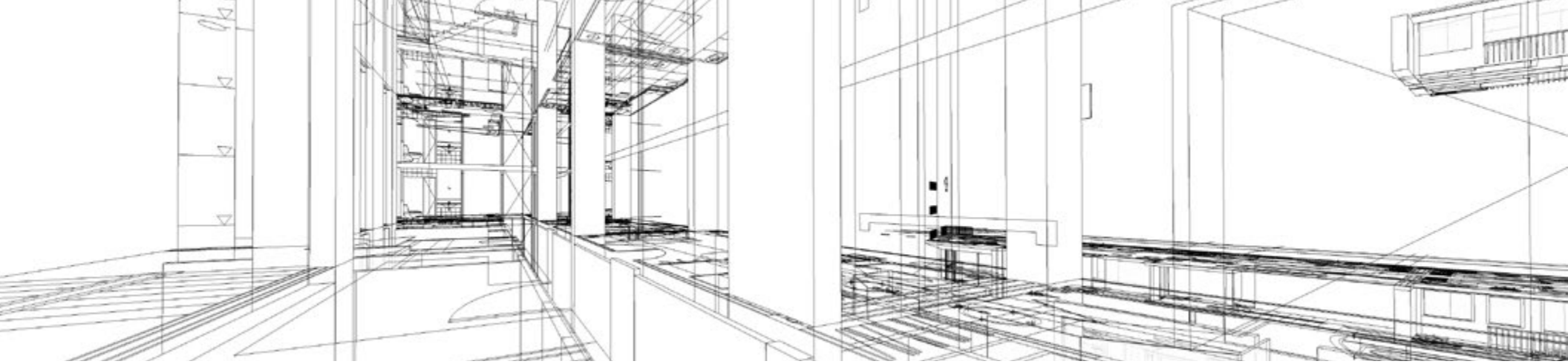# THE SMART WORKPLACE

Indoor GIS for Smart Buildings

esri® | THE SCIENCE OF WHERE®

Enabling the Next Generation Office
Boosting workplace productivity

The next generation office is a workplace that energizes employee performance. Here, workers easily talk about new ideas and plan ways to implement them. In this smart environment, everything is designed to help workers do their best. The facility's operating system seems to intuitively respond to the needs of its inhabitants. Various systems work together to ensure faster service delivery and site safety and security.

The building recognizes where people are using its conference rooms, monitors CO_2 levels, and adjusts airflow. In the afternoon, when sunlight brightly shines through windows, shades drop to lower the glare. Buildings wake up before employees come to work and switch to sleep mode in the evenings, dimming the lights and lowering indoor temperatures.

Sensors in the ceiling and lining the halls stream live information to the central operating system. The system intelligently manages building conditions and automatically activates responses that meet workers' needs. Because everything and every action happening inside the building is tied to location, sensors and smart devices stream operational data to a geospatial platform. The connected system provides context to the data via a smart workplace map.

A workplace map is not restricted to two-dimensional space. Its 3D scenes contain representations of all features on all floors. It shows objects, points of interest, and change over time. The map is a window into the database. Click a feature on the map and access information for an asset such as a printer's make, model, and service record.

But this smart map has capabilities beyond record management. It performs location analytics to show how traffic flows through buildings, where people gather to share ideas, or why utility costs are so high. It places buffer zones around construction areas that route employees safely past them. Managers set geofences around high-security areas to ensure that only approved personnel enter those places. The next generation's maps are intelligent. They support logistic planning for moving entire departments to other buildings or find a work area for a new employee that is close to a mentor.

> "Whatever good things we build end up building us."
>
> —Jim Rohn
> Renowned Architect

Start with your CAD schematic

Powering indoor intelligence

Traditionally, facility managers have relied on computer-aided drawings, but these static illustrations are limited. They do not reflect real-world indoor spaces as they currently exist. A geographic information system (GIS) drives the data behind workplace maps so that they are fresh and relevant to whomever uses them. Moreover, the system's maps show real-time information in multidimensional space. CAD drawings are still useful in GIS, as are legacy schematic maps and other facility documentation, which can be scanned and added to the database. The system's ability to manage different types of information and quickly visualize it makes GIS relevant to modern building management.

More than a single floor plan, the workplace map is actually a digital basemap on which to visualize different types of business information. For instance, by integrating GIS with SAP, the workplace map shows the names of employees assigned to specific offices throughout the facility and keeps up with every move. By joining inventory data to place data, the user sees the location of office equipment. Users can add all sorts of data to the map to see, for example, the locations of security cameras, ducting, and plumbing networks.

