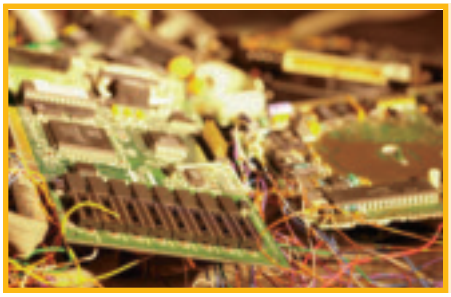
BY MARK EVANS

WIRED FOR CHANGE

It would have been appropriate to rename this column "coming up the wire" for this issue as it focuses on the impact technology will have on our industry, specifically hydronics, in coming years. Emerging technologies will soon effect great changes in how we design, install and commission control systems for hydronic applications in the residential context.

At first glance we may think we have already seen significant changes in the industry because of technology. State of the art in 1964 was a lot different from state of the art in 2004 – was it not? Consider whether the technology has really changed as much as we think it has.

We still have gear-driven motorized zone valves, mercury bulb thermostats and electro-mechanical relays and switches being installed today. The advent of solid-state technology certainly did change the picture and now digital technology has and is changing it further, but have we really realized the potential of these technologies? If not, what is holding us back from reaching the current potential of design options?



"The truth is that the vast majority of the components are not intuitive."

RESPONSIVE OR INTUITIVE

When most of us discuss control strategies and design, we explain function based on a few simple principles of electrical theory. Most of the conversations I have had involve installations where the majority of the system functions are simply on or off, contacts open or contacts closed. While some things like four-way mixing valves, variable speed pumps, or even gas valves on a given boiler might modulate within a range, the core design still assumes a lot of on/off thinking which determines the limitation of the installation and operation of the system. Why is this? The answer resides in some measure in the components being controlled rather than the controls operating them.

When the operator on the four-way valve modulates, why does that happen? Does any of the logic for that modulation reside in the operator itself? No it does not. The valve is simply responding to changes in current supply and is not intuitive in any way. When the variable speed pump or the boiler gas valve modulate, do they know why? Or, like the four-way valve, are they simply responding to controlled fluctuations in current supply?

The truth is that the vast majority of the components are not intuitive. We may think that the key to moving beyond the limitations of current installations is the development of newer controls that will allow these "dumb" components to do more things. What is really holding us back is a lack of evolution and innovation in component hardware and the fact that microchip technology has not found its way into the mainstream of hydronic component production and application.

THE WHAT-IF QUESTION

What if we could install a system that was controlled by a single host personal computer? This could be something as small as a hand-held personal computer, such as are currently available. It would use a standard operating system and allow for any number of software applications to run on it contiguously. The outboard devices, which in the case of hydronic systems would be things like the four-way valve, the gas valve, zone actuators, thermostats, temperature and flow sensors, and all other operating control devices would be connected through universal serial bus (USB) ports to the host personal computer (*see sidebar*).

Embedded with microchips, they would identify themselves to the host personal computer, define their own operating parameters and configure themselves (just as your new USB compatible printer did). Imagine not having relays.

Finally, as USB enabled devices, they would be powered through the bus (intrinsic) to the USB connection, meaning external transformers and power supply networks could be unnecessary. This means less work spent drawing and sending wiring schematics, fewer installation errors and product warranty claims, and less time spent on the job site troubleshooting jobs. If you think it sounds like science fiction, read on to find out what is possible now and what may be possible in the near future.

Where will the innovation come from? The HVAC industry has been pioneering the development of digital systems for many years. Some of the hardware used was initially developed for instrumentation and process control applications. The falling cost of microprocessor technology has encouraged migration to non-industrial applications such as HVAC systems.

CENTRALIZED VERSUS DECENTRALIZED

In the residential context especially,

Photos Hemera Technologies

hydronic installations tend to be designed around centralized control. The simple analogy is that there is a master control, where all of the intelligence resides. This control dictates the operating parameters of the system and overrides outboard devices to determine when and how to operate the heat source and control strategy devices such as the four-way valve.

In a decentralized system, the outboard components have resident intelligence and make changes in the process or function that they control. An example would be a thermostat that has proportional, integral and derivative (PID) function and can predict temperature overshoot based on an accumulated event history. It "learns" to shut down the supply of heat in advance of a decline in the actual room temperature in order to prevent an overshoot and attendant overheating of the room. A decentralized system incorporates as many such devices as possible, allowing the "master" control to monitor operating conditions without having to directly control all system functions.

