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Building intelligence into buildings

Integrating artificial intelligence into building ecosystems

IBM Institute for Business Value

Viewing spaces in new ways

Today, people, buildings, campuses and even entire cities are able to operate in new and different ways. As artificial intelligence (AI) is integrated with building systems and Internet of Things (IoT) devices, it has the potential to improve occupant experience, increase operational efficiency and optimize space and asset utilization. In the recent IBM Institute for Business Value (IBV) study, "The human-machine interchange," 76 percent of Chief Operating Officers reported that increasing automation in facility and asset management will have a positive impact on operational efficiency.[1] Although cost-control measures and flexibility remain key objectives, creating compelling, emotionally rich experiences is the new frontier.

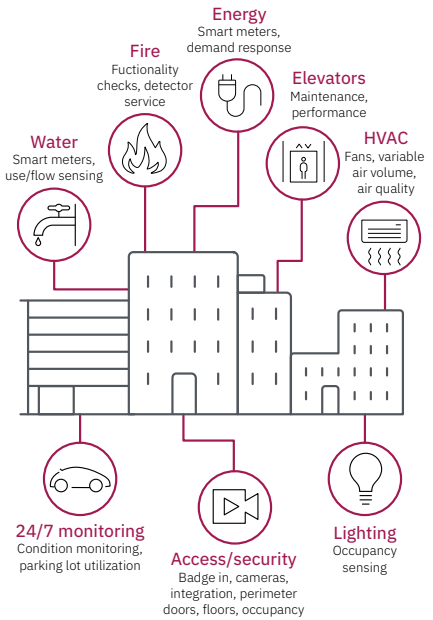
Optimizing building performance with AI

Buildings are becoming far more than walls, roofs and masonry. Thanks to AI, building systems are now able to autonomously integrate the proliferation of data from IoT devices and occupant behavior to apply learning, optimize performance and improve environmental efficiency. A vast array of information from digital devices, beacons and tweets provides insights about the operations, use and condition of everything from the building's infrastructure, physical environment, climate, water and energy usage, to an occupant's experience and satisfaction.

IoT and platforms embedded with artificial intelligence and learning make it possible to develop innovative new services for engaging with building occupants. These systems have the potential to radically reduce costs through automation and optimization of operations. Of the executives surveyed in the IBV study, 70 percent report that intelligent machines will provide new categories of insight that enhance decision making.[2] The new services also can improve occupant satisfaction by providing more personalized customer service.

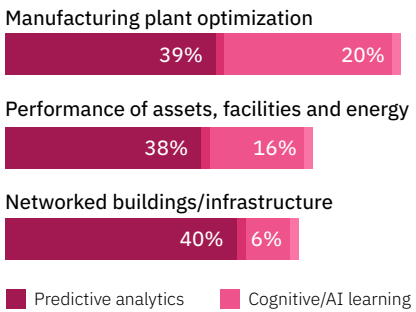
A comprehensive building optimization system leverages all aspects of building and facility management (see Figure 1). These types of systems allow for monitoring the use of space, water and the usage and allocation of energy. Taking this monitoring one step further, building equipment data collected from IoT sensors that is tagged by location or asset type and associated with business rules can trigger algorithms to not only detect but also predict and respond to anomalies. These optimized ecosystems of building technologies identify opportunities for efficiency controls through predictive maintenance. They identify possible root causes, so actions can be prioritized, assigned, monetized and prevented. Recommendations that appear on dashboards or adjustments can be routed directly to the IoT device for action.

Figure 1
A comprehensive building optimization ecosystem



Source: IBM Institute for Business Value.

Figure 2
The progression to artificial intelligence.



Source: IBM Institute for Business Value.

Identifying opportunities

After equipment performance information is collected through sensors and meters, a library of benchmark data is applied, analytics are performed and potential operational improvements are identified. To automate insights into actions as they optimize assets with IoT, many companies are advancing their use of predictive analytics to artificial intelligence or learning systems (see Figure 2).[3]

By taking advantage of powerful analytics and artificial intelligence, building owners can significantly cut energy consumption and achieve ambitious cost-saving targets. For example, by combining data for heating and cooling with Weather Company micro-location forecasts, an HVAC system can deliver more efficient heating and cooling.

Analytics can also be used to prevent energy waste by isolating inefficient energy use. Sensor-controlled systems can monitor dispensing and water use. Cognitive maintenance systems can help preserve the health of critical building equipment and assets by anticipating asset failure and guiding timely interventions.

