Smart Buildings: An Introduction to the Library of the Future

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ABSTRACT

Advances in building technologies are combining energy efficiency, networked sensors, and data recording in exciting ways. Modern facilities can adjust lighting, heating, and cooling outputs to maximize efficiency, provide better physical security, improve wayfinding for occupants, and provide detailed reports of building use. This column will briefly explore the idea of "smart buildings," describe some of the technologies that are being developed for these buildings, and explore their implications for libraries. A brief listing of selected smart building technologies is also provided.

Introduction

Buildings used to be fairly simple: their own requirements were four walls, a roof, and maybe some flooring. As humans have developed more complicated technologies such as plumbing, electricity, telephone systems, networked computing, and wireless networking, the level of complexity required in building projects has increased exponentially. Modern buildings are almost like living organisms, with intricate systems for providing amenities and information. Advances in sensors and networking are creating new ways for buildings to meet and even anticipate the needs of their users while reducing costs and increasing efficiency. This column will explore "smart building" technologies and discuss their use in libraries. A brief listing of smart building technologies is also provided.

What Are Smart Buildings?

"Smart building" is an umbrella term that has recently come into use to describe a number of different technologies that are being integrated into buildings. Unfortunately, there is no clear definition of what makes a building "smart." The term smart building is also often used interchangeably with

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"intelligent building," but they are not necessarily the same thing. As Buckman, Mayfield, and Beck noted, "there is a clear confusion as to the differentiation between smart and intelligent buildings."[1] They describe a progression of building technologies, from "primitive," to "simple," to "automated," to "intelligent," to "smart" buildings. First were the primitive buildings: four walls and a roof. Then there were simple buildings with manually controlled technologies such as lighting and climate control. Occupants turned the lights on and off and adjusted the temperature as needed. Then came automated buildings: using timers and central controls, buildings automatically turned lights and climate control on and off on a set schedule. The next step, the intelligent building, combines the best of both simple and automated buildings: systems are still controlled automatically, but sensors allow the building to adjust to user needs in real time.

Smart buildings take it a step further, beyond simply turning things on and off. Smart buildings also collect data about how and when a building is being used and provide a real-time picture of the status of a building. Using networks of sensors and cameras, smart buildings can count the number of occupants in a building at any given time and track that data over time. That can reveal interesting trends: what are peak use times? Where is there congestion in the building? Will there be a surge in the number of people in the building at certain times? Using the data from these sensors, building managers can see current and past use and predict future use. They can also adjust traffic flows as needed to reduce congestion and plan staffing levels to meet demand.

Smart buildings use a software interface called a building management system to supply this data to staff.[2] This software collects data from the various systems within the building and integrates it into one interface. It can also alert staff to issues like burned out lights, plumbing leaks, flooding, doors that have been left open, and people in secured areas.

Smart building technologies are also being applied to energy efficiency: advances in materials and control systems allow designers to create buildings that are nearly energy independent, or "near Zero-Energy Buildings."[3] Better insulation and more efficient building materials are reducing heating and cooling costs. Some smart buildings have solar arrays and geothermal heating systems, allowing them to produce their own power and heat. Electricity generated by the building can either be used to power internal systems or fed back into the electrical grid, offsetting costs. Technologies such as smart glass and automated blinds control the amount of solar energy that enters the building, further reducing costs. Some buildings even use rainwater harvesting systems and grey water systems to conserve water.[2] While these technologies have higher initial cost outlays, the cost savings due to efficiency should pay for the systems over time and can create a sense of pride within an organization for being environmentally friendly.

Many of these technologies have existed for years. The key to implementing them in a smart building is connecting them all together using the building management systems and controlling them with appropriate sensors.

Smart Libraries

The idea of using smart building technologies in libraries is not new, going back at least two decades.[4,5] What is new is the rapid growth in the number and variety of technologies that can be integrated into a building. As smart building technologies become more widely adopted, they will undoubtedly be integrated into future library building projects and existing building upgrades, but library space planners should exercise caution: just because a technology is "smart" doesn't mean it's a good fit for a library building.

