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The Future of Building Automation

Facility Managers Speak

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Executive Summary

In early 2004, E SOURCE interviewed 54 commercial facility managers and energy managers about their concerns and preferences for building automation and controls. We asked about their day-to-day issues and what they would want in an ideal world in terms of optimal building automation.

We learned that, although many facility managers are struggling to cope with current issues, their highest priorities for improved building automation center on two areas: a standard controls protocol and a trained staff. Clearly, neither represents a high-tech innovation. Many interviewees were passionate and vocal about the costs and hassles they endure in an effort to connect devices and systems to communicate critical data that would support more efficient energy management. That's even without integrating multiple systems into a single interface—an issue that divided the facility managers we spoke with. Some saw convenience and synergy with all their eggs in one basket; others saw risk and vulnerability.

As to the future, many of those we interviewed were ready to accept increased automation, by way of high-functioning "smart" systems, in order to save staff time. But they were not ready to take human intervention out of the decision-making process entirely. A smart system should at least report to facility staff any adjustments or changes the system initiates. Facility managers are willing to embrace new technologies for on-site generation as soon as the units are cost effective; that is, when they can meet stringent project payback requirements. Facility managers are hesitant to adopt wireless connectivity until communication of building control data is secure.

When asked to "dream of what they'd really like to have," all of their responses are technically feasible today. The reality is, facility managers are still coping with yesterday's problems with limited budgets, staff, and time.

Energy Information & Communication Focus

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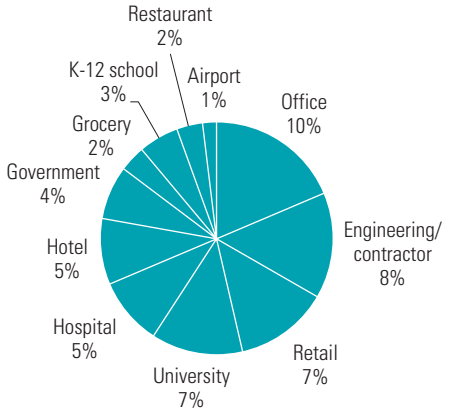
Methodology

In early 2004, E SOURCE interviewed representatives of 54 large companies or institutions about their current concerns and future preferences for monitoring and controlling their facilities. The persons interviewed managed facilities from school campuses to supermarkets and from airports to hotels in North America, Europe, and Asia. (All interviewees were assured anonymity. See the Appendix for a list of the questions we asked.) The interviews, about 45 minutes each, were based on a common question set, but as in any open conversation, the focus or detail varied from interview to interview. We began each interview with questions about the automation systems currently in use and closed with a wide-open "What would you really like?"

All companies interviewed were commercial or institutional, or were engineering contractors serving those markets. In North America, participants in this study included companies in office buildings and retail space as well as hospitals, hotels, supermarkets, and restaurants. We also interviewed government facility managers and managers of universities and K–12 schools.

Figure 1: Types of companies represented in interviews for this report

We interviewed individuals representing a total of 54 commercial business and institutions in North America, Europe, and Asia.



Source: E SOURCE

We spoke with managers from a total of 12 companies in Asia and Europe, ranging from airports to universities (**Figure 1**).

We asked interviewees what building automation and control (BAC) systems they use and, if they would tell us, from which manufacturers. More than 40 automation system brands were named (see sidebar). Most companies have multiple systems; one nationwide retailer has a mix of 24 systems in place among several hundred stores. A large military base has at least 19 systems at a single location.

The Current State of Automation

When discussing the current state of building automation, three themes were apparent: people, budgets, and communication.

Although we attempted to focus on sophisticated technology in our questions, many of the responses were about the human side of building management. Fully 26 percent of the interview subjects specifically mentioned people issues as a current problem. In an era of "do more with less," many companies have smaller operations and maintenance (O&M) staff than they had even a few years ago. As a big-box-retail energy manager said, "Trying to keep up with 1,600 stores with an hourly paid individual is not a good match." New hires tend to be less well trained, lower paid, and have less experience with automation systems than previous staff. They are, however, computer and Internet savvy and able to adapt to web-based control programs.

