HPAC ARTICLE

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Standardizing Control Sequences for Common Systems at Given Locations - Making the lives of operations personnel easier

How many ways can a typical HVAC air system, terminal unit, or pumping system be controlled? The obvious answer is, Many. But what would be the best way to control, say, a variable-air-volume (VAV) air handler? An appropriate response would be the classic consultant answer of, It depends. And it does. It depends on many factors, such as:

By **J. Jay Santos, PE**, Principal, Facility Dynamics Engineering

How many ways can a typical HVAC air system, terminal unit, or pumping system be controlled? The obvious answer is, Many. But what would be the best way to control, say, a variable-air-volume (VAV) air handler? An appropriate response would be the classic consultant answer of, It depends. And it does. It depends on many factors, such as:

- The size of the unit.
- Where the unit is located and the outside conditions.
- The cost of the utilities.
- The maximum complexity of a sequence the intended control hardware can handle easily.
- The maximum complexity of a sequence the operations personnel can understand.
- The amount of money budgeted for sensors.
- The configuration of the air handler and the subsystem control strategies that need to be written.
- The type of area being served and the criticalness of it from a temperature-, humidity-, and pressure-control perspective.

For the remainder of this column, our discussion will be restricted to a certain configuration at a certain location. This way, many of the above considerations can be addressed for a particular system. The approach for this system then could be applied to similar systems at the same location. The end result would be that operators would not have to deal with so many variations of the same basic control scheme.

Consider a typical campus, or school system. Lets say 200 air handlers are in operation in the various buildings. Of these, 75 are of the VAV variety. More than likely, dozens of different control strategies would be in effect for these 75 air handlers. Why would this be?

Most likely, the systems and/or their controls were installed over many years, with many different engineering firms responsible for design and a number of different controls contractors responsible for implementation. Control sequences typically are generic in nature, leaving many details to be designed during installation (for a discussion on making written performance-based sequences more specific, see the September Control Freaks, Communicating Control Sequences Through the Use of Logic Diagrams). Each firm and contractor has its own preferences. The result is dozens of different sequences running similar systems. This makes using and understanding the systems on a daily basis much more challenging. What can be done to change this?

Consider adopting a standard approach for common systems. In this case, develop a standard sequence of operation for VAV air handlers. Weigh the considerations listed above and others to determine the appropriate level of complication versus control benefits. It may be appropriate to develop large and small VAV air-handler sequences, as a 40,000-cfm unit may require more complexity than a 2,500-cfm one serving a similar space would.

Developing standard sequences for a given institution requires input from both the design and operations staffs. Once standard sequences are adopted, modifications should be allowed only with the owners approval. When a system not covered by the standards is needed, hopefully, some of the standard subsystem logic will be utilized for the control sequence.

Standard sequences could be incorporated into a design-guidance document or be part of a guide-specification package for the site.

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Once standard sequences began to be implemented, training programs could be developed. Over time, operations personnel might be required only to learn a few standard approaches to controlling the common systems they maintain.

Send comments and questions to controlfreaks@penton.com.

A member of HPAC Engineerings *Editorial Advisory Board, J. Jay Santos is a professional engineer focusing on controls and commissioning. He teaches courses on building automation, direct digital control, and commissioning for the University of Wisconsin, North Carolina State University, and the Iowa Energy Centers Energy Resource Station.*

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HPAC ARTICLE

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Specifying Integrated DDC Systems - Ensuring functionality with parts from different vendors

A direct-digital-control (DDC) system consists of sensors, controllers, network-interface devices, operator interfaces, and software packages providing database management, communication, programming, graphics, and other user-interface tools.

By **J. Jay Santos, PE**, Principal, Facility Dynamics Engineering

A direct-digital-control (DDC) system consists of sensors, controllers, network-interface devices, operator interfaces, and software packages providing database management, communication, programming, graphics, and other user-interface tools.

When a single manufacturer provides all of these parts, it is able to easily make available all of the functionality and parameters of the system at various workstations. It is relatively straightforward to see all of the points on a given system; build graphics with any hardware points, software, or calculated points; and see the program comprising the control logic. Additional features, such as alarming, scheduling, trending, and data archiving, are available through various manufacturers' software packages. This type of DDC system effectively is "pre-integrated."

