even on the edges. The Auto/Manual system switches off the PID control and manipulates the Wire Feed Drive setpoint directly either from the touchscreen or from the manual pots. In auto mode operators can optionally adjust and leave individual wires on manual. each wire has a min/max windows in which the control will operate.

An additional sensor has been installed in the wire feed motor shaft. The proximity sensor sees an indentation each rotation and determines the time it takes for one rotation. The PLC then calculates the linear speed of the wire in inches per minute. This assists operators in setting equal wire speeds to provide uniform boat usage.

Additional control features have been added to the Visual Basic application that automatically trims the fastest and slowest wire to obtain uniform boat usage without operator intervention. To eliminate the possibility of light optics, wires adjacent to a 0.75 low optic threshold have the maximum control limit automatically increased.

The control system assumes that boat heat has been evenly adjusted. Fast and slow running wires indicate possible heat problems to the operator. Boat heat requires

operator visual observation of the boat colour. The original pots were retained although operators always use the touchscreen controls except in emergencies.

Summary information is recorded for each roll, such as length, Optical yield, pump down times, idle time (in high vac but not running web) and runtime. More detailed logging is done while the roll is running using an MS Access database. Approximately every three seconds the OD, wire speed, pressure and boat amps are recorded. This data has been brought into Excel for one time analysis. An additional tool was built in Visual Basic to provide customers with OD summary reports of this data. Reports can be run against this database both from the workstation and over the network using other computers.

Conclusion

Success of the CMP project is a direct result of addressing operator requirements. The operator is the person who must use the display 24 hours a day. Customisation allows for operation to match the experience level of the operator. The touchscreen is intuitive and easy to use.

Manufacturing success requires a balance of good, well maintained equipment, personnel that understand the corporate culture and technology that support the business objectives. Automation has become a necessary tool but has many varied implementations. Choose that one that fits your environment. The dot com bubble was destined to be burst. The coming eCommerce businesses will be horizontally integrated with direct fulfilment partners. Get ready to ride the next wave.

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About the Speaker:
Robert J. Mah is the president and founder of RM Systems Integrators. He has over 19 years experience in implementing CIM systems. His experience with a wide range of hardware and software used in PLC's, PC's and mini-computers provide a unique insight into obstacles to integration. Mr. Mah is a graduate in Systems Design Engineering at the University of Waterloo and has provided system design, implementation and training for a variety of clients.

About the Company:
RM Systems Integrators is a supplier of integrated custom control solutions for various industries. This includes PLC's, Operator displays, SCADA systems, data collection and connection to ERP/MRP plant computer systems. Areas of focus are ultra high vacuum systems, wire and cable manufacturing, municipal water systems, automotive and control electronics.