Fully Smart Buildings Still In The Blueprint Stage

Intelligent buildings can cut costs while helping people feel better and work more efficiently. So why aren't more of them being built?

It began with the thermostat—the first electric building control device. "People used to bang on the pipe to alert the superintendent to send up more heat," says Kenneth Wacks, a building automation management and engineering consultant based in Stoneham, Mass. "That led to the development of the thermostat, a signaling device from the tenant space to the basement where the boilers were."

Today, control and communications technologies are converging to create the "intelligent building." Although a precise definition remains elusive, most experts agree that an intelligent building uses an array of technologies to supply, monitor, automate, and integrate environmental, security, and communications services.

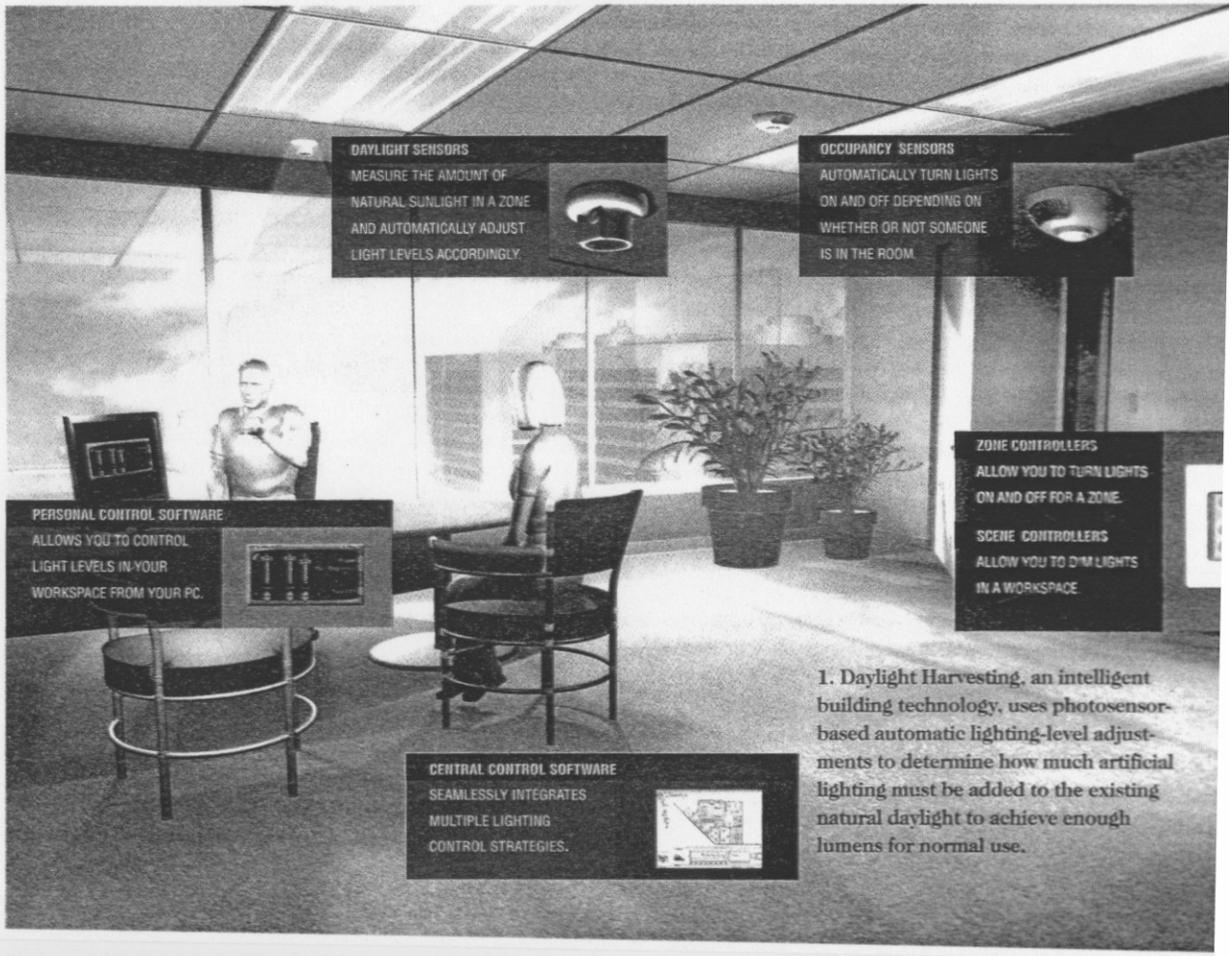
"Intelligent buildings are buildings that respond to conditions without human intervention," says Vladimir Bazjanac, a staff scientist in the Building Technologies Department of Lawrence Berkeley National Laboratory in Berkeley, Calif.