When one mixes parts from different manufacturers, the capability of providing much of the same functionality as with a single-source system exists. But to ensure this functionality, one needs to specify the requirements. This is becoming increasingly common, as networks, Internet-based systems, and open protocols are being applied to DDC systems on a regular basis.

It is becoming fairly easy and common--especially with the increased use of open protocols--to share information between systems and mix hardware from different vendors as part of a single system.

Usually, when speaking of sharing information between DDC systems, one first thinks of physical hardware point values. It has become relatively simple to "expose" a particular point from the controller of one system and "map" it into the supervisory software of another system. This is especially true with the use of a common protocol.

To change a set point or adjust a reset schedule from one system to another, the internal "points" or calculations must be exposed and mapped between the systems. This is a slightly higher level of integration, but one that usually is not too difficult to achieve by requiring "mapping" of the additional information.

The next level of functional integration involves mapping much of the pertinent parameter-level detail typically available. This detailed information, which may include point overrides, calibration offsets, and loop-tuning parameters, usually is not transferred between systems.

When Vendor A provides both the operator workstation and the controller-level hardware, there is a natural marriage between the two elements. But when Vendor A provides the operator workstation, and Vendor B provides the controller-level hardware, that marriage does not exist. What elements of interaction, such as point overrides and access to parameters, are lost?

First of all, you need to ask yourself, "Do I really need to see all of this information from a single workstation?" It is a good question. The answer is that it depends. It depends on how you operate your system. If your definition of "operate" is only to monitor point information on a graphic screen and occasionally manipulate a set point, then there may not be a need to "expose" all of the details of different underlying hardware on the other system. In such a case, you would need to use the software of the underlying DDC system to interrogate further.

But if you are attempting to replicate the full functionality that typically is provided by a single-source system, you will need to be more specific in your requirements. Some examples of important parameters that typically are available from a single-source vendor are:

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- The ability to put a hardware or software point in a "test mode."
- The ability to override a point or a set point.
- The ability to change a detailed tuning parameter of a PID block.
- The ability to add an offset to an input for calibration purposes.
- The ability to seamlessly and efficiently trend and archive control-system parameters.

In addition to all of the details of specifying the appropriate controller for the application, control sequence, sensors, and network performance, the specifying engineer needs to research the controllers and network interfaces to ensure they can handle the data transfer required to share the additional parameters.

Another important aspect of integrated systems is where in the network the programming (decision-making) resides. This can be an issue in single-source systems as well. The engineer should dictate that the majority of the control logic be located at the controller, where most, if not all, of the input data is acquired. Only supervisory or global logic (relative infrequent impact) should be allowed in any supervisory devices.

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HPAC ARTICLE

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Communicating Control Sequences Through the Use of Logic Diagrams The old saying is true: "The devil is in the details"

Design engineers typically rely on the written word to describe the desired operation of control systems. Often, their descriptions are generic and overly simplistic, which can lead to unintended results.

By **J. Jay Santos, PE**, Principal, Facility Dynamics Engineering

Design engineers typically rely on the written word to describe the desired operation of control systems. Often, their descriptions are generic and overly simplistic, which can lead to unintended results.

This column presents an alternative approach to communicating desired control sequences.

An analogy

Let's say I e-mailed the following message to my travel agent: "I want to travel from Washington, D.C., to New York City on Thursday morning and return Friday evening." This statement does not adequately communicate my intent and could lead to a variety of outcomes, including my being booked on a train when I wanted to fly.

The following is a more-specific set of instructions: "I would like to travel by air on a non-stop flight from BWI to New York LaGuardia on a major airline on Thursday morning, arriving before 10, and returning Friday evening, leaving after 5."

Even these more-detailed instructions leave out important considerations such as airline and fare class, as well as how early or late I am willing to fly. If my travel agent does not know my preferences, he has to make assumptions, assumptions that may result in a trip different from the one I intended to take.