Turnover in the O&M staff is also a problem, manifesting in training problems and resulting in underutilization of systems (see **Table 1**, page 3). That is, the automation system could be tuned to manage the building more efficiently, saving energy

Table 1: Common automation concerns within business types

Although many respondents offered similar comments on issues, the interviews reflected common concerns within industries.

Sector	Building automation concerns
University	Desire to integrate multiple systems
	Tend to be innovative and flexible
Hotel	All about guest comfort
Hospital	Critical systems must be independent
	Regulations
Retail	Customer comfort
Grocery	Priority is food safety
Restaurant	Customer comfort
	Building automation system not cost-effective
Office	More propensity for highly automated systems
	Occupant comfort a priority
Government	Deferred maintenance
	Systems underutilized
	Understaffed, undertrained
K–12 schools	Deferred maintenance
	Systems underutilized
Engineers/contractors	Consistently support Internet connectivity

Source: E SOURCE

and money, but the staff doesn't have the time, training, or experience to correctly program the system. According to a director of maintenance operations, "Part of the problem here is that we have some very sophisticated, talented, and capable building systems that sometimes outstrip the capacity of our people or their time to manage them."

The other side of the human equation is the building occupant. In hotels from California to Germany, the guest is the boss. The facility manager knows that a "consistent experience" will bring guests back. In restaurants, sophisticated and automated systems that are controlled remotely aren't appropriate, because the local restaurant manager has to respond to each guest's comfort. In office buildings, the tenant drives energy use and building parameters, not optimized machinery systems calculated for efficiency and low cost.

"Do more with less" applies to O&M budgets, too. Multiple-site enterprises and large campuses are centralizing facility and energy management but not necessarily supporting management with the tools required for centralized monitoring and control.

For capital improvements or major facility system upgrades, companies interviewed listed payback requirements of two to five years, although government and K–12 schools allowed much longer paybacks. Universities were more likely than others to examine life-cycle cost analysis. In virtually every case, budget is a hurdle to integrating, updating, or replacing systems. It can be said that not having enough money is preventing saving money on energy.

Another cost concern relates to a primary technology issue: communication. Because connecting sensors to the control system generally requires that the protocol (data exchange language) be the same for both,

Building Control Systems Used

Among the companies represented in the interviews, more than 40 building control systems were mentioned. In many cases, multiple systems were used within one company or even at a single building. (In some interviews additional control systems were mentioned, but what they were was unclear or difficult to confirm.)

Allen-Bradley

Allerton

Andover Controls

Automated Logic

Automatrix

Barber Coleman

Carrier, and Carrier Comfort Network

Computer Process Controls

Comtrol

CSI/TAC

Cylon

Delmatic

Fisher-Rosemont Delta V

Foxboro

Honeywell, including Honeywell pneumatics

Iconet

Inncom

(continued on page 4)

Building Control Systems Used
(continued)

Intellution

InterCon Data

Invensys

Johnson Controls Inc., and Johnson Controls Metasys

Landis + Staefa

Lennox

Lutron (for lighting)

Modicon

NCC Powers

Novar

Parker Hannifin

Pentech

Robert Shaw

Siebe

Siemens, and Siemens Insite

Site Controls

Square D

Teletrol

Toshiba

Trane Summit, Trane Tracer

Unitech

Yamatake

each system vendor's proprietary protocol means that each sensor has to be purchased from the same vendor, at the vendor's price. Although it would be cheaper to buy generic, off-the-shelf sensors, the O&M team must spend more money and weigh the advantages of increased monitoring against budget limitations.

Twenty-three percent of those interviewed offered, without prompting, "communication between systems and interoperability" as a problem with present-day automation systems. When prompted about standards and protocols, nearly every respondent who understood these terms had a negative comment about the lack of a common standard for the building automation industry. In fact, managers at a major retailer, a hospital, and a school system take pains to use only one vendor for automation systems so that they can avoid the cost and inefficiency of integrating multiple systems.