The march toward the intelligent building has been long and difficult. As long ago as the 1930s, pulp science magazines were predicting the imminent arrival of buildings that would cater to their occupants' needs with automated environmental, communication, and even entertainment services. Yet relatively few of us now believe we live and work in buildings that can truly be called "intelligent."

So what happened? Terry Hoffman, director of building automation systems marketing for Milwaukee-based Johnson Controls, notes that early predictions were sidetracked by a combination of overly optimistic engineering projections, battling proprietary technologies, and a general reluctance by people to spend large sums of money on a technology that many view as frivolous.

"The forecasters kind of got ahead of the curve and failed to fully consider all of the technical and financial requirements of building automation," he says.

But time and technology are finally catching up with years of deferred promises. Vendors are slowly putting away their proprietary attitudes in favor of alliances. Real-world standards are gradually emerging. And perhaps most importantly, people are becoming more comfortable using cut-



1. Daylight Harvesting, an intelligent building technology, uses photosensor-based automatic lighting-level adjustments to determine how much artificial lighting must be added to the existing natural daylight to achieve enough lumens for normal use.

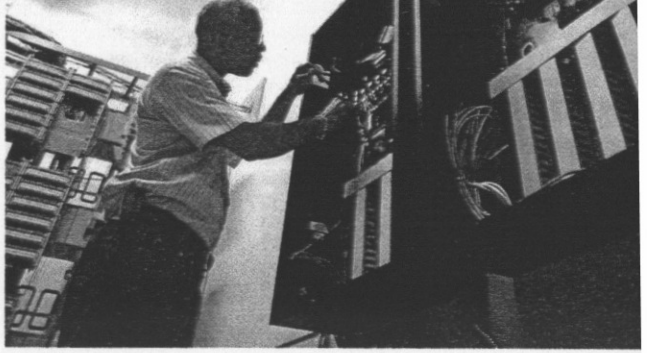
ting-edge systems in all facets of their daily lives. "We're moving forward," says Hoffman.

Building The Foundation

All inhabitable structures reside on strong physical foundations, but intelligent buildings also require a resilient technological underpinning. Until several years ago, this infrastructure was provided by companies such as Johnson Controls and Honeywell that developed and marketed various proprietary automation architectures.

"That doesn't mean they didn't recognize the value of standards, but they tended to shy away from standards that made all of their products interchangeable with their competitors' products," says Wacks.

The industry began moving toward an open environment in the mid-1990s, when a consortium of building management companies, system



2. This technician is installing intelligent building control circuitry (courtesy of Honeywell

What Are Intelligent-Building Technologies?

Property managers can substantially boost the efficiency of their real-estate portfolios by installing intelligent-building technologies. Intelligent-building technologies seek to enhance the building environment for occupants while controlling costs. These systems are designed to improve end-user security, control, and accessibility, with the aim of increasing worker productivity and user comfort levels.

"For commercial developments, intelligent-building technologies can result in above-market rents, improved retention, higher occupancy rates, and lower operating expenses," says Paul Ehrlich, president and founder of the Building Intelligence Group.

Such technologies are defined as integrated communication and control systems that provide both the building operator and occupant with an environment that is flexible, effective, comfortable, and secure. By using such systems, building operators can enjoy a single interface that can control a network of disparate building automation systems, which typically comprise electronic equipment that automatically performs specific facility functions.

The commonly accepted definition of a building automation system (BAS) includes the comprehensive automatic control of one or more major building system functions required in a facility, such as heating, ventilating, and air-conditioning systems. Automated systems include a collection of sensors that determine the condition or status of parameters to be controlled, such as temperature, relative humidity, and pressure. Similarly, output devices impart electronic signals or physical action to the control devices, which may be electric relays or damper and valve actuators. The sensors and output devices are connected either to a unitary controller or to a distributed processor.

Unitary controllers are limited to the needs of an intended function and, thus, have limited capabilities, such as memory size. Distributed processors can accommodate the requirements of several unitary controllers, as well as connect directly to input and output devices. Intelligent-building technologies revolve around the use of distributed processors that constitute "integrated systems."