While data can be collected in either digital or analogue format, most simple hydronic systems provide analogue data/signals. Much of the equipment we use day-in and day-out is also analogue. Analogue sensors, such as standard thermistors provide a resistance value to the control, which measures this and responds accordingly to enable/disable a circuit or function. Automatic outdoor temperature reset is probably the most evolved function such a relationship routinely performs.

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TERMINOLOGY

USB - UNIVERSAL SERIAL BUS is a plug-and-play system that enables the intermittent use of peripheral devices, most commonly printers and external drives, without the system having to be started, shutdown and/or reconfigured each time this happens. Individually or through hubs with up to 127 devices, USB enabled peripherals automatically alert the host personal computer to their presence, provide the appropriate driver and communicate the bandwidth required for them to function.

USB also allows many of these devices to be powered through the serial bus connection. Power use by devices can be categorized as either low, 0-100 mA, or high, 101-500 mA (DC). For reference, based on the operating voltages of the host personal computer, this would mean that the maximum power available would be approximately 2.5 watts. For the sake of reference, a standard DC thermo-hydraulic actuator will draw three watts. There are also "self-powered" USB enabled devices currently in use. So while the current state of USB technology would still require our valves, actuators and so on to be self powered, the power circuits would be much simpler and seldom if ever require any external relays.

There are a number of USB connected hand-held data retrieval and calibration devices available for process engineers and others who want to sample thermocouple readings and other process functions. These will acquire multiple devices and can maintain multiple time cycles.

SYSTEM ARCHITECTURE describes the structure of the overall local area network (LAN) or wide area network (WAN) of the system hardware. It maps function and allows the human user interface to take place. It dictates how the operator will communicate (directly or remotely) with the system. DDC system architecture can be configured in a number of ways. Ethernet, BACnet/IP, LONTalk, ARCnet, and MS/TP are the most common system architectures.

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SYSTEM MAINSTAY

Direct digital control (DDC) systems have been the mainstay of process control systems and commercial/institutional HVAC systems for over a decade. DDC systems, operating HVAC equipment are often part of a larger building automation system where the HVAC equipment may represent only some of many devices being measured, processed and controlled by the host personal computer or personal computers. Data storage locations or "points" receive data. Each point is uniquely identified in the system. These collections of points, as part of a DDC network, are part of the building automation system. DDC allows HVAC equipment, along with lighting controls, security and fire monitoring stations, and other building functions to be tied together to log data and define operating parameters in order to optimize energy use and reduce operating costs.

"Automatic outdoor temperature reset is probably the most evolved function such a relationship routinely performs."

In the case of the simple thermistors and other analogue signals we often employ in our residential hydronic systems, integration into a DDC system means that an analogue-to-digital converter would provide the microprocessor-based controllers with a digital signal. Software in the controller would then evaluate the signal and subsequently dictate the control action required, if any.

One of the major challenges in designing and installing an effective DDC system is the proprietary nature of business. It was intended that the software communication platforms and even system architectures (*see sidebar*) were inherently incompatible. Consider that even 20 years ago every building automation system and many of its hardware and software components were purpose built to function on a proprietary platform. This meant that in most cases Brand X equipment could not properly function on a Brand Y system (or if it was possible it would be very difficult to make it happen).

This has changed to a great extent due to the development of BACnet and LonWorks as open communications protocols. Building Automation and Control NetWorks (BACNet) was developed by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) and adopted by industry in 1995 as ANSI/ASHRAE Standard 135-995. Developed by Echelon Corporation, LonWorks is an open communication platform for DDC systems. It is administered by LONMark International, an industry stakeholder group.

BACK FROM THE FUTURE...

As an industry, if we consider the inevitability of DDC in residential installations, then the components being sold must become interoperable and intuitive. If you look at the size of the companies that dominate the DDC world, they are very large multinational firms.

Most participants in the hydronics industry are much smaller and will not be able to dictate system architecture or the communications protocols to be used. However, if as an industry we embrace a less proprietary approach to product design now, manufacturers will have more opportunity to participate and there will be more component choices for designers, installers and owners.

Creating products that incorporate the plug-and-play connectivity of USB is the ultimate extension of this philosophy. Regardless of how it happens though, we must all try to learn as much about DDC as possible, because certainly in this case, knowledge is power. HPAC

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■ *See www.big-na.org for more information on BACNet. See www.lonmark.org for more information on LonWorks.*

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