The point of this analogy is that, as the saying goes, "The devil is in the details" of control sequences. In this regard, an engineer cannot be too specific. Far too often, though, details are not included in written sequences, leaving important decisions to be made by controls contractors during the construction process. A more-thorough approach during design would help to eliminate this problem.

Control-logic diagrams

The development of a control-logic diagram forces the system designer to make critical decisions regarding the intended operation of the system. Figure 1 is an example of such a diagram.

Control-logic diagrams are not new. The process-control industry uses process-and-instrument diagrams, while many direct-digital-control manufacturers use graphical-programming interfaces (Figure 2).

Figure 3 is an example of a mixed- air control-loop logic diagram used in teaching mixed-air-subsystem control logic. Simply writing, "The mixed-air dampers shall open on a demand for cooling before the cooling coil opens and maintains minimum ventilation air, except when outside air is too warm for free cooling," is not adequate. There are many other considerations:

* The control-loop response (proportional, proportional plus integral [PI], or proportional plus integral plus derivative). In Figure 3, PI control is called for.

* How the mixed-air setpoint (MASP) is determined (is it fixed or reset, and, if it is reset, on what is it based?). In Figure 3, the MASP is reset based on the discharge-air setpoint (DASP) minus 2 F.

* What determines that it is too warm for free cooling. In Figure 3, the high limit is initiated when the outside-air temperature (OAT) exceeds the return-air temperature (RAT) or when the outside-air (OA) enthalpy

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exceeds 28 Btu per lb.

* What happens if the fan runs in an unoccupied mode. For the logic shown in Figure 3, the minimum OA requirement is interrupted if the unit runs when the space, according to a time schedule, is unoccupied.

* How the minimum OA requirement is handled. In Figure 3, a fixed 25- percent signal is generated to ensure ventilation air when the space is occupied, and the fan is running.

* What happens if the fan is off. The logic in Figure 3 shows a supply-fan current switch sending the outside-, return-, and exhaust-air dampers to their normal positions.

Advantages

The primary advantage of control-logic diagrams is that control-sequence requirements are detailed during the design phase. This allows flaws to be detected and sequences to be rewritten.

If control sequences are adequately detailed during design, there should be a savings in the cost of the controls contractor, who otherwise would have to devote a significant amount of time to controls design. This savings should more than offset the increase in design cost.

The documentation of control logic can serve as an excellent commissioning tool. Without specific sequences, commissioning engineers must weigh the design engineer's intent against the controls contractor's interpretation.

Finally, logic diagrams make excellent training aids for instructing operations-and-maintenance personnel.

Obstacles

Why don't we see more detail during the design phase? First, there are no adequate standard symbols for control logic geared toward HVAC. Also, with the consulting community moving to less control detail in its documents, the required expertise is not as prevalent as it once was.

A more-significant impediment to design-phase control logic is liability--the more detailed a control sequence is, the more liable the designer will be if something goes wrong. However, it is in the best interest of owners that an engineer design the details of control logic, given that the engineer has the experience to do so.

Conclusion

As the design engineer, ask yourself if your verbal performance specification adequately covers the details of the installed system. Could you write detailed functional-performance tests based on this sequence to test all of the modes of operation? If not, how could the sequence be improved? Consider developing a more-detailed approach to communicating the intended operation. Control-logic diagrams are an excellent tool for developing, communicating, and documenting control-system logic. Send comments and questions to controlfreaks@penton.com.

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HPAC ARTICLE

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All Controllers Are Not Created Equal - Knowledge of the differences is key to specification

Many direct-digital-controls (DDC) manufacturers make controllers of two distinct "levels," while some make controllers of only one. These levels refer to where the controller resides within the system architecture on the control network. Knowing the difference between these levels is important because controllers are application-dependent. Unfortunately, many specifications do not distinguish between the various types of controllers. This article will explain the differences and discuss ways t...