Many smart building technologies are well-suited to library spaces; energy efficiency measures like sensor-based lighting and climate control are ideal for areas that are often unoccupied, for example, stacks, archive space, or conference rooms. Networked sensors for smoke, heat, moisture, and intrusion will improve the safety of patrons and collections. Automated blinds or auto-darkening windows will reduce glare and fading of materials and make patrons more comfortable. Building dashboards and occupancy sensors will offer better data about how library spaces are being used and when and where staff should be available to assist patrons. Token-based access control systems will provide better security and logging than traditional keys and allow for scheduled access to rooms. Larger libraries will be able to provide indoor mapping to improve patron wayfinding and show patrons real-time data about availability of computers or other resources.

Although many of these technologies are clearly net positives for the library, there are also some concerns about the tracking and data recording that needs to happen in the background for these systems to work. Libraries have long been a bastion of privacy and free access to information, and any system that tracks and records the whereabouts and activities of its users is a potential threat to that privacy. Libraries need to very careful, or a smart building project can turn into what Denton calls "a well-intentioned ROI-demonstrating panopticon."[6] Whether the library means to do anything intrusive with the data or not, simply having a large pile of data about patron behavior can represent a risk. If these data are stolen or accessed inappropriately, it will reflect poorly on the library. If patrons perceive that their use of library facilities is being tracked, it may affect how they view the library and what information they seek out from library resources. Library staff will also need to routinely check that these automated systems are functioning correctly. Patrons will be frustrated if malfunctioning sensors leave them in the cold and dark. The data being collected by these systems should also be checked for accuracy before using the data to make any decisions. If building

use data are inaccurate, management may close spaces that are heavily used, leave unused spaces open, and staff at inappropriate levels.

Smart building technologies have great potential to help libraries better serve their patrons; buildings that can automatically respond to users' needs and provide accurate data about how the spaces are being used would benefit everyone. But librarians should be sure they understand the implications of the data being gathered and stored before signing on to a smart building project.

Selected Examples of Smart Building Technologies

- New, energy-efficient LED light fixtures can be powered via Ethernet cables, which can also relay control and data information to the light fixtures. These lights lower material costs, simplify installation, and allow easier automatic control of lighting. LED lights are ideal for integrating with solar arrays; solar panels produce the DC current that these lights use, eliminating the need for AC to DC conversion that current LED replacement bulbs require.[7]
- Occupancy sensors use infrared, sound, or ultrasound to detect when a room is occupied or unoccupied. They are frequently connected to lighting and ventilation systems to conserve energy when rooms are empty.[8] They can also function as part of a security system, notifying staff when areas that are closed have been entered.
- Building dashboards are publicly available websites that provide real-time data about how much energy a building is consuming and producing, how many occupants are in it, and other customizable data points. For example, Salt Lake County Library Services has a dashboard for several of their buildings <http://buildingdashboard.net/slcolibrary/>. Multiple buildings on a campus can be tracked individually, allowing for "gamification" of energy efficiency initiatives which, as Brigham put it, "takes advantage of human competitiveness and the ambition to do better."[9] Competition between buildings could encourage conservation and drive down energy use across the entire campus. Both proprietary <http://www.lucidconnects.com> and open source <http://www.measurethefuture.net> dashboards are available.
- Electrochromic windows, or "smart glass," comprise thin films and an electrolyte sandwiched inside glass, reducing glare and thermal transfer while allowing visible light to pass through the windows. The darkness of the tint is adjustable by passing an electric current across the glass. These windows can reduce air conditioning costs by 50% in large buildings.[10]
- Indoor positioning systems give users indoor location data on their mobile device to simplify wayfinding.[11] As these systems are deployed in smart buildings, visitors will be able to receive step-by-step instructions to their

destination. Some of these systems also have the ability to locate specific people within the building, using badges or cell phones.

Conclusion

Smart buildings have been around for a long time, but they keep getting smarter. Modern smart buildings can do much more than just turn the lights on and off. Networks of sensors allow these buildings to count and track occupants, adjust temperature and lighting to maximize efficiency, and provide real-time data about building use. Librarians should be aware of these technologies for future building projects and renovations. The long-term cost savings of more efficient buildings and the detailed data about building use provided by these technologies can help offset the increased costs, and the relative longevity of the typical library building means there will be many years to realize the benefits of these technologies. However, there are patron privacy and data collection concerns with some sensor systems, and the increased cost of these technologies may make it difficult to get management buy-in. Librarians should be aware of trends in smart building technologies so that they can advocate for those that are a good fit for the mission of their institutions, and avoid those that would be wasteful or harmful to their patrons. Buildings may be getting smarter, but they're still only as smart as the people that run them.

Notes on Contributor

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