Integrated systems bring a modicum of centralized and simultaneous control over lighting, security, heating, ventilating, air conditioning, fire suppression, and other building systems that form the crux of any intelligent building system.

Using such advanced intelligent-building technology provides both property managers and tenants with a comprehensive access and security system that can effectively and efficiently exchange information with other building systems. Fully integrated functionality makes it possible to open doors, notify responsible staff of unwanted intrusions, and ensure that lighting, fire, and other building-management systems are informed of personnel that enter or leave the building. This information then can be used to manage the local environment and resulting energy usage. Most intelligent-building systems are characterized by:

- standardized building wiring systems that permit full building control over a single infrastructure
- higher building value and leasing potential via increased individual environmental control
- consumption costs that are managed through zone control on a time-of-day schedule
- tenant control over building systems via computer or telephone interface
- comprehensive tracking of tenant after-hour use for charge-back purposes
- a single human-resources interface that modifies telephone, security, parking, local-area network, wireless devices, building directories, etc.

Increasingly, intelligent-building technologies are noted for their capacity to concurrently carry both a tenant's voice and data communications over the same wiring infrastructure that carries building control data. Many industry insiders say that an intelligent building should have high-speed wiring, real-time communications, real-time information, real-time services, and real-time integration. Generally, an intelligent building also should be flexible.

"A good intelligent design should incorporate flexibility to allow for easy change," notes Ehrlich. "Examples of this type of design characteristic include CLA (communications, life safety, automation) structured cabling design, and open space with movable or demountable partitions. An intelligent building needs to be designed to meet the needs of initial occupants and be flexible to meet the needs of future occupants."

For detailed guidelines on what constitutes an intelligent building or information on the latest intelligent building technologies, contact the Continental Automated Buildings Association. CABA is a not-for-profit industry association that promotes advanced technologies for the automation of homes and buildings in North America. The organization has published an in-depth examination of intelligent building technologies. The report, entitled Technology Roadmap for Intelligent Buildings, is freely available online at *www.caba.org/trm.*

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users, and manufacturers joined together and finalized the Building Automation and Control Networks (BACnet) protocol. Today, BACnet is recognized as the oldest and most widely used open protocol communication standard for commercial intelligent building applications.

"BACnet is both a U.S. ANSI and international ISO standard," says Wacks.

BACnet supports virtually all types of building systems, including heating-ventilating-air conditioning (HVAC), security, access control, fire, vertical transport, maintenance, waste management, and lighting. It works with any device featuring one or more compatible functions, such as analog and binary inputs and outputs, schedules, control loops, and alarms. As an open protocol, it doesn't demand any proprietary chip sets or other components.

The technology's approach differs from its prime rival, LonWorks. This widely used automation communications protocol, developed by San Jose-based Echelon Corp., demands a proprietary Neuron chip inside the controllers that connect individual devices into the network. Despite this requirement, numerous building device vendors have adopted LonWorks as the foundation for their product and service offerings.

Everything IP

BACnet and LonWorks now dominate the commercial intelligent building market. However, both protocols face competition from the planet's most formidable open networking technology: the Internet.

"IP (Internet Protocol) is the great neutralizer," says Tom Shircliff, partner and co-founder of Intelligent Buildings, a Charlotte, N.C., company that designs and deploys intelligent building systems into commercial structures. "For years, the engineers and the software writers had different silos for security, building controls, and energy management. Now what's happening in all of these entities is their little silos are going to IP because it's efficient and secure."

Historically, building controls needed to run on low-cost hardware, says Paul Ehrlich, president and founder of the Building Intelligence Group, an intelligent building consulting firm in St. Paul, Minn.

"Many of the standards were industry-specific and were designed to work with a high degree of reliability on 8-bit devices that ran on a serial bus," notes Ehrlich. "Today, as hardware costs are declining, we are seeing a movement to make control systems Web-enabled and follow various TCP/IP standards."

While BACnet and LonWorks each can be used over TCP/IP networks, both protocols have trouble dealing with routers, firewalls, security technologies, and other network applications. Waiting in the wings to remedy these difficulties, and possibly replace the older protocols, is the Open Building Information eXchange (oBIX).

