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EFFECTIVE INTEGRATION DRAMATICALLY IMPROVES BUILDING PERFORMANCE

High performance buildings can achieve increased sustainability and improved payback through thoughtful control system integration

Executive Summary

Market forces from energy codes to disclosure laws have driven an increasing number of business owners to invest in smart building technology. Happily, as the green building movement matures and the demand for high performance buildings increases, that investment is yielding greater returns. In fact, thoughtful system integration not only reduces total life-cycle ownership and operating costs, it improves occupant health, safety and productivity.

This paper examines the drivers behind control system integration as well as the many benefits of integrated systems to building owners and managers. It outlines best practices, including the use of flexible technologies and a single platform from which to manage building infrastructure.

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Marketplace needs for effective control system integration

The most significant drivers behind the development and adoption of smart building technology are building codes and standards, including voluntary reach codes that challenge architects and engineers to design sustainable projects. As Brendan Owens of United States Green Building Council (USGBC) says, "Codes set the floor and rating systems set the ceilings. There's always been a conceptual interplay between these two instruments."

The reach codes, including ASHRAE 189 and the USGBC's LEED rating system, pave the way for new levels of building performance in mandatory energy codes, including ASHRAE 90.1-2010, adopted in 2012 in Ontario, Canada, and currently being adopted by a number of US states.

Satisfying code requirements increasingly demands not only energy efficient designs, but also detailed energy performance data. New disclosure laws in several jurisdictions, including New York City and the state of California, also require building energy performance data. In most cases, networked control systems provide the easiest access to the data.

Networking building controls also creates opportunities for higher performance through system integration. Integrating lighting and HVAC controls boosts efficiency by delivering savings via automation with a minimum amount of equipment and decreased labor.

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When the network design is based on open protocols, resulting in simplified integration, capital and operating efficiencies are also easier to achieve. The right technology pays for itself providing both a rapid return on investment as well as reduced operational expenditures. Interestingly, smart buildings also command higher rent and increased sales prices, as tenants and occupants increasingly appreciate and demand sustainable surroundings, and corporations work to improve their social responsibility profiles.

Finally, integrated building networks are easier to make grid responsive. Sophisticated demand response programs have the ability to maximize the utility of existing electrical generation capacity as well as excess capacity from new net zero buildings. These demand response strategies support policy goals aimed at reducing the need for new power plants. With network lighting controls that offer precise, granular load control, it becomes practical to intelligently shed lighting energy along with HVAC setbacks.

Collaboration helps ensure success

Experienced integrators add significant value based on their proficiency with state-of-the-art digital control products.

Extensive collaboration is the key to overcoming the many challenges of designing high performance buildings, and the most successful projects partner owners, engineers and integrators early in the design process. Owners must clearly communicate their expectations, including requirements for performance and reporting. Engineers, among many other duties, ensure that regulatory requirements are not overlooked. Modeling and mockups play an important role in establishing feasibility, and the most successful project teams include suppliers and installers early in the process.

In addition to meeting current code and project requirements, building owners typically want solutions that can evolve with their needs. Careful specification helps prevent selecting controls that are inflexible, or difficult and expensive to integrate. Products based on a modular system architecture help ensure scalability beyond the initial project design. Owners also benefit from products that use industry standard BACnet protocols to communicate with other building systems, enjoying not only the widest range of integration options, but also the most cost effective solutions.

System integrators are being called on to provide more and more complex services, including programming specific sequences of operation for energy code compliance. Experienced integrators can add significant value to a project based on their proficiency with state-of-the-art digital control products. Integrators who are less experienced working with lighting controls will have to rely on the controls manufacturer for assistance. In either case, products that configure automatically and use familiar BACnet protocols help speed the process.

New BIM (building informational modeling) software can help designers coordinate complex systems, and controls manufacturers should offer BIM object files to support their products. Of course even the most advanced modeling is ideally supplemented with hands on mockups that allow the team to interact with user interfaces, assess ease of installation and ensure the integration will be seamless.

After installation, experienced integrators can also often work around minor problems that may have been overlooked during specifications. And, they can set up systems to facilitate continuous commissioning. Based on the wealth of data that is collected, buildings can not only maintain just-built levels of performance, but actually improve over time, helping the bottom line.

Case studies reveal integration best practices

Two recently completed projects in Ontario, Canada, offer best practice examples of a collaborative design process including owners, engineers, integrators and manufacturers followed by successful system implementation. Both projects relied on Vanderwesten, Rutherford and Mantecon (VRM) for electrical and mechanical engineering, WattStopper for lighting controls and WattStopper integrator partner Durell Control Systems for control integration.