Workplace maps scale to the view that users need to see, whether that be the entire complex, just one floor, or a drill down to the fifth-floor conference room. Zooming in to a traditional floor plan simply magnifies the image. But map views seamlessly respond to a simple scroll of the mouse that scales facility data to the view level. By doing so, users understand more about a site, building, room, or asset.

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Creating safety and security situational awareness

During routine safety inspections, indoor maps that locate physical security assets are very helpful. They show the locations of fire extinguishers, closed circuit television (CCTV), access control points, facility entries and exits, first aid kits, secure zones, and so forth. If these assets are connected to the Internet of Things (IoT), security personnel can monitor their location, status, and condition using GIS. Sensors detect when and where these items are active or inactive. They also detect and report suspicious activities and hazardous conditions. GIS recognizes these anomalies and shows them on a real-time map. It also triggers notifications to the right people—wherever they are.

New building security systems incorporate cloud solutions and the IoT. The geospatial platform integrates multiple disparate building security systems and streams data to a centralized system. Security personnel can log in to their building systems from anywhere by using their devices to check on different aspects of the building's safety. Dashboards deliver situational awareness by bringing together security information into one view.

Empower First Responders

Public safety departments that have authorization to connect to the building's safety systems can respond quickly. They receive automatic alerts on their command center map. First responders connect to the workplace map to see which floor reported the problem and the context surrounding the incident. They can also see routes included in the company's emergency evacuation plans to assist personnel still inside the building.

Concert, sports, and political event planners can use indoor mapping to plan and practice effective event response. Using digital twin data, GIS generates complete 3D models of the venue for analyzing security aspects such as viewsheds and individual lines of sight. Security services can analyze exit routes and other conditions that might interfere with emergency response.

Bringing people together

Members of the next generation workforce prefer to use their own smart devices to connect and communicate with colleagues. Workplace apps encourage workers to meet face-to-face when they work on projects and plan strategies. Indoor cloud services provide facility information to employees. By subscribing to the indoor tracking service, they can see where team members are working and find nearby spaces to meet and exchange ideas.

An indoor positioning system (IPS) runs throughout the entire facility. Its beacons track smartphone and smart ID badge locations. It transmits that real-time information to the tracking service, which makes it accessible to other subscribers.

Complementary apps add value to the IPS. As easily as people use routing apps to get to their friends' homes, workers use a mobile wayfinding app to navigate to a conference room meeting. The app drops a pin at the destination, and a blue dot shows the employee his or her current location. If the employee is on the way to a meeting, the app estimates how soon he or she will arrive.

An important goal for administrators is to ensure that buildings are healthy. Research published by the American Psychological Association finds that healthy buildings improve employee performance. Thermal conditions and lighting affect cognitive functions, while noise impedes concentration.

Bringing people together (continued)

In the connected workplace, sensors monitor the health of the indoor environment. They detect humidity levels, which, if too high, create mold. Carbon monoxide sensors locate toxic air on upper floors that rises from indoor boilers and chemicals in the basement. Maps of carbon dioxide sensor data show where more ventilation is needed.

Noise-sensor maps help employees be more conscientious of colleagues working in quiet zones. Some managers are toying with the idea of using the IoT to automatically nudge noisy employees via short message service (SMS). Others perceive office noise as a good thing because it indicates people are communicating face-to-face. By analyzing workspace and work practices, managers can reorganize space to complement different work styles. They can create quiet zones that have paneled nooks and single desks. Or they can furnish discussion areas with community tables and comfortable chairs with ottomans.

Understanding how employees use the workplace gives designers insight into how to plan environments that enhance employee performance and meet business goals.

Managing a green building

Facilities management is a science that undergirds effective operational and strategic decisions. GIS brings information together in infinite ways to show space, time, relationships, patterns, costs, key performance indicators (KPIs), and so forth.

The smart maintenance system filters sensor data. If something goes awry, it triggers an alarm that notifies the maintenance department. Immediately, the map shows the location of an incident as well as its history of alarms. Using this history, the system deduces cause-and-effect conditions that create problems. This facility intelligence enables managers to respond quickly to incidents in the short term and plan solutions for the long term.

