Improving HACCP Performance With Remote Monitoring and Control Technology

Since the early 80's major advances in computers, computer software, automation and robotics have dramatically increased manufacturing efficiency. The development of satellite technology, the Internet and wireless communication systems have enabled the linking of on-site and remote production and processing equipment with headquarters. The cost of satellite time has dramatically decreased, making the monitoring of products in transit (trucks, rail cars and ships) much more affordable.

The ability to collect performance data from each machine and analyze it at a remote central location in real time can generate huge productivity gains by:

1. Maintaining efficient manufacturing and high product standards (processing and product specifications can be controlled and corrected in real time).

2. Reducing labor costs (centralized control requires fewer plant engineers and supervisors).

3. Preventing equipment failure by sending warning signals ahead of time about deviation from standard operating conditions and estimates of failure time.

4. Integrating production data from one facility with data from other manufacturing plants. This includes production schedules, raw material status, materials in process and finished product inventories and provides better manufacturing and inventory control.

5. Integrating manufacturing data with strategic business systems information to maximize profits.

Only a few companies have been utilizing this technology. Among them is UNIFI Inc, a textile and yarn producer with headquarters in Greensboro, N.C. The company's production machinery in 22 manufacturing plants is connected to the Internet and is constantly sending data on equipment operation, production schedules, status of product completion and inventories, for real time analysis at headquarters. Selected data are also posted on the company's website for client use.

This technology is also of great interest to multinational companies having many production and processing facilities around the world. Although remote monitoring and control technology is in its infancy, revenues from sales of software and services reached $1 billion in 2000. Despite the slowdown of the world economy this industry is expected to reach $2.5 billion in 2005.
Benefits for HAACP

Remote monitoring and control systems can improve the performance of Hazard Analysis of Critical Control Points (HACCP) systems. This application is being developed through a cooperative project between E-Control Systems, Chatsworth, California (A. Berstein, Tel. 818-885-5228) and the Department of Animal Sciences/Cooperative Extension, University of California, Riverside (G. Zeidler, Tel. 909-787-5038).

HACCP systems have been implemented in various forms and shapes in most animal production, processing and food service facilities around the world. In the U.S. the egg industry has incorporated HACCP in various egg quality assurance programs such as the California Egg Quality Assurance Program or United Egg Procedures Five Star Program. These programs are voluntary, but enjoy the participation and commitment of the majority of all egg producers. In California, program participants own more than 90% of the commercial laying hens.

A typical HACCP system (Figure 1) has several major disadvantages:

1. In many cases data collection and preparation of reports is laborious due to the lack of an integrated monitoring system and fully automated procedures. For example, egg wash water and rinse water pH and sanitizer concentration testing are still done manually by wet chemistry.

2. Corrective action is conducted based on historical data and not in real time. Therefore, prevention of unfortunate events is difficult.

3. In the era of major industry consolidation and multi-facility companies, often no real time integrated quality assurance data are available for use in decision-making.

4. Many companies have weak central quality assurance supervision. Company supervisors or USDA Inspectors cannot access the system data and must physically visit all locations to get this information.

Most HACCP systems use a variety of hardware to directly monitor specific critical control parameters. Often these units are not integrated into one system, and therefore, more work is needed to prepare final HACCP documentation.

The satellite, Internet and the wireless systems have been available for some time, but have seen little use in quality assurance programs for food processing. In 1991 Zeidler successfully monitored the temperature of chilled venison meat in refrigerated containers during shipment across the Pacific Ocean using satellite communication. Hourly temperature monitoring at headquarters allowed deviations from optimal storage temperature to be corrected during the voyage. The ability to control the container temperature at 28°F + 2°F dramatically extended the product shelf life. The product was of excellent quality when it arrived in California from New Zealand after a 3 to 4 week ocean voyage. This technology enabled the substitution of sea transport for airfreight, reducing transportation cost by 80%.

Satellite communication is currently used in truck locating programs and optimal trip routing systems. Wireless and the Internet systems are relatively new and only recently are being considered for remote monitoring in the food processing and food service industries.
Figure 1: Typical HACCP System

Form the HACCP Team

Define the process

Identify the hazards (control points)

Assess the Severity of Risk

Determine Critical Control Points (CCPS)

Specify CCPS Ranges and Implementing Monitoring Techniques

Documenting Data in ready for inspection format

Corrective Action For out of specification event

Periodic verification

Improving of HACCP Procedures

Figure 2: System Schematics

PC with a Monitoring Software

Site #1 - Monitoring Unit

Printer

Cell Phone, Pager, or email

Hub

Internet, Wireless, Satellites

Operator Station(s) (optional)

Site #2 - Monitoring Units
The new system under development will have the ability to integrate the signals from all available sensors into one monitoring system. It will also be capable of monitoring remote sensors on moving targets such as trucks and ships. Other possible locations for sensors would be poultry houses, incubators, feed mills, processing plants, etc. This would vertically integrate the quality assurance of the whole operation. A simplified version of this system was installed and tested in 100 small coolers and freezers at the newly remodeled Bengal Tigers stadium in Cincinnati, Ohio. Here the 2.5 mile route to check conditions was drastically reduced by the ability to monitor the units from the manager’s office. Sensors monitor temperature, lights, open doors, and compressor and evaporator operation.