The integration of cognitive analytics, sensors and existing building systems can significantly improve occupant experience. Future workplaces will be flexible, adaptable and able to predict occupant needs. These workplaces may include:

- *Voice and display-enabled rooms.* AI or IoT "in the walls" to respond to voice commands and questions.
- *Building request management.* By requesting that a concierge perform tasks for them, building occupants can reduce time spent on unproductive activities.
- *Asset, workstation and personnel location.* Floor maps guide occupants to their selected workstations. Work-space sensors and beacons detect occupant locations and available workstations.
- *Real-time parking data.* Parking-spot sensors indicate availability, so building occupants can easily locate available spaces.
- *Social media tracking.* Occupant requests are identified as occupant emotions and experiences are evaluated.

A new world order: Buildings that think, engage and learn

AI is able to capture data from day-to-day building operations to enable new levels of automation, which enables buildings to "think," engage and learn. These buildings can autonomously monitor and predict their own maintenance needs. Data transmitted from connected assets, such as boilers, pumps, chillers and elevators, is analyzed and enriched to identify anomalies, such as equipment operating outside of normal parameters. Potential failure modes are identified from tolerance and business rules, and devices are automatically instructed to take corrective action. The building memorizes the result of the intervention so it can improve the accuracy of detection and resolution of future incidents.

Three case studies

Facilities management. In Denmark, ISS A/S, a facilities management and office services provider with 25,000 customer buildings under management, installed a scalable platform to help it better understand how people use its buildings. The implementation team deployed approximately 700 sensors across the building, each of which generates a stream of data that is captured on the cognitive cloud platform and analyzed using cognitive algorithms.[4]

Real estate management. Aircraft manufacturing company, Airbus, implemented a solution that provides a single, comprehensive view of usage, cost, condition and maintenance-related data for all of its manufacturing facilities in four countries.[5]

Asset management. Teradyne deployed an integrated facilities management, maintenance and asset management solution that provides the insight it needs to make informed decisions about the use of space and capital for asset purchase and maintenance.[6]

The top five opportunities for cognitive-enabled buildings

1. Create efficient environments from richer data and predictive analytics
2. Decrease total building infrastructure operational costs
3. Cut energy consumption and reduce water waste
4. Reduce maintenance costs as assets monitor themselves
5. Redefine workspace environments, anticipating occupants' needs

Envision going to work in a building that works for you. While you're there, IoT sensors are constantly monitoring your movement and the temperature. It turns lights on and off for you, adjusts the flow of water in restrooms and listens for your voice commands. Even the breaths of you and your coworkers are monitored for carbon dioxide concentration in case an airflow adjustment is needed. And when the building detects that people have left their assigned workspaces, it turns on the lights in the parking garage, places the building systems into rest mode and checks tomorrow's weather.

Now consider a network of location beacons, which powers mobile apps that understand people flow and their experiences. The app helps you navigate a complex campus in 3D, so you can virtually traverse the campus. As you move, you can view an occupancy use heat map and choose an available space. Once it's selected, the map guides the way. The space knows your preferences and proactively prepares the environment for you. Beacons in digital screens and sensors know when you have arrived and start your media feed.

Getting started

Building intelligence into buildings will take some effort, but you can begin your journey toward an intelligent building without making a significant investment. Then you can gradually build it into a powerful ecosystem with sustained benefits. To get started, follow these steps:

Optimize building maintenance and improve responsiveness. Use advanced algorithms to detect future operating faults before they occur. Expose faults with predictive analytics to determine case, impact and recommendation. Automate device responses. What percentage of your buildings operating costs is allocated to maintenance?

Integrate sensors, devices, data and external data sources. Infuse weather data, micro-location forecasts and advanced analytics to make more informed energy decisions. Identify and reduce water waste, usage and costs by detecting leaks and other anomalies. What annual percentage of wasted workspace, energy and water are you experiencing?

Enhance occupant workspace environment, engagement and experience. Implement workstation and workspace availability apps in 3D with sensor and beacon devices. Help occupants locate open space faster and reduce under-utilization of space. Make the space intelligence to occupants' requirements and moods. How state of the art are your buildings? Do they attract millennials?

As you look at ways to create an optimized building network powered by IoT, consider these questions:

1. In what areas can I get the most return on investment quickly?
2. Where do opportunities exist to drive down operation costs and improve workplace experiences?
3. Are there situations in which my buildings can operate and manage themselves?

Experts on this topic

Mark Peterson

VP, Partner and Global Lead, Building and Asset Optimization, IoT.
mpeterso@us.ibm.com
linkedin.com/in/mrkptrsn

Nina Desrocher

Partner, Building & Asset Optimization
Nina.Desrocher@ibm.com
linkedin.com/in/ninajdesrocher

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Notes and sources

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