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By **J. Jay Santos, PE**, Principal, Facility Dynamics Engineering

Many direct-digital-controls (DDC) manufacturers make controllers of two distinct "levels," while some make controllers of only one. These levels refer to where the controller resides within the system architecture on the control network. Knowing the difference between these levels is important because controllers are application-dependent. Unfortunately, many specifications do not distinguish between the various types of controllers. This article will explain the differences and discuss ways to specify the appropriate level of control hardware. Also, it will point readers to a Website where they can find unbiased information on a number of manufacturers' products (Figure 1).

Levels of Controllers

Higher. Typically, higher-end controllers live on a higher-level network and communicate in a peer-to-peer fashion. I will call these "primary controllers" (Figure 2). "Peer-to-peer" means that the controllers can share information with other peer-to-peer devices without going through an intermediary, which I will call a "supervisory interface" (SI). These primary controllers can range in cost from $1,500 to $4,000 and more. They have more memory, more-sophisticated CPUs, higher-resolution A/D converters, and more-accurate clocks and can store more-complex control strategies, as well as trends, schedules, and alarms.

Lower. Manufacturers also make lower-level controllers that typically reside on a lower-level polling network. These controllers have more-limited memory and processing capabilities and must utilize a supervisory-interface device to communicate with all other devices. They come in a number of flavors and can cost from $100 to $1,000. Some are designed for typical terminal applications such as VAV boxes and fan-coil units, while others are designed for air-handling systems with simple to moderately complex sequences of operation.

These terminal controllers typically are configured for the number of points required for the application. Some utilize a free form of programming (they require a complete set of custom programming), while others have application-specific programs for typical applications. These programs have selectable parameters that can be set up for each application. Since these controllers have more-limited memories, they typically do not store historical information (such as trends), relying on the supervisory interface for this function. The secondary polling networks are configured so that one supervisory interface can monitor a limited number of controllers. This limitation varies by manufacturer. A large number of controllers on a secondary controller network can negatively impact the number of trends that can be utilized practically, the amount of data that can be processed, and the data's speed of transmission over the network. How many controllers is too many on a secondary network? The classic answer is, "It depends." It depends on the manufacturer, the speed of the network, and the application.

Specifying the Appropriate Level

Most control specifications are performance-based, which both levels of controller types can meet. The engineer should indicate which controller is best-suited for the application at hand. A Pentium III-type processor is preferred for a computer running a CAD program, while an older 486 may still be adequate for a basic word processor. In HVAC controls, these lower-level controllers are adequate for many simple applications, while a primary controller is appropriate for more-critical ones. How does one specify these distinctly different controllers? First, the engineer must define requirements of various types of controllers and their corresponding interfaces (both network and operator). Once these are defined, the engineer can dictate which controller should be used.

What if the vendor does not make primary controllers? There are two options:

* If, in the engineer's opinion, a primary controller is warranted because of the sophistication of the system, the specification could disallow all but these peer-to-peer devices.

* The engineer could allow a dedicated supervisory interface for the secondary controllers required for the control sequence of a given system.

Sometimes, depending on the manufacturer's product line, it is necessary to use more than one controller to accomplish a given complex sequence of operation. This forces the application engineer programming the sequence to split up the various control loops of the system. This could result in the control loops for the starting and stopping of the fans and the variable-speed drive to be on one controller and the control loops for the mixed-air section and cooling and heating coils to be on the other. The potential problem comes from the polling nature of the secondary network. If one controller needs to send information to the other controller, it must first send it to the SI, which then forwards it to the other controller. Any loss of communication between these devices would interrupt the proper operation of the controls for the system. The engineer must determine whether this is acceptable for the application. As some product architectures move toward a flatter profile, with more distributed control logic, these controller classifications may not apply, but the engineer still will need to assess the robustness of the communication required for reliable and accurate control.

If the vendor is allowed to install a large quantity of units on this secondary network or implement a lot of network-heavy functions (such as trending), this could slow down critical control communication. For example, if the output to a variable-frequency drive is connected to one controller, and the controlled variable input is connected to another controller, the time delay in transmission could render the loop difficult or impossible to control.

The bottom line is that the design engineer needs to be more specific in dictating controller type. To accomplish this, he must possess detailed knowledge of the various control products. If the engineer has not kept up with the DDC industry, this will be no small undertaking.