The flexibility of the new system can significantly reduce investment costs. It is a single system that can be expanded as needed to meet future monitoring requirements and to discontinue obsolete ones. It can also be connected to most existing monitors and can integrate them into one operating system.

Connecting the system to the Internet and to wireless communications enables the addition of warning and alarm functions. Whenever HACCP parameters approach the upper or lower specification limits, a warning is generated. This may be sent to cell phones, pagers, phones, palm pilots, and laptops or other computers when the decision makers’ are away from the facility. The alarm can be set to stop until confirmation is received from one of the decision makers. The warning signal is turned into an alarm when the pre-set specification limits are crossed. Managers will be able to access the system from remote locations to identify the problem and determine its exact location in the facility. They can then contact local employees to have the problem corrected before it results in serious damage. With appropriate arrangements it could allow regulatory officials to monitor cold-room temperatures or other conditions from a central location. Reports from the company could be sent to the agency with the click of a button.

Internet and wireless communications are very low cost, while satellite use is more expensive. However, many trucks are already connected to the satellite with truck locator programs or trip map route advising systems. Where this exits, a truck temperature monitoring system could be added at low cost using the existing connection to the satellite. Finally, the initial investment could remain low as the basic system is low cost and customized expansion can be done later.

A schematic of the system is illustrated in Figure 2. The heart of the system is the monitor that could be connected by wire to seven sensors of any kind. If several monitors are needed, they are interconnected through hubs. In a large system the hubs are also interconnected so that a single wire can connect the monitoring system with the central computer where the monitoring software is installed. With the monitoring unit the sensor can be easily calibrated, the upper and lower limits set and the specifications for warning and alarm signals can be defined. Access to the monitoring unit is controlled by an access code to prevent unauthorized changes.

HACCP critical control points that are commonly monitored in egg packaging and processing plants in the U.S. are:

- Cold-room temperature
- Cold-room humidity
- Egg wash and rinse water temperature, pH and sanitizer concentration
• Egg wash and rinse, water flow rates

• Time and temperature profile of liquid egg products during pasteurization, holding tank temperatures, heating profile, holding time and cooling down periods

• Holding tank liquid level

• Freezer temperature

• Truck ambient temperature

Other parameters that can affect HACCP performance can also be monitored. Some of these are proper sensor operation, cold storage or freezer doors ajar, electricity shut down, emergency generator start up and electricity consumption by refrigeration equipment such as compressors, evaporators or other motors. You can add other functions such as projecting time of equipment failure and time of needed maintenance.

It was found that the installation cost is a significant part of the system price. The cost and ease of installation can be dramatically improved if a wireless system is used. The wireless system eliminates long wire lines in the production and processing facilities and complicated wiring of the sensors. Using the wireless system, sensors and the monitors are easily installed and hubs are not needed. The units transmit data directly with a small battery and amplifier. A warning signal is generated when battery replacement is needed (battery life is about two years). The maintenance of a wireless system is simpler and cheaper.

Utilization and Limitations of the System

A rule of thumb for planning the system is that anything that can send electronic signals can be monitored. Many existing units such as water meters, feed weighing devices, egg counters and electrical meters can be integrated into the system by use of connectors that translate their measurement into electronic signals.

The major limitations of the system are the availability, sensitivity and price of existing sensors. The good news is that numerous companies and institutions are working on sensor development and improvement. New sensors will likely be available in the future and can be added to the system.

As mentioned at the beginning of this article, the kind of system that we are currently developing to monitor HACCP critical control points could also be expanded to integrate production, processing and business applications. Companies will need this new technology to survive in the egg and poultry business.

References


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2001 National 4-H Poultry and Egg Conference

The 2001 National 4-H Poultry and Egg Conference was held on November 15 at the Kentucky Fair and Exposition Center in Louisville, Kentucky. The annual conference allowed 4-Hers from all over the country to compete in educational events that help them learn to make and defend decisions, speak publicly, and gain skills in poultry-related subject matter.