Over the past several years, the push by building engineers, architects, contractors, and device manufacturers to improve interoperability led to development of two standards for device communication: BACnet and LonWorks. The first is a standard that resulted from many participants in the building automation industry working through a long comment-and-consensus process within the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).[1] LonWorks, however, was developed over the same period of time by a small group of people who formed Echelon, a company whose goal was to enable simple device networking within many different industries.[2]

Many building managers try to integrate on the BACnet or LonWorks standards but are finding that neither system ensures as much interoperability as they would like in order to take advantage of truly networked systems. As one control system technician said, "The problem I've seen with most of the BACnet and LonWorks is that they're great at pulling information out and giving it to you, but they don't let one system talk to another system very well."

Whereas 15 respondents said they already use or preferred moving toward BACnet or LonWorks, another 8 said that Internet Protocol (IP) or even extensible markup language (XML) should be the common communication protocol for monitoring and control in the future.

Some facility managers feel quite strongly about whether systems are "open protocol" or not. "That's one major issue in the business right now. . . . You deprive the industry of something that we need to have. . . . Some companies tell you they're open protocol, but they're not," when it takes two years to connect two devices. "It's disgusting sometimes."

Integration

Should all building automation, including lighting, air handling, and people movement (elevators, for example) be in one single, integrated system? With a 60/40 split, more comments were in favor of full system integration, or "putting all your eggs in one basket." Many favored the convenience and simplicity of having a single interface for managing one building or multiple buildings—a common front end and plug-and-play components. This single interface would be easier to monitor centrally and easier to train staff to use.

Yet even those saying that the convenience would be a valuable time-saver were concerned about "putting all your eggs in one basket." Explained a senior energy team leader, "If you were to have a major catastrophe and that system went down, you'd have lost your ability to do everything. I believe in redundancy, or in

two systems, so you don't take everything in the building down at once."

The roadblocks or hurdles to integration are essentially those described before: people, budgets, and communication. Not only are various people in the corporation concerned for reliability and accountability of systems that maintain occupant comfort, but different company segments also have different ways of relating to the building automation system. The information technology (IT) group is concerned about data traffic and interference. The human resources department is concerned about occupant safety, comfort, and good working conditions. At a retail chain, the occupants are both employees who are in the space for hours and shoppers who are only in the space a short time but may have particular comfort requirements. (Lighting varies according to the merchandise being sold; humidity levels can affect clothing purchases.) Meanwhile, the facility managers might be most concerned with equipment and structural maintenance. All these different groups have different cultures, different ways of communicating, and sometimes conflicting preferences.

Not surprisingly, cost—both the first cost of integration and maintenance cost—is a common hurdle to integrating systems. Technicians are concerned that by integrating into one system, there will be less price competition for individual components. They're conscious of the risk associated with counting on a vendor to be a permanent or long-term supplier. Additionally, a fully integrated system could be so complicated that maintenance might only be done by the vendor and, therefore, would be more expensive.

Integration of multiple systems is another level higher in complexity, because it involves the problem of communications protocols. If it's already difficult to install new sensors or controls in the HVAC system, imagine what it would be like to expect the HVAC system to "play nice" with the lighting system.

But there should be a common standard, said several interview subjects, much as Microsoft has achieved in computing. All peripherals and applications work with the operating system, and there are common formats, toolbars, and a graphical user interface. Yet the standard is flexible enough to allow for different and new kinds of peripherals and applications to be developed by multiple vendors at competitive prices. The facility manager at a major university described this scenario as "flexibility and standardization—you get a lot of choices [in components], but they all conform to certain basic things."