Under the auspices of the Organization for the Advancement of Structured Information Standards (OASIS), oBIX is an effort to bring XML- and Web services-based technologies to building control systems.

The oBIX initiative aims to define a standard Web services protocol that will enable communications between building mechanical and electrical systems, as well as enterprise applications, says Ronald J. Zimmer, president and CEO of the Continental Automated Buildings Association (CABA). Located in Ottawa, Ont., Canada, CABA promotes home and commercial building automation technologies in North America. It conceived oBix back in 2003.

"The objective of oBix is to have a common, standardized, secure way to manage intelligent buildings with greater operability between systems," says Zimmer. "OBix will improve operational effectiveness, giving facility managers and building owners increased knowledge and control of their properties, helping to fulfill the vision of truly intelligent buildings."

Home Smart Home

People have been thinking about smart homes for decades. Shortly after the arrival of small, affordable home computers, hobbyists began experimenting with X10, a protocol developed in 1975 for the automation of household devices. Unfortunately, X10 commands sent via home powerlines or radio signals tended to be slow, error-prone, and unreliable, frustrating most adopters.

Today's home-automation market is dominated by a variety of slick specialty companies, such as Dallas-based AMX and Creston Electronics of Rockleigh, N.J. With prices starting at five figures, most smart-home systems are installed inside lavish houses owned by well-heeled clients. "You and I will not have an AMX system in our home," says Daryll Fogal, vice president of engineering and technology at Minneapolis-based Honeywell Automation and Control Solutions.

Affordable smart homes, when they arrive, will most likely be created without the use of expensive, commercial-level cabling and devices. Wireless technology stands out as the most attractive approach. The wireless standard most widely touted for home automation is ZigBee.

ZigBee is a mesh protocol developed by the ZigBee Alliance based on the IEEE 802.15.4 standard. Most ZigBee transceivers operate in the 2.4-GHz ISM band, the same band used by 802.11b and Bluetooth. It can connect up to 255 devices per network. The specification supports data-transmission rates of up to 250 kbits/s at a range of 10 to 30 m depending upon the environment.

ZigBee is slower than 802.11b (11 Mbits/s) and Bluetooth (1 Mbit/s), but it consumes significantly less power. Other versions of ZigBee operate in the 868-MHz European band and the 915-MHz U.S. band at speeds of 20 and 40 kbits/s, respectively. Atmel's AT86RF210 Z-Link transceiver is an example of a chip that can be used in these bands. Texas Instruments (Chipcon) and Freescale also have unveiled ZigBee chips for the 2.4-GHz band.

ZigBee's low cost, currently about $1 per node (in high volume), promises to make even exten-

sive smart-home networks incorporating dozens of client devices affordable. The standard's simplicity and low battery drain also make it well suited for monitoring applications.

"Lick the sensor, stick it on the wall. ZigBee's perfect for that," Fogal says.

Still, ZigBee is not meant to be all things for home automation. Its bandwidth is too narrow to support media streams, as the protocol is intended for environmental, security, and other monitoring and control applications. But that's not necessarily bad, says Lawrence Berkeley's Bazjanac. "Automation and entertainment are two different things, so there's no reason why there shouldn't be separate networks for both."

Many observers believe ZigBee, combined with skyrocketing energy prices, may finally give homeowners the justification needed to purchase and retrofit smart homes, if only to trim their utility bills.

"Some people will design a smart home regardless of the payback, just because they want to have the latest toy," notes Don Millstein, president of Encelium Technologies, an intelligent-building energy-control systems developer in Philadelphia. "But there's no doubt that as technology prices come down, and as the need to minimize energy expenditures grows, more people will want to put automated control systems into their homes."

Before Our Eyes

Intelligent buildings may already be here—if one looks close enough. That's because nearly all existing commercial buildings and many homes already benefit from some type of intelligent monitoring and control.

"Automatic lighting, smoke alarms, timed water sprinklers—these are all intelligent technologies," says the Building Intelligence Group's Ehrlich. "They're just not integrated."

Ehrlich sees the evolution of intelligent buildings as an ongoing process rather than a mission with an ultimate goal. "In a lot of buildings, there are discrete systems that just don't get integrated," he says. Air conditioning, heating, security, and fire alarms may all run separately, yet relatively efficiently. "We like to see everything integrated, but they can work standalone, too."

In other words, your building may not be intelligent, but it's probably smarter than you think—and getting smarter all the time.

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