Information Resource

In an effort to make information about control products more readily available, the Direct Digital Controls Website (www.DDC-online.org) was created. This Website presents 20 different product lines in a generic "ladder" by the classification of the device. Figure 1 is an example of one of these ladders. Note that not all products fit on a single layer. For example, some devices contain both a primary controller and a supervisory-interface device. From this system-architecture drawing, the user can double-click on a device and see a generic cut sheet appropriate for that product. This allows the user to more readily compare similar products.

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HPAC ARTICLE

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Five Principles to Specify Controls By - Clearly stating requirements is easier said than done

In the ever-changing world of direct digital controls (DDC), the focus of design engineers has been on new technologies, such as open protocols, Web-based control, interoperability, and the like. While these are important considerations, we should not lose sight of the more basic--and more important--aspects of DDC systems. Following are five principles--in general order of priority--offered as guidelines for developing coherent specifications that clearly state the requirements of a DDC system.

By **J. Jay Santos, PE**, Principal, Facility Dynamics Engineering

Clearly stating requirements is easier said than done

By J. Jay Santos, PE,
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In the ever-changing world of direct digital controls (DDC), the focus of design engineers has been on new technologies, such as open protocols, Web-based control, interoperability, and the like. While these are important considerations, we should not lose sight of the more basic--and more important--aspects of DDC systems. Following are five principles--in general order of priority--offered as guidelines for developing coherent specifications that clearly state the requirements of a DDC system.

1. The control system must provide effective and reliable control commensurate with the systems it is controlling.

Obviously, not all control products are created equal. In fact, they can vary greatly with respect to architecture, controller power/quality, network, etc. It is the design engineer's responsibility, then, to research the various options available to specify the most appropriate, cost-effective solution. This is not a trivial task, but rather an essential one.

An effective way of specifying controllers is applying the concept of generic "application categories," in which performance requirements of controllers (relative to stand-alone capability, memory, analog-to-digital conversion, communication facilities, etc.) are placed. The various systems are assigned to the applicable/optimal category. This dictates, for instance, whether the engineer accepts that the network is the controller, as is assumed with pure node-based LonWorks systems, or places critical/complex systems/equipment on high-powered, high-quality stand-alone controllers. Leaving such decisions to the contractor may result in too much or too little relative to the DDC hardware.

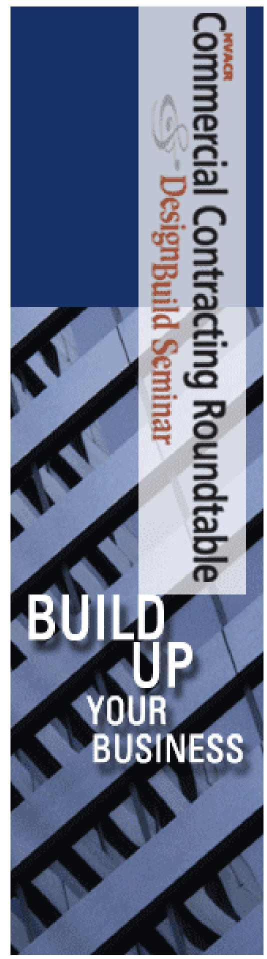
2. The manufacturer and installer must be highly qualified with extensive experience and committed/bound to a thorough Commissioning of the system.

Just as important--if not more so--as the power/quality of the control system is the expertise and commitment of the installing contractor, the installing contractor's collaboration with the design engineer, and the overall commissioning effort.

A specification should ensure that a quality contractor with a proven track record thoroughly commissions the control system, whether or not a formal commissioning process is employed. Given the critical nature of this, the designer must consider only those installers who can deliver effectively within both the construction and service/support arenas.

A specification should dictate qualifications of both the installer and manufacturer of the system. This may call for some research into the capabilities of local control contractors on the part of the designer.

3. The control installation must be fully documented as consistently as is practical with nothing that



is required to operate and maintain the system withheld from the owner.