Some systems just should not be integrated, according to almost all of the respondents. Security systems are installed at more than 70 percent of the companies and fire systems at more than 80 percent. But these systems are almost always separate from the building automation and control systems. (The fire system may receive signals from some sensor units that are primarily part of the automation system.) For one thing, local fire and safety codes may require an independently maintained fire monitoring and alarm system with its own dedicated wiring. Considered "critical" by both the company's IT department and facility management team, the reliability requirements mean that companies aren't taking a risk that high data traffic or network interruptions would limit the effectiveness of systems designed to protect personnel and assets. Plus, fire and security systems are often directly monitored by a third-party service, which needs a simple interface with no extraneous data.

Specifications, Design, and Maintenance

Even at initial building design or first installation of a single automation system, mechanical, electrical, architectural, and field maintenance contractors all have different ideas of how to manage a building efficiently. They need to communicate their expectations and goals before a building is constructed and its system is commissioned. One contracting engineer said, "My pet peeve is that typically when a building is built, the engineer [for the architect] puts in pretty plain-Jane, generic language [on specifications] and doesn't really design energy conservation into the control strategies." In New Zealand, a facility engineer for a property management firm recommended that, "when systems are chosen and installed, there needs to be communication between the mechanical, electrical, and every other contractor in the field putting their equipment in. In the early stages you need to get a roundtable going so all the needs are met."

In real life, a corporation or institution will have multiple building locations and "there will be a handyman on staff who goes around and puts out the fires before they have to call in the expensive contractor," said a California-based engineer. "The majority of the time, the handyman knows just enough that, 'Hey, I could bypass this, and the system comes on line, so it must be fixed.' " Human intervention to reset design parameters is a leading cause for recommissioning a building. A change in occupancy or space use is another; equipment degradation is a third.

BAC systems report numbers (values such as temperature or humidity) or states (fan off or on). But too often undertrained O&M staff look at the monitor and don't have the training to know whether the reports are matching the optimal settings for how the building was designed. The senior technical staff leader of a large technology corporation explained, "The operator gets completely divorced from the intent of the design, which sometimes costs you a lot of energy. When I get involved in the design of a building management system, I always like to put a window next to all the data on the screen for the operator, to tell the operator, 'Look, this is supposed to be X. If it's not X, it should be an alarm.' " Although many systems do alarm when a condition is outside set parameters, those settings aren't necessarily the ones the designer or original building commission team established.

Building automation systems are more than hardware and software, to be sure. Facility managers report the difficulty of learning multiple systems and their upgrades and keeping new staff adequately trained. One alternative is to outsource monitoring and recalibrating the controls to an engineering contractor. Another alternative is to contract with the system provider on a maintenance agreement. A consulting engineer warns, "Most manufacturers of systems say you've got a one-year warranty, but after that they don't tell you what it's going to cost to keep it operating. That's never in their equation for your 'payback' when they're trying to sell you the system."

In fact, a study published by the Business Communications Company Inc. reports that, "Equipment accounts for less than a third of all revenues generated by installation of an integrated building management system. The remainder is attributable to services that include consulting and design, installation, training and commissioning."[3]

Key Components of an Automation System

In an open question designed to get opinions and comments more than cold data, we asked what the most important part of any building automation system is (the sensors, the communication network, or some other component). Surprisingly, the responses often were about humans, not hardware.

The energy manager of a high-tech global corporation was decidedly un-tech when he said, "It's the person sitting behind the computer. He's got to be able to determine what's real and what's not real, and be bright enough to understand the system."

We heard that it's not only the human factor that is important but also the connection factor. After the responsibility of the human manager and the interface between human and machine, the next most important part of a system is the wholeness of it. If we use the dictionary definition of a system as "an interdependent group of items forming a unified whole," then the value of the system comes from being interdependent and unified. The sensors, communication network, process controllers, devices, and interface software must all be reliably balanced and connected.

When respondents did talk about hardware, they regarded the main supervisory and process controllers as the most important hardware of a total system. The programming logic at some central control unit takes inputs and causes an output. "It's the ultimate reason for an automation system to exist," explained the controls engineer for a government site.

