Controls Education: More Critical Than Ever

The key to improving control systems is education. We need to educate everyone who influences the planning, budget, design, procurement, installation, acceptance, operation, maintenance, and service of DDC systems. These training needs are increasing exponentially as DDC products and systems rapidly evolve.

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Over the last 20 years, no one area of the HVAC industry has changed so dramatically as controls. These critical HVAC subsystems have undergone significant, fundamental changes-perhaps the most drastic of any in our industry. We have evolved from pneumatic controls to "overlay" energy management systems and first generation Direct Digital Controls (DDC), to current generation distributed DDC. The transition has been rapid and today we find ourselves dealing with control systems that are very different than those that were available just a few years ago.

The computer industry's trend of increasing processing power and memory at a lower cost over time is quickly influencing DDC controllers. The advent of open protocols and increased availability and use of site/building/campus networks has increased the complexity of the design, procurement, and operations of these systems.

Twenty years ago, we were looking at pneumatic receiver controllers, transmitters, and actuators, along with first-generation, expensive, and centralized DDC products. Today, our control systems are graphical, decentralized, relatively inexpensive, and serve up information to us via the Internet. We have moved from a non-proprietary communication protocol that relied on air pressure, to a very proprietary one that allows us to receive and respond to control alarms via our cell phones. Additionally, the control logic that in the past was distributed to single-function hardware components (receiver controllers, switching relays, etc.) now resides in software.

In general, design professionals and related parties have not kept up with these changes. While there are exceptions, a vast learning curve exists.

TRAINING NEEDS ARE WIDESPREAD

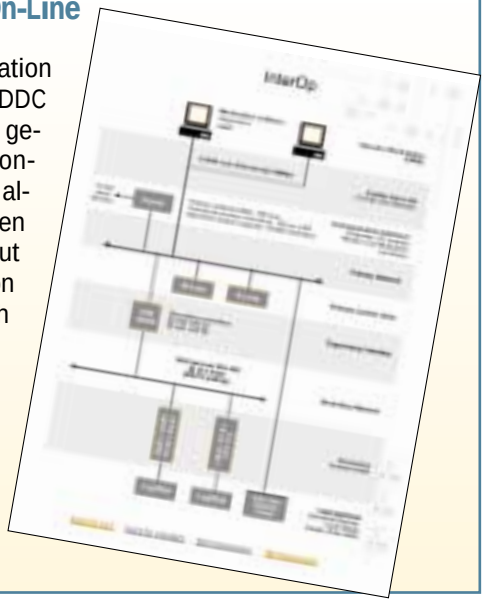
Controls are vital to the performance and basic operation of our buildings. The DDC system is the "brain" of the HVAC system. It dictates the position of every damper and valve, along with which fans, pumps, and chillers run, and at what speed or capacity. Yet, proportionally, it receives very little consideration as compared to the rest of the system during the design phase. Historically, controls have received too little attention during the procurement and installation phases as well.

We need to improve our knowledge of current DDC sys-

DDC Information On-Line

Visit *www.DDC-Online.org* for excellent, basic information about DDC. It presents unbiased data about the major DDC product lines. Twenty-one product lines are presented in generically described layers. The vendors' proprietary controllers and interface devices are placed on these layers, allowing a user to compare similar products. The user can then penetrate from this architecture diagram to a detailed cut sheet on each product. The cut sheet includes information about the product presented in identical templates for each type of device.

One of the goals of this Website is to provide information about products so engineers and owners can make an apples-to-apples comparison and hopefully produce better specifications. The site also includes a basic introduction to controls and a section on input and output devices and criteria.



tems and the issues surrounding their correct deployment into HVAC systems. This need extends to many different players involved in the process of influencing the quality of the DDC systems that are ultimately installed in our buildings. These include:

- The owner's design process managers.
- The owner's project managers.
- The owner's procurement/contracting specialists.
- The owner's inspection personnel.
- Operations and maintenance (O&M) managers.
- O&M personnel.
- Design engineers.
- Commissioning authorities.
- General, mechanical, and balancing contractors.
- DDC vendor personnel.
- Service contractors.

Any of these individuals may have to make decisions relative to DDC systems. The owner's project managers may make budgetary decisions that affect the breadth of the DDC installation or whether a commissioning authority is hired. Principals from the design firm may dictate that in-house standard specifications be used, rather than a custom specification based on researching new or project-specific products. Contracting personnel may require procurement guidelines that are not easily adaptable to the practical application of current DDC systems. Commissioning authorities accept or reject conformance with the specifications, and in many cases interpret "less than specific" specifications. All need some level of training on current DDC system technology.