Whether it is proprietary or interoperable, a control system always must be put in the context of the inheriting organization and, wherever possible, implemented and documented using standard approaches. Point-naming conventions, programming logic, network configuration, security information, etc. must be adhered to strictly and documented fully. Nothing that is essential to the continued operation and maintenance of the system should be withheld.

It is unacceptable that operators today do not have software that allows them to see how their systems are programmed. In some cases, they do not even "own" the programming to their own sequences of operation. Design documents need to address these issues. Of course, this is only part of the battle, as the documents need to be enforced as well.

4. The system must be interoperable to the appropriate level.

Seamless interoperability is an important, yet elusive, goal. As you navigate the sea of claims of interoperability, you most definitely will find that the devil is in the details because of the multi-dimensional nature of modern-day building automation systems.

There are many levels of interoperability that can be specified. A discussion of these are beyond the scope of this column. The designer must determine an appropriate level of interoperability, investigate and validate the necessary requirements, and specify those requirements clearly. Blanket statements requiring conformance to an open protocol are meaningless and unenforceable.

Interoperability can be classified into five categories:

- Enterprise historical data.
- Enterprise real-time data.
- Control internetwork communication.
- Control intranetwork communication.
- Point-level interoperability.

5. The sequence of operation for each system must be communicated clearly and completely.

The sequence of operation for each system designed must be complete and detailed. Performance specifications that are general in nature "punt" design responsibility to the contractor. The engineer must figure out how each system is to work in all modes of operation and clearly communicate this in the sequence.

Consideration should be given to developing logic diagrams during the design phase. A generic sequence makes programming and commissioning difficult, as there may be many possible interpretations. Which is most appropriate for the project? That should be the design engineer's decision. Period. Far too often, the commissioning engineer must find common ground between the design engineer's intent, the control vendor's interpretation, and the owner's desires.

Conclusion

Adhering to these five principles will result in better specifications and sequences of operation. This, however, is easier said than done, as research is necessary to meet the requirements. Design engineers must invest their time to shorten the learning curve if their intent is to specify better DDC systems. For previous Control Freaks columns, visit www.hpac.com.

HEATING/PIPING/AIR CONDITIONING
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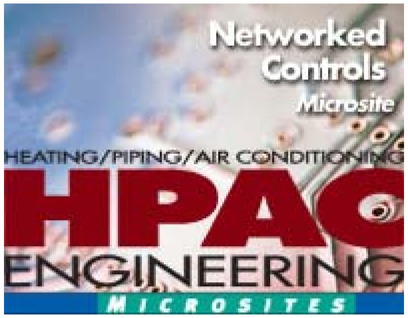
Control Freaks **January 2005**

Control Specifications: Ask for What You Need; Enforce What You Ask For

Good control systems begin with good documentation



By David A. Sellers, PE
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During the late 1980s, I was working for a consulting engineering firm for which detailed control strategies and heavy field involvement were the norm. Drawing on some less-than-ideal experiences I had working for a design/build contractor, and with the controls industry moving from pneumatic to direct digital controls, I undertook the task of rewriting the firm's control specifications. The result was three specifications: one for pneumatic controls, one for electric/electronic controls, and one for direct digital controls. All shared several characteristics:

- A fairly detailed statement of scope of work, including requirements for interfacing with other trades for the installation of sensors, dampers, valves, and interlocks.
- A very specific (down to make and model) list of acceptable components. This was fairly radical, especially in the pneumatic specification, which included only components that had proven successful. As a result, many of the required components could be supplied from only one or two commercial product lines (all could be supplied from process-control product lines), and no manufacturer could meet the spec by supplying only products from a proprietary product line.
- Very specific fabrication and installation details. In essence, this portion of the specs was written to prevent problems on past projects from recurring. For instance, having had trouble with NEMA ratings and compliance with NEC Article 725, I included very specific language regarding the fabrication and arrangement of control panels.
- An augmented library of standard details.
- Control drawings showing the location of sensors, control panels, and other major equipment.

- Detailed narrative operating sequences with system diagrams showing how systems were to work.

The direct-digital-control spec also was supplemented by a fairly detailed points list.