The Role of the IT Department

The role of the corporate IT department is changing as it relates to building automation. Increasingly, the IT department is being brought in on project planning and decision-making. In the past IT had been simply a gate-keeper, preventing use of the corporate network for automation systems or requiring firewalls and security implementation that limited remote access to multiple systems within buildings.

In our interviews, about twice as many said that IT involvement is crucial or helpful, especially to bring in at the beginning of a project, as those who said IT is not essential and shouldn't be involved. Remaining respondents said that the IT department either simply demanded security requirements be met or interfered and "messed up" the project.

Said one maintenance director, "I believe IT [staff] are a part of the solution, but the way they are cast in many organizations causes them to be part of the problem." A controls engineer advised, "IT's support is very important, especially if you want to take advantage of an existing network so you don't have to duplicate a network and go through all that expense; also to coordinate firewalls and IP addresses. And if you can talk the same language, you're more likely to get that support."

Two engineering contractors summed up their advice in these words: "We certainly need their input, but they've been very heavy-handed in driving decisions about building automation. There's a fair amount of education involved. Once they understand what we're doing, we get a lot of support."

Building Automation as It Could Be

After we encouraged facility managers to talk about their current problems, we asked them to talk about technologies that are currently available but underutilized.

"The Internet is the future," they said. Using such words as "required," "major factor," and "fundamental," just short of 70 percent of facility managers interviewed support Internet access to combined data, even in real time. "The Internet is the only way to go to move information around," we heard repeatedly. However, even among supporters, many are concerned about security. Having automation systems connected to the Internet potentially leaves a port open for persons with malicious intent to work through one system into another and finally into corporate financial or personnel records. Technicians are also concerned about the automation systems themselves being vulnerable; they wonder whether it might be possible for an unauthorized person to initiate controls and change programmed setpoints.

We asked if it would be important to monitor building systems in real time and to include weather conditions as one of the inputs. More than 80 percent answered that real-time monitoring is important. This is not to say that real-time streams of data piling up in a database are important, but rather that conditions are being monitored and alarmed in real time so that faults can be addressed immediately. Some facilities are monitored by third-party services, and these outsourced service agreements require real-time monitoring for prompt response. Many respondents said they are likely to monitor more factors in real time as their systems are improved, their energy management is centralized, and they are able to view the status of systems over the Internet. Of those valuing real-time monitoring, more than half said that weather should be monitored in real time as well. Even universities, offices, hospitals, and supermarkets consider weather to be a relevant data stream.

Wireless data transfer is a two-edged sword. It can reduce installation costs and allow more sensors and monitors to be put in place in historic buildings and spaces with asbestos problems, for example. But cost is one issue, said a corporate campus energy manager. "The wireless thermostats and receivers aren't that expensive to produce, but they do have expensive price tags." Wireless access to devices, however, is already widespread for short-range reading of control units by handheld devices. Wireless machine-to-machine communication is growing at a rapid pace and is likely to increase dramatically with adoption of a new short-range wireless standard called Zigbee. (For more information, review the Zigbee Alliance at www.zigbee.org.)

Access to the whole building or even corporate enterprise automation systems from laptops and personal digital assistants would give staff more flexibility and save time. Currently, among many of the facility managers who believe wireless data collection could be an advantage, security is blocking adoption. Until wireless data transfer is perceived by the general public and corporate IT departments as being as secure as a hard-wired network, adoption rates will be slow. A hospital chief engineer expressed a typical concern: "It seems you can stand next to a building and extract a bunch of data like Social Security numbers and patient care information."

This fear is well-grounded. Justin Lowe of PA Consulting Group demonstrated in a video to the Manufacturing Excellence

Conference in June 2004 that simple process control systems are easy to invade. The video showed Eric Byres, IT security specialist from the British Columbia Institute of Technology, in a parking lot outside a manufacturing plant. "In a little under five minutes, Byres had simulated a hacker scanning the plant's Modbus network, finding the IP addresses of devices on the system, and accessing the set-up software of 'well-known' PLCs [programmable logic controllers] controlling the plant—all from a conventional wireless laptop."[4]

Reliability of a wireless signal is also a worry, here expressed by a contract engineer: "I'd just be concerned about even inadvertent interference, let alone covert interference," especially for monitoring life and safety systems.