Traditionally, when we think about who needs DDC training, we focus on consultants (who design the systems), vendors (who install them), and HVAC personnel (who inherit them). These are the people who influence the system outcome the most—right? The designers need in-depth knowledge because they're "theoretically" writing the specifications. The installing vendors need specialized training in the application of the particular system. The HVAC personnel need similar in-depth knowledge so they can operate the systems.

However, the individuals who establish the criteria for the design and determine the rules for the procurement ultimately may have more influence on the quality of the final installation than those who have a more direct role. Unfortunately, there is little education directed at their specific needs.

Most DDC education opportunities are provided through continuing education courses. These programs offer a general education for an extremely wide and varied background of all the parties listed above. Also, the material is compressed into programs that last from only a few days up to one week. The end result is that the programs are not targeted or customized for the varied needs of the many different students who need this education and training.

Additionally, there are many decision makers and influencers (e.g., managers and procurement specialists) who don't require the same intensive education as the engineer or operator. They need a different program that speaks a less detailed language, addresses broader issues, and teaches the fundamentals so they can make better decisions—a course such as "DDC 101 for Non-HVAC Engineers." In some cases, there may even be a need for a prerequisite course in "HVAC 101 for Non-Engineers."

SPECIFIC REQUIREMENTS

Let's look at some specific needs among the following groups:

HVAC Design Engineers: Engineers are responsible for devel-

When Specifications Are "Gray"

A good example of the need for increased DDC training is the confusion that results while "translating" specifications.

Take a look at a "typical" DDC section of a mechanical specification. Unfortunately, most are not very specific, or if they are, it's in an area where it doesn't matter much, if at all. This forces (or allows) the controls contractor to "clarify" the controls design very late in the construction process. These clarifications may not always be in the best interest of the project. Unfortunately, the quality of these "clarifications" is directly proportional to the capabilities of the application engineer and may be influenced based on a contractors' financial/business position on a given job.

There is also the important issue of how well these changes are documented. The end result is that many control systems are in effect design/built by the controls contractor. Additionally, when the specifications are "gray," the design becomes more difficult for owners or their representatives to enforce.

Here is an example of a "gray" specification:

"The Facility Management System (FMS) shall monitor the chilled water supply and return temperatures and start/stop chillers in combinations as required to maintain CHWS temperature setpoint (44 F - adjustment) and provide the most energy efficient operation of the plant ... The contractor shall submit the logic of a chiller sequencing in detail."

"The DDC system shall be BACnet compatible ."

"The DDC system shall be capable of ..."

"All controllers shall have 20 percent spare point capacity of all control types: AI, DI, AO, DO (this includes VAV controllers)."

oping quality specifications and drawings for these systems. This requires fundamental controls knowledge as well as a significant level of effort to stay current on the diverse products available from the many vendors providing DDC systems. Additionally, they have to keep up all the advances and particulars of the movement toward open protocol and Web-based control. In other words, fundamental skills are required, as well as real world experience with current products. This is no small undertaking; the learning curve is long and steep

O&M Personnel: These are the people who must make the systems work on a daily basis, by hook or by crook, and many have been climbing this learning curve. They need HVAC system knowledge, HVAC controls expertise, an understanding of electrical principals, PC skills, networking knowledge, and with some systems—computer programming. Many have developed into excellent HVAC DDC technicians. Some are able to influence the design direction and decisions, yet others are never consulted for input. There is a great need for operations personnel who possess DDC knowledge to understand the design process and be included in it.

Procurement and Contracting Specialists: Buyers need to acknowledge that this part of the HVAC system is not the same as buying pumps, fans, coils, or dampers. They need to understand the proprietary nature of this business. They need to appreciate the impact on O&M personnel when five or six systems are installed at a single location. In many control specifications, the phrase "or approved equal" just doesn't quite cut it.

Commissioning Engineers and Technicians: Controls-related testing represents anywhere from 70 to 90 percent of HVAC system functional testing. Those who work in commissioning need a strong knowledge of the details of controls.

Commissioning is rapidly becoming "business-as-usual" for projects of any substantial size and where quality control and operability is important to the owner. The control system design—and its commissioning—is the key to successful building operation. Commissioning engineers need to know a great deal more about controls than they did just a few years ago.

However, if it weren't for the relatively poor way many DDC systems are designed, installed, and quality-controlled, commissioning would not be needed to the same degree that it is today. Again, the first step to improving control systems is education.

For too long, continuing DDC education and training for these parties has been neglected. Changing the situation will require an investment—especially in time—on the part of technicians and their employers. Options include continuing education programs about the fundamental principles of DDC. Manufacturers also offer specific programs about their equipment. In the final analysis, though, there is no replacement for experience.

