Process Optimization & Order Quality Traceability Using a Real-Time Data Acquisition & Management Network

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Current technologies in microprocessors, software, data storage and Local Area Networks make it possible to cost effectively acquire, store, manipulate, trend and adjust key process variables in real-time. This capability enables coaters and converters to improve quality, reduce production costs and obtain a competitive edge.

Today's Customer Demands

To remain competitive in today’s marketplace, coaters and converters must be able to tune their processes to optimize product quality and reduce production costs. Customers are demanding lower cost product with consistent quality that is verifiable. In addition they would like to place orders for variable quantities and still receive the same quality and timely deliveries.

Benefits of Real-Time Monitoring and Data Collection

With a real-time automated data acquisition and management network, coaters and converters can achieve lower production costs, improve their quality and achieve a competitive edge.

One means of achieving lower production costs is to capture “best run” settings of key process metrics and save these for future similar orders. In Continuous Quality Improvement programs, these settings can be used to optimize the process for given order quantities as well as make the processing of orders more efficient; thus ensuring less downtime and more timely deliveries.

To achieve a competitive edge in today’s marketplace requires going beyond just providing a quality product on time and at a good price. It requires giving customers that extra level of service that the competition doesn’t offer. One way to provide customers this extra service is with order quality traceability reports. These reports are generated at the end of each order run and show how key quality parameters such as coat weights, moisture content, dimensions, etc. varied during order processing and what grades of stock and adhesives were used.

Process Variables Affecting Cost and Quality

In a typical pressure sensitive label manufacturing process, there are a number of process variables that can affect cost and quality. The following illustration shows such a process:
Typical Pressure Sensitive Label Manufacturing Process

Some of these key variables and their unit processes or equipment include:

- **Temperatures**—Dryers, Web, Coatings
- **Pressures**—Laminator setting, steam pressures
- **Speeds**—Pumps, line or web, rolls, winder settings
- **Coat weights**—Die gaps, corona settings, face tensions
- **Liner & Label Stock**—Moisture levels, grades

**Requirements to Optimize Process and Provide Traceability and Continuous Quality Improvements**

In order to optimize the production process, provide quality traceability and enable continuous quality improvements requires a data handling method which can:

1) Collect and correlate key manufacturing process variables in real-time
2) Time stamp important information
3) Process information from support databases (e.g. inventory, quality, production scheduling)
4) Provide information access from multiple locations (e.g. plant floor, office, mobile devices)

Such requirements suggest a computerized solution would be optimal in terms of processing capability and information accessibility.

**Typical Local Area Network for Data Acquisition and Analysis**

The following schematic illustrates a typical Local Area Network configuration which addresses our requirements:
This network configuration consists of a server for configuring the system and storing information; client stations for accessing information (e.g. trends, alarms, reports) in both the office and the plant environments; control system(s) and PLCs to provide real-time process information; network cabling and connectors and the connection of other databases (e.g. scheduling, quality, etc.). To ensure continuous information access and system integrity, sufficient data backup and uninterruptible power supply systems (UPS) would also be employed.

The hardware components for building this network configuration consists of standard off-the-shelf PC hardware for server and clients; standard Ethernet cabling and network cards; standard disk storage and UPS devices and plant floor PLCs and/or control systems.

The software components to configure the devices, collect and time stamp the data and to store, analyze and display information consists of standard Windows XP operating systems, device drivers and a proprietary data acquisition and analysis software platform.

The total investment for installing a network data acquisition and analysis system, which can accommodate up to 3000 variables, would typically be less than $40,000. This estimate does not include the cost of control systems, PLCs and other SQL database servers.
Basic Functionality of a Data Acquisition and Analysis System

Some of the basic functionality of a typical data acquisition and analysis system would include the ability to handle and record alarm conditions; correlate variables and display trends; capture and store “best run” settings for use in process optimization and continuous quality improvement programs; and archive key quality metrics which can be retrieved and reported for individual customer orders. Let’s look at each of these briefly.