Each of the specs was more than 100 pages long. When I showed them to the firm's senior project managers and principals, the reaction was: "We need to talk about this. Technically correct or not, we can't issue specs that are 100 pages long." After we met, the specs grew to 125 pages, as it turned out I had forgotten some stuff.

Having concluded that perhaps we should issue specs--edited to reflect project requirements--that long, we faced the challenge of obtaining bids. Responses from the bidding community typically ran along these lines:

- "Nobody does things this way." (My response: "I know. That's why I wrote it all down for you.")
- "It will cost more if I have to use products from another manufacturer." (My response: "That's OK. I think my project budget supports the spec I wrote.")
- "If I bid to this spec, somebody else will low-ball it and get the job." (My response: "I hope not because I plan to enforce the requirements.")

Enforcing the specs was not always easy. First, some of those who took exception were quite good at arguing their points. Then, there was the emotional pressure that came with forcing someone to do something I knew, while legal and technically correct, would cause him or her to lose money. (I had a dream in which a controls salesman I knew was selling pencils out of a tin cup on a street corner. He said, "I had a bright future ahead of me until you enforced the spec on that project I low-balled.") I stuck to my guns, however, and enforced my specs--or at least their intent. As a result:

- I started to get superior control systems. Commissioning became less a matter of getting things to work and more one of optimizing how they work.
- The costs of my control systems were higher than those of other control systems; however, my control systems tended to produce better results that persisted longer. I budgeted for the higher costs, my belief being that the best machinery could be reduced to an inefficient mess (and, occasionally, debris) by a bad control system.
- Some controls salespeople began to actually like the specs, which they believed leveled the playing field and gave them a foundation for doing what they were capable of doing.

Which brings me to my point: The control problems many of us so often complain about are not entirely the fault of controls manufacturers. Some can be traced to the early phases of projects, when budget and technical details are established (or not). Using vague, unenforced (and, perhaps, unenforceable) performance specifications in a competitive-bidding environment is an invitation to disaster.

What is needed is a change in culture:

- Owners need to provide higher fees and more time. Consultants are underpaid to the point they leave much of the design function to controls vendors; additionally, the design window is so tight, they have little time to think. I have seen mechanical engineers hired mid-construction--the mechanical design issued as an add-alternate-bid package (with an addendum for controls) and bids due the following day.
- Owners and design teams need to develop construction budgets significant enough for good equipment to be purchased and configured in a manner allowing design intent to be realized. That means sensors with accuracies greater than ±5 degrees, network configurations supporting the data handling necessary for program execution and trending, points for commissioning and operation, quality final control elements, etc.

For these changes to take place, the design community will need support in terms of education, training, and tools. Some of this support can be found in the form of "Large Commercial System Design Guide" (www.newbuildings.org/pier/downloadsFinal.htm), "Control System Design Guide" (buildings.lbl.gov/ hpcbs/FTG), and CtrlSpecBuilder (www.ctrlspecbuilder.com).

In short, many product-quality and application problems exist because our current design and construction process will support nothing better. Just as we did not arrive at this situation overnight, neither will we emerge from it.

Supplementing the design effort will need to be a rigorous construction-observation, start-up, and commissioning process. Otherwise, our investment in high technology will be wasted.

I know many designers and controls professionals who are as alarmed as I am by the current state of affairs. Their alarm is compounded by their frustration at not being able to apply the things they know and the technology available to them because the realities of contract documents, the competitive-bidding environment, and the need to stay in business force their hand.

The bottom line: We in the design and construction community need to take the time to understand and ask for what we need and then enforce it. If we can do that, everyone will win: Designers will realize the intent of their designs, manufacturers will get to supply the best that technology has to offer, and building owners will realize the benefits of properly applied equipment and systems.

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Some Final Words of Wisdom

Editor's note: This month, HPAC Engineering *bids a fond farewell to Control Freaks. Since its debut in February 2001, this award-winning column has covered a broad range of topics, presented by many of the best and brightest minds in the controls community. Among the first contributors was J. Jay Santos, PE, who has written a fitting send-off. For a complete archive of Control Freaks columns, visit* www.hpac.com. *In March, look for the first of* HPAC Engineering*'s Application & Resource guides on building automation and controls.*

Over the nearly six-year history of this column, the direct-digital-control (DDC) industry has seen major changes—most significantly, the continued advancement of computer hardware and software, networking, and the incorporation of information technology (IT). This progression has brought tremendous good—and some unwanted complications and challenges.