Western University built a 66,700 square-foot Western Centre for Public Health and Family Medicine building (PHFM) from the ground up to serve as a research hub for primary care. (See sidebar on page 4 for project highlights.) The building brings the Department of Family Medicine and the Centre for Studies in Family Medicine together for the first time, and provides classrooms and seminar rooms for collaboration and study. Fanshawe College completely remodeled a 50,000 square-foot former bank building, originally constructed in the 1970s, to create the Centre for Digital and Performance Arts. (See sidebar on page 6 for project highlights.) The new training facility, which is remote from the main college campus, includes a black box theatre, motion capture studios, scene, prop and costume shops, as well as offices, classrooms and lounges, and is part of an urban renewal in downtown London.

The two spaces benefit from several common integrated control solutions, but also utilize specific sequences of operation best suited to not only the different types of buildings, but to the different space types within each facility. They rely on Delta control systems including a single centralized user interface that simplifies end user training and programming.

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>
> *- Evan Chase, Electrical Engineer, VRM*

The greatest common energy saving measure involves harvesting data from hundreds of lighting control occupancy sensors via the Delta system, and using that data to optimize operation of the HVAC equipment. The system, which also monitors indoor and outdoor temperatures, provides predictive operation that improves as it collects richer historical data. VRM Electrical Engineer Evan Chase says, "HVAC sensors are not sensitive enough to accurately detect occupancy. The far more discriminating lighting control sensors let us fully automate HVAC operation. Previously we've had to rely on manual switches." Chase selected a combination of ultrasonic and dual technology occupancy sensors to cover different spaces within both buildings. Chase concludes, "The integrated solution is more efficient and it improves the comfort of the buildings, because it starts up at the optimal time and constantly makes adjustments based on current conditions."

WESTERN UNIVERSITY

WESTERN CENTRE FOR PUBLIC HEALTH AND FAMILY MEDICINE (PHFM)

- New building with control network connected to campus-wide BACnet-based building automation system
- Dimmable lighting in most spaces; manual-on control with energy savings from occupancy and daylighting sensors
- Predictive HVAC controls, integrated with lighting control sensors, automatically adjusts airflow and dampers
- Candidate for LEED Silver certification

> ***"You need to write one specification for both sections, describing who does what, to prevent anything falling into the cracks with no one taking responsibility."***
>
> *- Hernan Asuncion, Mechanical Engineer, VRM*

Chase and VRM Mechanical Engineer Hernan Asuncion worked carefully to detail the scope of work for both trades. "You need to write one specification for both sections, describing who does what, to prevent anything falling into the cracks with no one taking responsibility," they agreed. These were the first projects they completed with such extensive integration-based automation, and start up was easy with the room-based lighting controls operational even before the network control was fully implemented. Chase comments that the distributed lighting controls solution allows the building owners to make changes in the future fairly easily while the network simplifies ongoing maintenance.

> ***"We can adjust the sensitivity remotely instead of getting out a ladder to fine tune sensors with a little screwdriver."***
>
> *- Jamie Whitty, Manager of Mechanical and Energy Engineering , Western Environmental Systems*

Control System Specialist Dan Larkin and Manager of Mechanical and Energy Engineering Jamie Whitty of Western Environmental Systems, Western University's in house systems department, echo Chase's comments about maintenance. "We have five people to maintain 85 buildings on campus, and in PHFM we can adjust the sensitivity remotely instead of getting out a ladder to fine tune sensors with a little screwdriver," they say. "Nobody even has to get in a truck!" Larkin and Whitty participated in the design process with the engineers and integrators, and encouraged the use of brands that have performed reliably in other campus projects.

The controls for the new facility include digital switches for manual activation of lighting in classrooms, offices and seminar rooms. Most of the building lighting is dimmable, and the many spaces with windows, including offices and hallways, are equipped with photosensors to automatically adjust lighting levels based on the daylight contribution. The large classrooms and meeting rooms have scene controls assigned to a combination of dimmed and switched lighting. Occupancy sensors turn lighting off throughout the facility after spaces are vacated. A sweep command of the networked controls at the end of the workday changes the time delays on the sensors from 20 minutes to 5 minutes for greater savings after hours.

The lighting controls in each room include a network bridge that is connected to the nearest BACnet MS/TP network, each of which hosts 25 to 30 rooms. Delta routers connect six of these subnets to the building automation system, which, with about 51,000 control points, is one of the largest installations in North America. The carefully designed network architecture ensures sufficient bandwidth for communication with the lighting and HVAC controls. It also maximizes the utility of the IT infrastructure, minimizing the capital expenditure and improving ROI.

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In addition to remote maintenance, the facility team can lock out lighting switches during special events, see actual hours of occupancy, and monitor power consumption in the different rooms. A Delta Historian can archive data for years to help them observe and act on trends.

The design at PHFM now serves as the model for future campus construction, and the team comments that not only are occupants happy with the building, but the community is as well. "The community has been asking the university to employ energy savings measures. When they see that the lights are off in unused spaces they understand we're committed to the environment. It's a great public outreach tool," says Larkin.

