Electro-Mechanical vs. Direct Digital Control Systems

Decoding the Differences

by Gerry Fitzsimmons

The world continues to move along at a torrid pace, with digital everything taking over. But what is this all about and how does it impact ice arena operations? Let's look at both electro-mechanical and direct digital control systems in order to provide a better understanding of the benefits of each system.

Electro-mechanical (thermostatic) control (EMC) systems

Electro-mechanical components and systems have been around since 1885, when the Buzz Thermo-Electric Regulator Co. registered a patent for a thermostatic system that automatically adjusted room temperatures in a residential building. In 1924, another pioneer named Mark C. Honeywell developed a clock-controlled thermostat. This was the start of the electro-mechanical control industry as we now know it.

EMC controls are individual controls that measure a single parameter, such as temperature or pressure, and through some mechanical action use this force to cause a mechanical/electrical switch to operate (for this discussion, thermostats are included as electro-mechanical devices due to their singular control functionality). With an electrical power source and relays connected to these controllers, various pieces of equipment are started and stopped. The earliest versions were completely mechanical, with moving parts including springs, levers and mercury switches (Fig. 1). Over time, new technology replaced many of the mechanical components, reducing the costs and improving the reliability of the controllers.

Although the hardware has improved over the years, the basic system architecture has remained the same. These devices continue to measure a single parameter and, through a manual setting, have a single stage of control.

Figure 1: Reverse acting high-pressure controller

For example, in an arena, a temperature controller measures the rink slab temperature (Fig. 2, Rink No. 1 Floor Slab Temperature) as the slab temperature rises (indicating a rising ice surface temperature) at a predetermined set point (e.g., 24 degrees Fahrenheit), and a set of contacts closes and starts the refrigeration plant (Fig. 2, Cold Glycol Pump No. 1). EMC controls have a predetermined dead band (e.g., between 23 F and 25 F) in which no action takes place. Once the set point is achieved, the control turns off the refrigeration plant.

The logical control sequences for an EMC system reside within the control and the wiring between various components. The most difficult challenge with this system is the constraint on control strategy.

Then, along came direct digital control systems.

Figure 2: Two-stage slab temperature controller

Direct digital control (DDC) systems

Although the EMC systems provide basic operation, the technology boom has yielded more sophisticated electronic controls. The transistor patent was completed in 1928, but it was not until 1948 that Bell Labs produced working models and set the digital revolution in motion. Over the next 50 years, these products progressed and became commercially viable, allowing the use of digital controls for everyday functions and equipment.

A key difference with a DDC system is the ability to separate the control strategy and system logic from the control devices, components and wiring. With DDC systems, control strategies are only limited by the knowledge and imagination of the system designers. How is that possible?

DDC systems are set up under a completely different architecture. The systems are divided into three functional blocks. The first block is inputs. Inputs are all types of measured parameters (temperature), date and time functions, vir-

Continued on page 8

Continued from page 6

tual inputs (set points and desired operating temperatures or pressures), status points (pump on) and positional points (valve is 75 percent open).

The second block is outputs. Outputs are signals and information leaving the DDC system, including equipment stop/start signals, variable signals to modulate valves and pumps, and equipment status for other control equipment.

The third and most important piece of the puzzle is the programming, or intellectual property, component. The DDC controllers have no built-in intelligence and require a human to tell them what to do in every situation. For example, the DDC programmer tells the DDC controller to start the refrigeration system if the ice surface temperature is greater than 22 F, and to shut it off if the surface temperature goes below 18 F. The logical controller will continue automatically performing this and many other functions until programmed otherwise. Figure 3 shows the relationship between inputs, outputs and system intelligence.

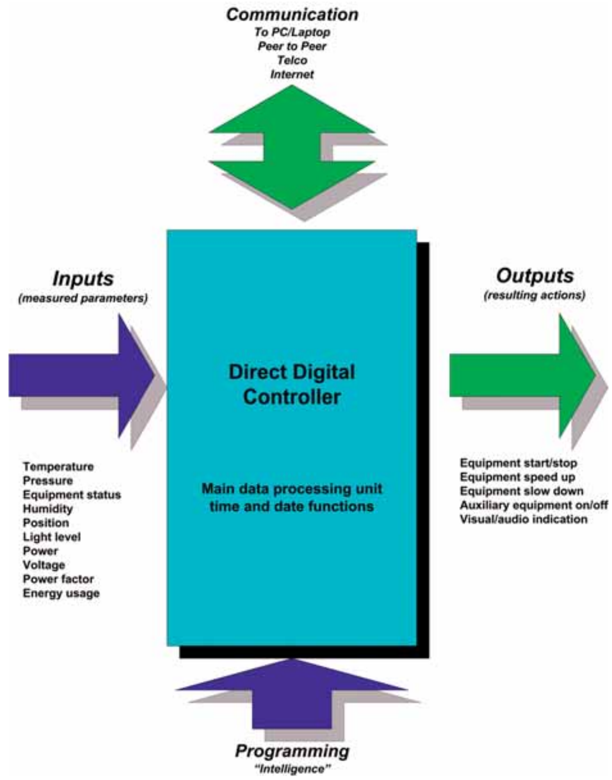

Figure 3: Direct digital controller

The DDC hardware (Fig. 4) resembles the block diagram, with the various system inputs wired on the left side and the resulting outputs located on the right. The DDC controller contains all the programming and system intelligence.

Figure 4: DDC hardware

Both EMC and DDC systems have their place in ice rink applications. As an arena owner, ensure that you completely understand the long-term advantages and disadvantages prior to making important decisions regarding your control system. Using either system with an effective preventive maintenance program, you will realize the maximum operational performance available.

Gerry Fitzsimmons, P. Eng., is the business development manager-service for Cimco Refrigeration.

EMC and DDC System Comparisons

EMC

Advantages

- Lower initial cost
- Interchangeable components
- Larger labor service pool
- Generic vendor options
- Troubleshooting ease

Disadvantages

- Inflexible
- Limited capability
- Single function
- Single-facility oriented
- Limited measured parameters
- Adjustment requires manual intervention
- Manual changes will not revert back
- Calibration points move with time

DDC

Advantages

- Lower life-cycle cost
- More energy-efficient operation
- Multi-facility capability
- Very flexible
- Programmable logic
- Better operating conditions
- Ability to look ahead
- Intelligent data management
- Built-in operational protection
- Improved remote communication capability

Disadvantages

- Proprietary systems
- More difficult to troubleshoot
- Smaller/specialized service labor pool
- Higher first-time costs