Facilities use location intelligence to meet green building goals. Energy-use analytics, cooling charts, and alerts flag potential trouble. Managers view them on dashboards to understand power loads, trends, and capacity on all tiers of the infrastructure. Using 3D visualization, operators track energy consumption within the building and optimize usage by location and time of day.
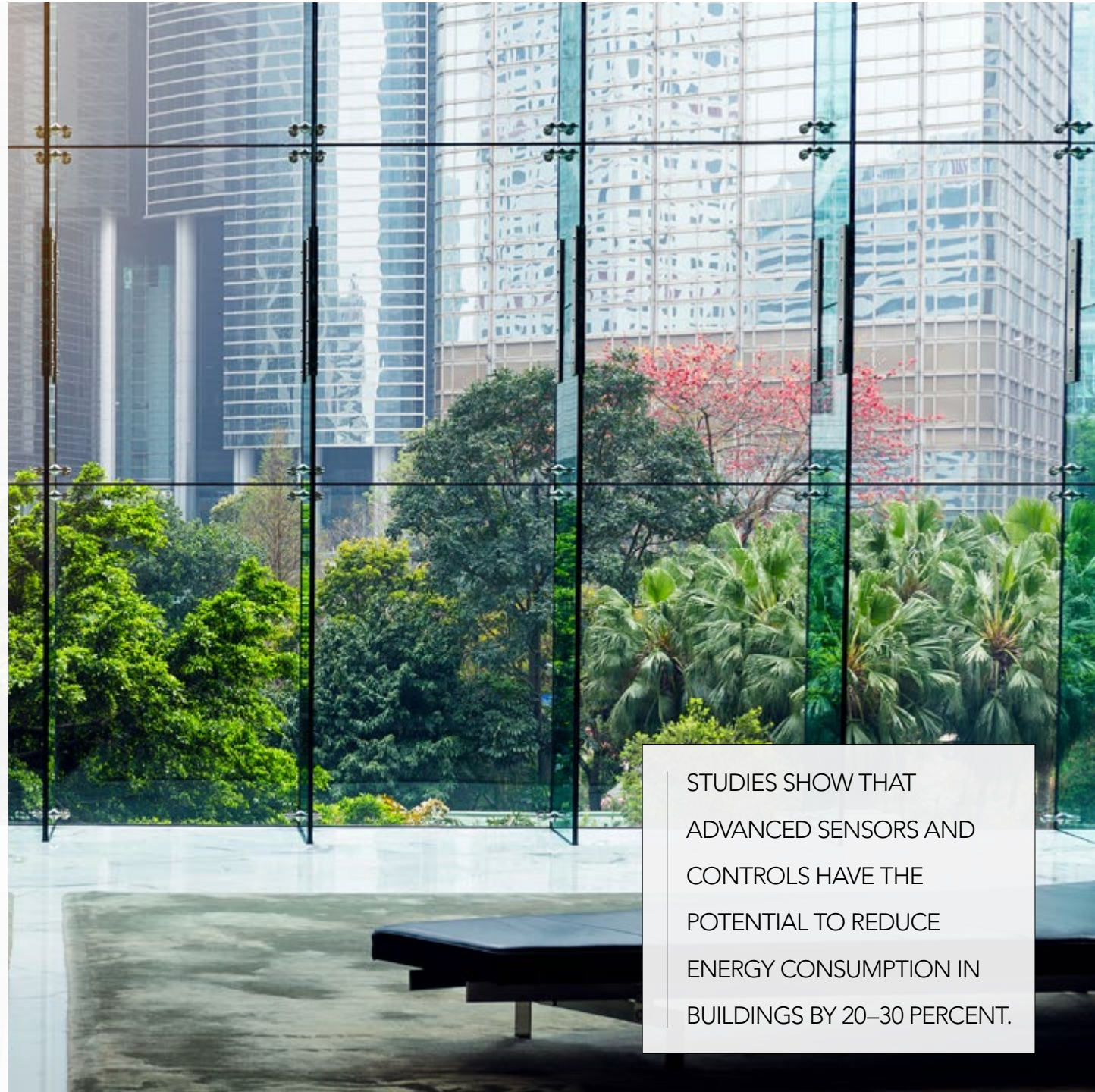
STUDIES SHOW THAT ADVANCED SENSORS AND CONTROLS HAVE THE POTENTIAL TO REDUCE ENERGY CONSUMPTION IN BUILDINGS BY 20–30 PERCENT.
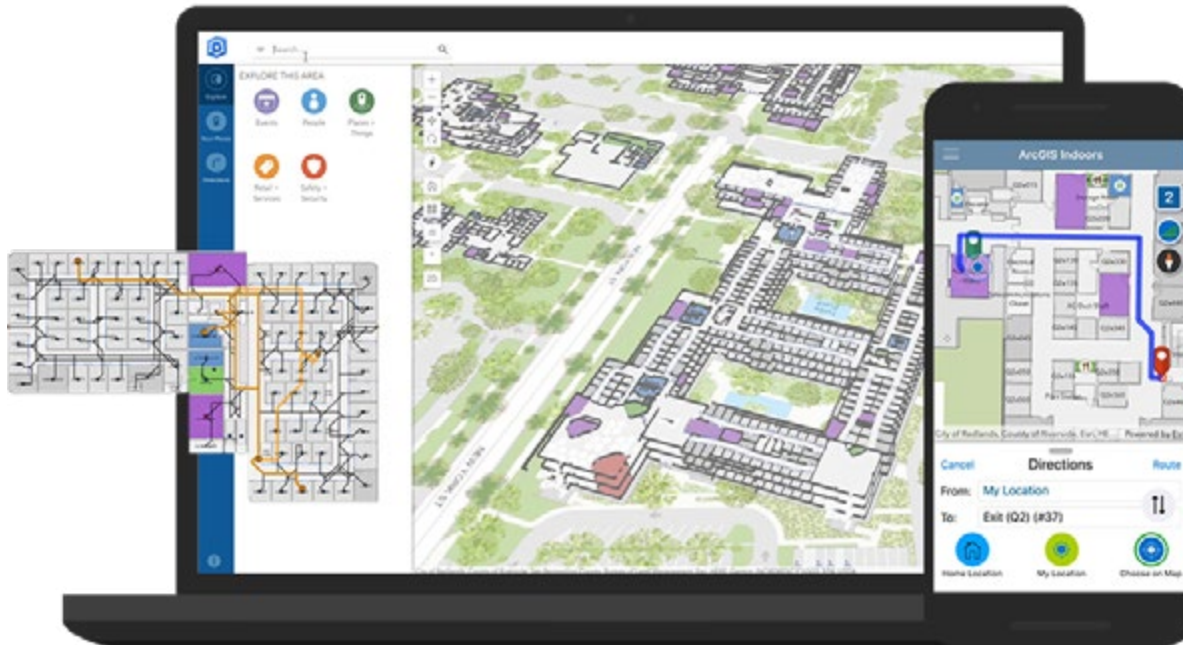
Managing a green building (continued)