The 2001 conference included five separate events. In the poultry and egg judging contest, 4-Hers judged ready-to-cook poultry, live production hens, and market eggs. In the chicken and turkey barbecuing contests, the 4-Hers prepared barbecued chicken or turkey and gave oral presentations on the broiler or turkey industries. The egg preparation demonstrations involved preparing an egg dish and giving an oral presentation on the nutritional value of eggs. In addition to these events, an avian bowl was conducted. The avian bowl is a round robin tournament in which the contestants are required to answer questions regarding poultry science, poultry production, game bird and waterfowl production, and information about the poultry industries.

A Poultry Careers Workshop was also held during the Conference. 4-Hers were exposed to hands-on information from poultry food industry personnel and the participants were given pertinent information about the career and educational opportunities in the poultry food sciences and industries. The Conference Committee greatly appreciates the time, dedication, and efforts of the industry representatives. The Workshop was sponsored by Maple Leaf Farms, The State Executive Poultry Association, the Southeastern Game Breeders and Hunting Preserve Association, and the North American Gamebird Association.

The 140 senior 4-Hers, representing 24 states, participated as teams or individuals. Team competition was held in the poultry and egg judging contest and the avian bowl. Individuals competed in the egg preparation and the turkey and chicken barbecuing contests. Nineteen teams judged poultry and eggs, and twelve teams competed in the avian bowl. Eleven individuals participated in the turkey barbecuing contest, ten in chicken barbecue, and fifteen in the egg preparation demonstration. Larry Brown of the U.S. Poultry & Egg Association, Dave Clem of Perdue Farms, and Alan Wise of Tyson Foods attended the Conference and participated at the awards banquet. Along with the 4-Hers, about 270 people, including county extension agents, 4-H leaders, chaperones, coaches and poultry specialists, helped make the conference a success.

Francine Bradley, Poultry Specialist at U.C. Davis attended the conference along with a contingent of 15 California 4-H members, leaders, parents and one grandparent. The California Avian Bowl team captured the National Championship, defeating Kentucky in the finals. In the Poultry Judging Contest, Travis Kroger from Contra Costa County took two individual awards (8th in Market Poultry and 2nd in Market Eggs). The California Judging Team placed 9th in Market Poultry and 7th in Market Eggs. The Egg Preparation Demonstrator, Jonathon Withrow of Sacramento County did a find job, but did not break into the top 10.

Listed below are donors and sponsors from California who helped make this Conference possible:

Dr. Francine Bradley
California Poultry Industry Federation
California Egg Commission
Pacific Egg and Poultry Association

Francine A. Bradley
Extension Poultry Specialist
UC Davis
New Book

The new addition of "Commercial Chicken Meat and Egg Production" edited by Don Bell and William Weaver, Jr. has just been published by Kluwer Academic Publishers. This is a complete revision and expansion of the book with addition of 14 new authors. The new book has 61 chapters, over 1300 pages, is cloth bound and will list in U.S. for $399.95/EUR 440.00/GBP 175.00. A special introductory price will be available until March 31, 2002 as follows U.S. $250/EUR 275/GBP 175.

The book can be ordered on line at http://www.wkap.nl. Telephone orders can be placed from North America toll free 1-866-269-9527. From outside North America phone 31 (0) 78 6576474.

Authors of the new addition include Paul Aho, Don Bell, Carol Cardona, Craig Coon, Gregg Cutler, Ralph Ernst, Joan Jeffrey, Doug Kuney, Mike Lacy, Joseph Mauldin, Thad Morrison, III, Gene Pesti, Charles Wabeck, William Weaver, Jr., A. Bruce Webster, Mike Wineland, and Gideon Zeidler. Major book sections are:

1. General
2. Feeds and Nutrition
3. Poultry Health
4. Business
5. The Breeder and Hatchery Industries
6. The Broiler Industry
7. Poultry Processing
8. The Table Egg Industry
9. Egg Processing
10. References
11. Appendix

2002 Calendar

*January 14-15
International Poultry Scientific Forum, Georgia World Congress Center, Atlanta, GA. For more information go to the U.S. Poultry and Egg Association website at: http://www.poultryegg.org/expo/index.htm.

*January 16-18
International Poultry Exposition, Georgia World Congress Center, Atlanta, GA. For more information go to the U.S. Poultry and Egg Association website at: http://www.poultryegg.org/expo/index.htm.

*March 20-21
Midwest Poultry Federation Convention, RiverCentre, St. Paul, MN. For more information visit the website at: http://www.midwestpoultry.com.

*May 1-4
51st Western Poultry Disease Conference, Puerto Vallarta, Jalisco, Mexico.

*May 7-10
Pacific Egg and Poultry Convention, Harrah’s Stateline, Lake Tahoe. For more information please contact Debbie Murdock at (916) 441-0801 or visit their website at: http://www.pacificegg.org/.

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http://animalscience.ucdavis.edu/avian

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California Poultry Letter

November/December 2001

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