Smart (Really Smart) Systems

Without hesitation, automated diagnostics and alerts on out-of-norm conditions are desired by virtually all technicians. But just how smart should automated systems be and, for that matter, how automated? Recalibration is important and always an issue with running a system efficiently. Could a system recalibrate itself?

Many respondents said that building automation and control systems should be smarter than people. The central processor could correct inefficient conditions by changing setpoints, but it should always report to humans its observation, evaluation, and corrective action. Rather than wanting a "self-healing" system, most facility managers were uncomfortable with having the BAC system that makes its own decisions. Self-healing means that the automation system can recognize the need for change and make the change. But the system is only comparing a current condition to a desired setting, identifying the cause for the disparity, and initiating an adjustment to remove the disparity. As clarified by a federal agency engineer, the system "should not be self-healing and hiding, but optimizing and reporting." The same engineer continued, "I'll accept it re-tuning my controller, but I want it to tell me that it did it. But there are things that I don't want it trying to do because of the puzzlement that it will cause on the part of the O&M staff who's responsible for understanding and making sure that the system functions." Again, no matter the technology, the human side of building management is paramount.

When thinking about the future and how buildings could ideally be managed, facility managers began using terms such as "adaptive and predictive intelligent agents." An order of magnitude smarter than self-healing, intelligent agents are similar to subprograms that monitor changing conditions and how operators or devices realign settings for better performance and then predict future automated action that meets operator-specified goals.[5] These systems could be tied to market energy prices and to weather forecasts. The really smart and integrated system could shift or reduce energy loads, trigger on-site generation, or switch fuel resources.

The senior vice president of a North American engineering and design firm believes there will be more intelligence in buildings. "They're going to be self-learning; they're going to be decision-making." When the price of electricity the next day is to be higher than usual during peak hours, the building automation system can "shift load out of that period of time to a lower-cost period. We're going to be building intelligence into the system so that it automates a lot of that decision-making."

Another way to look at smart systems is to focus on the sensors. The facility manager of a university in Japan describes automated control that uses many sensors: "Recently, a new building has been completed. It is designed for students to use rooms any time of the day and night. In order to comply with this requirement and also not to increase the number of facility management staff, all possible automation was incorporated. Base load air conditioning is cut off at 19:00 [7:00 p.m.] automatically. After that, small-scale electric air conditioners installed at individual rooms are started when students come into the room. Their entrance to the building and each room requires the student's ID. Motion sensors automatically turn off individual air conditioners and lights when no motion is detected."

On the other hand, simplicity has its place, too: "Just give me a single system that's simple, easy to maintain, easy to control, that basically tells me what's wrong with it, and gives me a report that I can send to my service contractors."

The Future

By and large, the person who's responsible for managing buildings for occupant comfort, equipment reliability, and lowest cost is coping with yesterday's problems and playing catch-up. Systems are not properly commissioned, sensors are not properly calibrated, the interface software is not sending an alert, and the systems aren't integrated or coordinated.

When thinking past these frustrations to opportunities for managing buildings better 5 or 10 years from now, engineers, technicians, and strategic planners were able to dream of real solutions. As shown in **Figure 2** (page 11), fulfilling their dreams doesn't require building the city of tomorrow.

We asked, "What would you really like?" and were surprised by the practical and reasonable answers. None of the ideas was so odd or futuristic that it couldn't be implemented immediately—except for the lack of a common, interoperable standard for building automation and control systems. This remains the greatest irritation, the single most desired solution to today's hurdles, and the solution that's furthest from reach.

The last question we asked was, "Can you think of one or two ways to save energy or save money using technologies, systems, or standards that are not common yet?" Perhaps it should not be a surprise that many responded, "Applying what's possible today but not being tapped." So many facility managers are still dealing with yesterday's problems that they can't think of the future. "We try to salvage what may have been a poor design or poor construction effort. We're managing with inadequate personnel and inadequate training. That relay that needs to shut off something may or may not still be working, so we're not even responding to the everyday alarms to the point where we would have reliability."