IPS contributes to green facility operations. An IPS connected to a lighting system detects that an employee is far from the office, and it turns off the lights. Along corridors, lights dim when there is little or no traffic. Meeting rooms detect the number of participants present and accordingly set lighting, temperature, and airflow. Throughout the building, climate temperatures are continuously adjusted based on the needs of workers.

Employees can also be sensors because they see facility problems as they traverse the campus. Web apps make it easy for them to report problems on-site. Using a mobile survey app, employees answer a few questions and can add a note and a photo. The app tags the report with time and location. As soon as the employee taps the app's Submit button, the reported information instantly streams to GIS, which immediately posts the problem to the maintenance map.

A workplace map helps operations managers view all aspects of a building's status and life cycle. It shows condition, use, occupancy, ownership, accessibility, and sensor information. The map is a canvas for understanding the activities occurring within a building's walls and the resources used to carry out those activities.

No matter the size of the facility, GIS indoor mapping is an intelligent method to track, report, and analyze key metrics that help workers do their best and decision-makers increase the bottom line.

CASE STUDY: LOS ANGELES COUNTY
Wayfinding 4,000 facilities

Wayfinding is indoor navigation technology that
safely and quickly routes users through facilities.

Wayfinding system improves county services

Los Angeles (LA) County operates about 4,000 facilities that provide services to the area's 10,000,000 residents. For years, the county has used GIS to map the street locations of its buildings but not the indoor areas. This has been a disadvantage to building maintenance staff and citizens alike.

A common street navigation app routes citizens to county building addresses, but the navigation stops at the entrance doors. County staff responding to maintenance and work order requests have difficulty finding specific rooms. Citizens have similar problems when trying to find where to apply for a permit, pay a bill, or get a flu shot. Some buildings are labyrinths in which the public, and even county personnel, get lost.

Efficiency researchers estimate that employees spend up to two minutes a day going in the wrong direction. LA County employs more than 100,000 people. The time that staff and maintenance workers waste being lost adds up to a significant loss over a year.

The county's Internal Services Department turned to Esri for a solution. The company suggested the ArcGIS Indoors wayfinding app. The app connects users to the facility map via an IPS that includes GPS sensors, the building's Wi-Fi, and the beacons that stream information. County building visitors can also find these directions at the facility's interactive kiosks.