**Alarm Handling**

The above screen shows how variable values are displayed in real-time and the red backgrounds indicate where variables have exceeded pre-set limits and generated an alarm condition. All alarms can be time stamped and their duration and the values of affected variables archived and retrieved for quality reports. In addition to displaying alarms in real-time, e-mail messages can also be generated when alarms occur.

**Process Improvement**

In order to optimize process efficiency and improve the quality of products produced, it is helpful to be able to compare process variable values and
equipment settings during a production run with a known standard or “best run” setting to see which variables or settings may be out of line. The following screen shows an historical trend line comparing variable values and settings.

Once a “best run” setting is achieved for given order specifications and quantities, it can be stored and downloaded to the control system and operations staff the next time a similar order is run. Using this iterative process, it is possible to achieve continuous quality improvements, higher production efficiency and lower costs over time.

**Quality Traceability**

By collecting and storing key process values, equipment settings, alarms and quality measurements on an order-by-order basis it is possible to produce quality traceability reports for customers. These reports document how the customer’s order was run from start to finish. They include the specifications for raw materials that were used such as face stock, liner stock, and adhesives, quality data (e.g. coat weight, Dyne level, releases, etc.); average, minimum and maximum values for process variables and equipment settings; and alarms that occurred during the order run.
The following is an example of an order quality traceability report:

Order Report

Order Number: **988076**  Setup #: **2**  Customer: **Acme Labels**  Date: **Nov 6, 2011**  Time: **6:47 – 6:58**

Product Code: **XXXX**
Footage Produced: **3400 yard**

<table>
<thead>
<tr>
<th>Line Speed</th>
<th>Roll Speed</th>
<th>Oven Temp</th>
<th>Web Temperature</th>
<th>Face Tension</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avg</td>
<td>Max</td>
<td>Min</td>
<td>Avg</td>
<td>Max</td>
</tr>
<tr>
<td>760</td>
<td>842</td>
<td>660</td>
<td>1201</td>
<td>1251</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Laminator Pressure</th>
<th>Steam Pressure</th>
<th>Winder Setting</th>
<th>Corona Treater</th>
<th>Pump Speed</th>
<th>Die Gap</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avg</td>
<td>Max</td>
<td>Min</td>
<td>Avg</td>
<td>Max</td>
<td>Min</td>
</tr>
<tr>
<td>72</td>
<td>79</td>
<td>69</td>
<td>88</td>
<td>92</td>
<td>77</td>
</tr>
</tbody>
</table>

Stock Used

<table>
<thead>
<tr>
<th>Item #</th>
<th>Face Stock</th>
<th>Adhesive</th>
<th>Liner</th>
</tr>
</thead>
<tbody>
<tr>
<td>SC391056</td>
<td>MS275596</td>
<td>SC416235</td>
<td></td>
</tr>
<tr>
<td>Lot #</td>
<td>102511-065</td>
<td>102211-056</td>
<td>100111-032</td>
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</table>

Quality Data

<table>
<thead>
<tr>
<th></th>
<th>Average</th>
<th>Maximum</th>
<th>Minimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adhesive coat wt.</td>
<td>23</td>
<td>25</td>
<td>21</td>
</tr>
<tr>
<td>Releases</td>
<td>57</td>
<td>65</td>
<td>49</td>
</tr>
<tr>
<td>Dyne Level</td>
<td>44</td>
<td>45</td>
<td>42</td>
</tr>
</tbody>
</table>

Alarms:

<table>
<thead>
<tr>
<th>Time</th>
<th>Event Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>6:48</td>
<td>Low Web Temperature</td>
</tr>
<tr>
<td>7:01</td>
<td>Pump failure</td>
</tr>
<tr>
<td>7:03</td>
<td>Steam Pressure Low</td>
</tr>
</tbody>
</table>

Economics

An investment in an automated, real-time data acquisition and analysis system can help coaters and converters achieve better bottom line results through improved efficiency, lower production costs and fewer credits for returned product that doesn’t meet quality requirements. It can also provide a competitive edge, and hence increased revenues over time, by enabling coaters and converters to offer customers quality documentation for each order.

The exact savings or marginal increase in revenues will vary by situation, but it is not unusual to achieve a pay back on the investment in less than 12 months.