Asking a controls engineer to dream of the future, the one thing he thought would most save energy and save money is "to hold individuals and building owners responsible." We heard more than once that the dream technology for the future is the simplest human consideration. An independent consulting engineer in Europe reminded us, "The most energy-saving factor is common sense. To save energy is in the attitude of people."

Figure 2: The future of building automation doesn't require building the city of tomorrow

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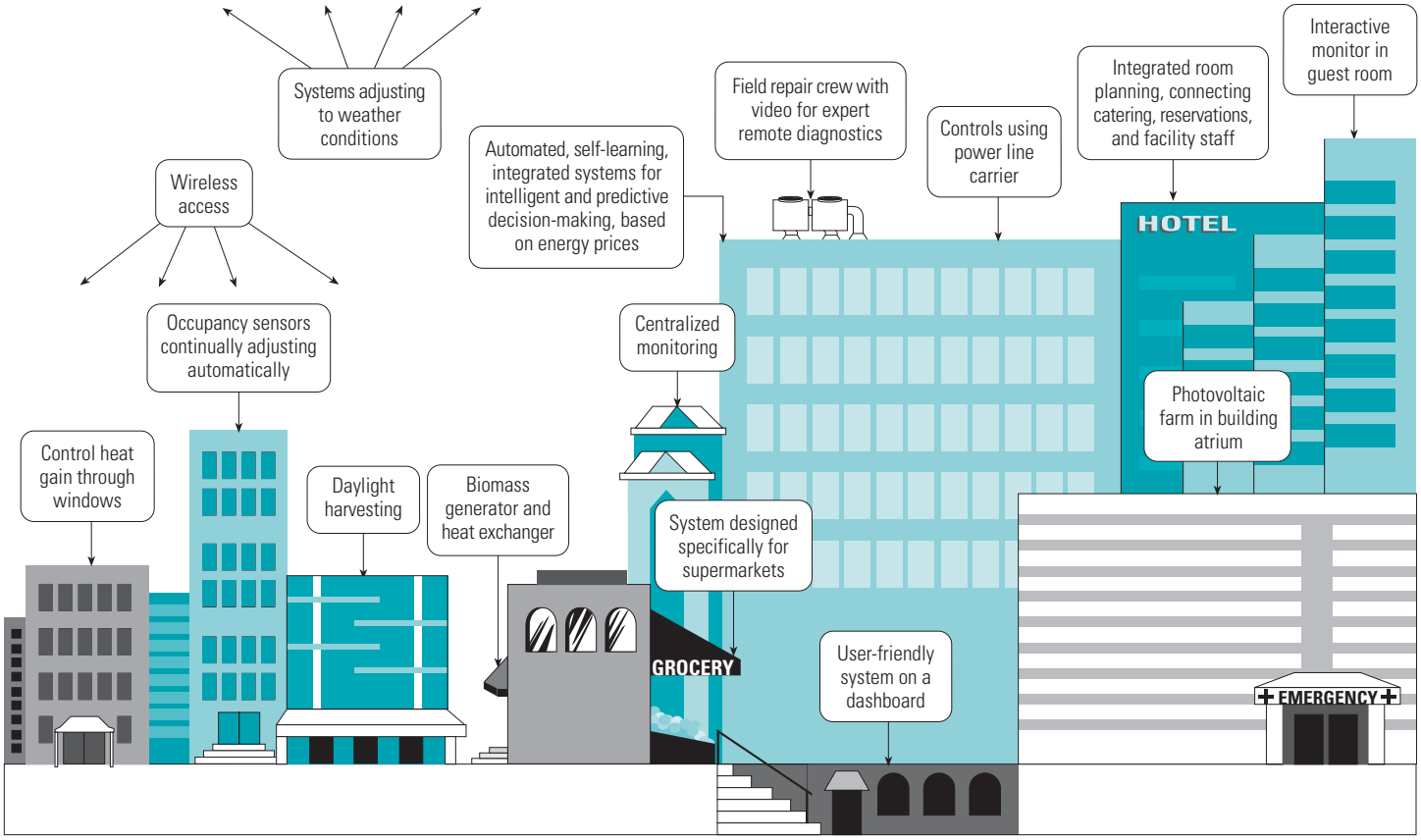