The project was designed to meet ASHRAE/ANSI Standard 90.1-2004 and earn a LEED silver certification, and the design team reports that they exceeded the requirements for LEED silver. Their approach was to automate lighting and HVAC control wherever reasonable, and make it easy for occupants to save energy.

Design goals and strategies at the Fanshawe College training facility were similar to those employed at Western University's PHFM, however the college prefers "LEED-like" solutions and will forgo the actual certification. Also, the Fanshawe team worked together to plan for potential changes and additions to the system, both in terms of physical layout as well as capacity to integrate with more systems.

While developing project specifications, Evan Chase designed a standard high and low voltage box system to house all the control components required in the plenum for each room. The box is mounted in the same location above each room, making it fast and easy to access and maintain the system going forward. He comments that with the modular nature of the controls, it will be easy to add or change components.

"We'll establish a baseline for budgeting based on occupancy and activities."

- Doug Calder, Manager, Maintenance Services and Utilities, Fanshawe College

Fanshawe College's Doug Calder, Manager, Maintenance Services and Utilities with Facilities Operations and Sustainability, comments, "We plan to trend everything. With a fresh building, we'll establish a baseline for budgeting based on occupancy and activities." Chase notes that in the future Fanshawe wants to compare occupancy trends with security data to confirm whether or not rooms are used when they are reserved. They are also studying additional security integration, including interfacing with the card key access system.

FANSHAWE COLLEGE
CENTRE FOR DIGITAL & PERFORMANCE ARTS

- Renovation of existing buildings separate from main campus; BACnet-based network designed for future integration of security systems
- LED lighting throughout the building with switching and dimming controls; manual-on control with energy savings from occupancy and daylighting sensors
- Predictive HVAC controls, integrated with lighting control sensors, automatically adjusts airflow and dampers
- Sustainable design exceeds ASHRAE 90.1 requirements

Until recently, Calder was the Project Coordinator within the Facilities Project and Construction Management Department at the college, so he played a key role developing the facility. "We wanted smart, modern technology throughout the space," says Calder. Recessed lights are LED-based and controls are designed to evoke the best lighting for activities from computer use to cleaning, with multi-button switches programmed for different activities. For normal use, the top button activates all the lighting zones, and daylighting sensors take control of lights next to the windows to keep the zone off if it is not needed. Another button turns on just a few lights for presentations. Two more buttons evoke all on and all off. Selected rooms include dimming controls for added flexibility. "We couldn't ask for an easier high tech solution than these controls – you can make them as simple or as complex as you want – we've chosen a middle ground, and we can tweak the sequences of operation a little bit as needed," he explains.

The new Centre for Digital and Performance Arts is scheduled to welcome students and faculty in January 2014. Since the faculty was involved in the design, and the controls are standardized throughout the building, Calder does not anticipate having to make many adjustments, but he can do so from a convenient central user interface. "We experiment as appropriate for each building, whether it's new construction or a retrofit," says Calder. Based on previous experience with another building, he is confident that this new facility will be easy to operate and maintain, and credits the controls as well as the installation and integration.

In fact, the VRM engineers and the maintenance and engineering staff at both campuses stress the importance of the integrator's expertise with both BACnet and the selected controls. Using open protocol BACnet, the integrator was able to successfully incorporate the new facilities into each institution's existing infrastructure. And, because they have experience with the lighting controls as well as the HVAC system, they were able to configure all the controls, simplifying the final stages of construction.

Hands on bench testing, along with support from the manufacturer, helped the integrator develop the advanced proficiency that made the jobs so successful.

This expertise was gained not only on the job sites, but in the shop prior to installation. Hands on bench testing, along with support from the manufacturer, helped the integrator develop the advanced proficiency that made the jobs so successful. At VRM, the engineers have had less success with other integration projects using different vendors and products. "Having a local representative who is knowledgeable is a major key to success," concludes Chase.

Conclusion

Embracing opportunities to incorporate integrated networked controls systems offers building owners and managers far greater benefits than simply meeting legislative requirements. Networked control systems are increasingly affordable, and designing systems that boost building performance provides excellent return on investment. Experienced integrators using modular digital control systems based on open protocols can successfully deliver:

- Code compliant functionality
- Beyond code energy savings
- Comfortable, inviting and easy-to-use spaces
- Single user interface
- Ladder-free maintenance
- Reporting and trending
- Smart grid integration
- Continuous commissioning
- Ability to support changes and additions

Designing high performance buildings requires careful collaboration, and the keys to success are great communication. Architects, engineers, owners, installers, integrators and suppliers for multiple trades need to participate early in the process. When systems are unfamiliar, the time spent ensuring proof of concept is well spent, as the resulting building will have a higher value than a traditional building.

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