THE OWNER'S ROLE

Owners must realize the long-term financial impact and importance of controls decisions and be as proactive as possible. Ideally, they should develop in-house expertise to make them smarter consumers of what the controls industry has to offer and how vendors try to deliver their products.

Owners should also strongly consider a master plan, which will be important as they move forward and new options become available with DDC systems. Many large institutions have plans for their buildings and other areas of facility management, yet very few have a "Controls Master Plan."

Developing a plan for how and what DDC systems an organization will procure over the next five to 10 years is an important exercise given the numerous choices available today. Delaying or avoiding this process can be costly in the future. Of course, this is easier said than done. This plan requires an unbiased (non-vendor) resource that has stayed current with the 20 or more vendor product lines and all the relevant open protocol issues.

One of the fundamental decisions one must make on a given project is, "What criteria should determine the selection of a system?" This is an easier question to answer for a single stand-alone

Table of Contents for a "Controls Master Plan"

A "Controls Master Plan" can be very valuable as owners move forward with building plans and new options become available for DDC systems. The following is a suggested Table of Contents:

- **Current Installed DDC Systems**
  - Hardware
  - Work stations, operator interfaces
  - Communications
- **Planned Installations**
- **Analysis**
  - Cost issues (what, if any, premium is being paid?)
  - Procurement/contracting limitations and requirements
  - Open protocol considerations
  - Accuracy requirements/types of applications
  - Current use of system
  - Training needs
  - Commissioning needs
- **Internal Issues/Perspectives**
- **Capabilities of Local Control Vendors**
  - Products
  - Resources (people)
- **Need for Standards**
  - Specifications
  - Sequences.

building versus a site with multiple buildings, or for a corporation or campus wanting to limit the number of systems in its buildings.

Do the managers of the design process understand the fundamental options that go into the specifications that can dictate the type of system? Far too often, unrealistic parameters are placed on the DDC system as a result of decisions based on misinformation or misperception. Many institutions or sites are after one of two "holy grails" in the procurement of their controls: They either want a single-source contract that is "cost competitive," or they want "truly" open systems where they can swap control hardware from any vendor without having to learn multiple software packages to set-up, program, and use the system.

Although the industry is moving toward open systems, it is not quite there yet. There are many choices beyond the selection of the vendor that should be considered in a planning process. Owners can use the following questions to help them develop a plan. Note that answering these questions requires a keen understanding of the complexity and variety of DDC products on the market, so outside assistance may prove to be valuable when needed. The following is only a partial list:

- How large is the system? How large might it become?
- How will the DDC system interface and communicate with the existing installation? Is there any requirement for remote communication?
- How does the end-user plan to grow the system, if at all? How will costs be controlled in the future?
- What factors of the system are most important: operation and maintenance, ease of use, ease of programming, energy, reliability, human resources, cost?
- What type of equipment needs to be controlled? Is it all packaged and terminal equipment, large built-up equipment, or central plants?
- What type of accuracy is required?
- How complex is the control logic?
- What are the end user's data collection requirements for trending, analysis, or diagnostics?
- What types of operator interfaces are required?
- What types of DDC system interfaces are required to other systems or equipment? Is there a need to interface with any life/safety systems?
- What are the training needs?

(For more information, see the sidebar, "Table of Contents for a Controls Master Plan".)

Once the plan is developed, owners may want to consider developing detailed guide specifications to clearly communicate their requirements to the various design professionals who may engineer their HVAC systems. Owners/managers of large companies, campuses, hospitals, or military installations may consider standardizing common systems. There is no reason at a given site to have dozens of different control strategies for a common variable air volume air handler configuration. This approach can improve the control engineering, simplify commissioning, documentation, operation, and training requirements.

CONCLUSION

Many engineers responsible for system design need to improve drastically their controls knowledge and research DDC products. No one can afford to stick their head in the sand and hope or trust that things will work out. Control systems are the brains of the HVAC design—engineers should not delegate the design responsibility to the vendor. In this environment of rapid change, engineers are also responsible for educating other decision makers in the design/construction process so they will understand the ramifications of their decisions.

All parties involved in the process need to examine how they plan, design, procure, install, and maintain their DDC systems. Examine your process to budget,

design, buy, install, accept, and operate DDC systems. Ask yourself these questions. Is my approach current? Does it make sense in today's world of DDC systems? Do I have the education necessary to make these decisions? If changes are necessary, do I have the information necessary to make the changes? If not, where can I get it? NC