Source: E SOURCE

Appendix: Questions Asked/Script

Thanks for taking the time to help us with our research. While we want to talk about what's broken and needs fixing of course, the main emphasis of our research and the report we will write will focus around what the future of building automation and controls should be. I'd like to ask you just some general questions first and then more specific questions about topics such as remote controls, connectivity, and networked systems.

Questions

1. Tell me briefly what [company name] has you doing for them. What are your responsibilities; what is your title?

2. Does [company name] generally own or lease building space?

3. What investment criteria are used when considering purchasing building controls and/or building management systems? How does this differ if you are considering an upgrade or replacement in an existing building versus new construction?

4. Do you currently have an automated building control system? Are all your buildings using the same system, or is there a mix? Are you willing to offer the name(s) of the manufacturer(s)?

5. Do you currently have an automated security system? Fire detection system?

6. Tell me about how you'd like to manage or control your facilities differently than you are doing it right now. I'd like to hear your issues and concerns.

7. Tell me about what you'd prefer to work with in terms of standards and protocols, to connect devices and systems.

8. Tell me about devices and sensors (lighting, occupancy, temperature, fire) and how those devices communicate with a central system. What do you think would work better than what you currently have?

9. (If they are not currently.) Do you believe that all of your facility's special or critical building systems such as fire, security, building access, IT systems, even video surveillance should be fully integrated into a common system?

10. What would be the biggest obstacle to converging all of these systems today?

11. How critical or influential is IT in decisions in building automation?

12. What would be your biggest concerns about moving all of these control and monitoring systems into a common and single platform?

13. What role should the Internet play in your current building management and control systems? What role would you like to see it play in the future?

14. Do you connect devices and building systems by Ethernet? (or . . .) Is this good, or what would you prefer? Have you considered wireless?

15. Do you think having wireless access to your systems would be beneficial? Should it include PDA (handheld) connection?

16. Do you currently have systems that allow you to view building performance in real time? What do you think the critical functions of such a real-time monitoring system should be? Should it include weather?

17. Should the system monitor and automatically control the indoor air quality of the building or of individual spaces?

18. Should the system be self-healing? That is, should it automatically adjust and control setpoints to reach certain comfort or efficiency settings?

19. Do you currently utilize your facility control and management systems to participate in peak demand response programs or load curtailment programs?

20. How would you feel about microgeneration of electricity that worked to reduce cost or reduce demand? (Such as photovoltaic window panes.)

21. Forget for a moment the issues of cost, security, or vendor proprietary problems. If you could wake up 5 or 10 years from now and have anything you wanted, what would corporate energy staff, facility managers, or engineering teams want their control, monitoring, and building management systems to do for them?

22. (For certain interviews) Do you think work and learning will become more decentralized in the future? Will more people work or learn from home or another small, remote location? Will office space become more flexible, where a space is used differently from day to day, or will it go the opposite way and will the buildings get bigger, with more dedicated spaces for more people?

23. If you could wake up 5 or 10 years from now, what would be the best parts and worst parts of multi-facility management? How "smart" should/can the system be?

24. What is the most important part of a building automation and control system? Is it the sensors, the devices (chillers), the smart system in the computer, or the connected network?

25. Finally, can you think of one or two ways to save energy/save money using technologies, systems, or standards that are not common yet?

For More Information

We invite you to contact us for more information or to get answers to your questions: Kathleen Burns, director, *E SOURCE Major Accounts Service*, tel 303-444-7788, e-mail kathleen_burns@esource.com.

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Notes

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