On the plus side, for the same cost, we have greater power, memory, speed, and more at our disposal in the control and monitoring of HVAC systems. We have moved from relatively limited terminal-unit controllers to relatively robust ones. Communication has moved from proprietary networks and modem-based communication to the use of the Internet and existing intranets for remote communication. Central "head-end" workstations are being replaced with server-based systems. Notebook computers are a common tool of the trade, both for installers and operators. And, of course, we have the hope and promises of "open protocol."

On the negative side, we, as an industry, have had trouble keeping up with all of the technology change that has taken place over such a short period of time.

In recent years, we also have seen a "maturing" of the business of commissioning, which is becoming increasingly common on projects of all types. The commissioning process has the potential to place an independent controls-knowledgeable individual in the controls-design and installation process.

Although the overall impact is unclear at this point, the consolidation in our business as various DDC manufacturers merge has been another interesting trend.

All of this "progress" has increased the knowledge and skill requirements of the typical designer, installer, operator, and decision maker. A controls installer or operator now is expected to have:

- HVAC-system knowledge.
- HVAC-control knowledge (logic, sequences, etc.).
- Electrical knowledge.
- Computer skills.
- IT networking and server skills.

So, as we face the next 10 years of continued advancement in the controls industry, I offer some words of wisdom (some tongue in cheek) to the various "players" influencing building-control-system installation:

- To the DDC salesperson: Please stop exaggerating the benefits of open protocol. It is a communication protocol plain and simple; it is not a procurement panacea. Overstating the benefits and downplaying the challenges only leads to disappointment.
- To the manufacturer: Focus on developing systems that are easy to use and install. Do not worry so much about interoperable systems. Develop better training and manuals for installers and users.

- To the design engineer: Study, study, study, and write more-prescriptive specifications, sequences, etc. Too many documents go out for bid without clear direction for prospective controls contractors.
- To the facility manager: Seek, develop, and reward controls experts within your organization. An individual with the aforementioned knowledge and skills is unique. We need to recognize such people and develop a career path that rewards them.
- • To the facility manager's boss: Support requests to compensate control specialists according to their value—or risk having your organization become a training ground for control and commissioning firms.
- To the owner's contracting personnel: Be creative; the DDC system is not a commodity item. It needs to be procured more in the way IT hardware, software, and related infrastructure are.
- To the commissioning engineer: Learn controls, and use this knowledge to influence design decisions that produce more-prescriptive and detailed specifications and control sequences.
- To the inheriting DDC operator: Stay positive. As much as possible, take advantage of opportunities to learn controls, and get involved in the design, construction, and commissioning process.
- To the installing DDC contractor: Take quality-control seriously. Fight (within your organization) for the time necessary to do a first-rate job.
- To other contractors: Be realistic about schedules. Allow the DDC contractor the time needed to do a quality job.
- To the owner: Develop a plan to deal with the realities of DDC in today's world. Considering your specific application, limitations, procurement issues, and goals, provide guidance to those supporting you. Good control-system installations do not just happen; they require planning, diligence, and focus.

Hardware and software are maturing to the point that our projects should be more successful. All of the pieces to the puzzle of doing a better job are there. The key to putting them together lies with the people involved and the process implemented on projects. Some of the people are in place; however, the industry could use more, which means better training is needed. The process, on the other hand, needs to be more consistent. At the heart of a successful control project are planning (owner-and engineer-driven), quality and definitive specifications and control sequences, quality installation, quality control (commissioning), and turnover to trained and committed operators.

A longtime member of HPAC Engineering's Editorial Advisory Board, **J. Jay Santos, PE**, is a principal with Facility Dynamics Engineering, one focusing on controls, commissioning, and direct-digital-control (DDC) master planning. He teaches courses on building automation, DDC, and commissioning nationally.