Once visitors search for where they need to go—an office, a service, or a person—the app shows them how to get there. They have a choice of routing options for finding their way—a list of step-by-step directions, photo navigation, or an arrow indicating direction.

LA County already has an enterprise GIS, and the indoor mapping apps expand its applications. The system imports preexisting CAD drawings, runs building information models (BIM), and adds facility data as layers to indoor basemaps. Database updates keep maps synced with facility changes when they happen.

The bottom line

Indoor apps work with every smartphone operating system so that both the workforce and visitors have complete mobility inside county facilities.

By using the indoor apps, LA County increases public goodwill. Contract costs decrease when technicians can navigate directly to an incident.

USE STUDY: TECH COMPANY

Tech Company's name

A little definition of the technology company and how this relates to Indoor workspace software.

Indoor Tracking

Startups are often launched by teams that have a collective purpose. Their innovation thrives on shared ideas, and their success comes through teamwork. Within a few years, these companies expand product lines and services. Their growing workforces demand more office space, which increases maintenance and energy costs. These expanding work areas inhibit teamwork and idea building.

In this scenario, a midsize tech company wants to use a location strategy to create a smart workplace that encourages face-to-face collaboration and improves employee performance. This includes equipping staff with location intelligence that connects them with colleagues and meeting spaces. The connected system will also manage an environment that helps employees do their best work. Another strategy is to reduce energy usage by deploying the IoT in the company's Web GIS platform.

Connecting the workforce

Using location analysis, workplace planners see ways to improve employee interactions. For instance, GIS calculates distances between members of the same team. Indoor maps show who works where, the type of work they do, and their proximity to primary and secondary teams. The workplace map shows common routes to colleagues' offices and collaborative space so that the planner can assess the space and rearrange it to better accommodate face-to-face interaction.

Using location analytics to visualize occupancy, planners readily see where office vacancies create space fragmentation. These "holes" in office space impede collaboration. The workplace map is the canvas for implementing a consolidation plan that brings teams together.

Mobile apps are also a useful collaboration tool. Connected to the indoor tracking service hosted on company's web services, mobile apps help employees find each other. Staff use their smart devices to navigate to locations in the building and elsewhere on campus. Upon subscribing to the service, they share their current location with others who may need to find them. In addition, staff publish their calendars to show when they will be at other locations on the campus.

Indoor apps show coworkers how far away a teammate is from a meeting. When running late, an attendee sends the meeting coordinator an estimated time of arrival. If the meeting location has changed at the last minute, the coordinator texts updates to all participants and sends a map to the new location. As long as employees are connected to and within range of the business's IPS, they can access location intelligence.

Facility sensors collect information about people and objects in the building and transmit it to the tracking service. For instance, an IPS sensor detects when an employee is in his or her own office and then streams the data to the central system. The service turns on the app's on-demand capabilities, so the employee can raise the office's temperature.

Service providers also take advantage of indoor tracking to monitor when high-traffic spaces are unoccupied. They can then schedule maintenance and housekeeping services at times that are least disruptive.

Connecting the facility

The smart workplace is responsive, automatically setting optimum lighting and temperatures for occupied rooms. For instance, when people use a conference room, the smart workplace system adjusts the room's airflow and ventilation. It automatically dims or brightens lighting and adjusts blinds and louvers to reduce glare. A Web GIS platform manages these smart building services by powering algorithms that activate heating, ventilation, and air conditioning (HVAC); lighting; and other systems.

To begin the transformation to smart facility management, the IT group creates an indoor geospatial database by using a Web GIS platform. It manages all aspects of geospatial information such as CAD drawings, floor plans, points of interest layers, and personnel information. Managers access the operations data to monitor facility performance and security in the context of location. Once they see where problems are happening, they can respond quickly.

Web GIS brings together data from different systems to create a real-time operational picture. It tracks facility system operations and creates reports for analysis, such as energy use by location. Dashboards show indoor temperatures and other building performance metrics. Managers understand facility performance using GIS to query, analyze, and report information about all buildings across a site or even broader geographic regions.

The bottom line

- Employee productivity increases due to face-to-face collaboration.

- Service calls are resolved faster.

- Energy spent on unused space, such as vacant offices, is reduced.

- A real-world tech company is piloting ArcGIS Indoors tracking for operations management. It predicts that the return on this investment will be at the break-even point by the end of the first year, 111 percent by the third year, and 242 percent by the fifth year.

Indoor maps

Government organizations and multinational corporations manage geographically dispersed real property portfolios. A university's property portfolio contains academic buildings, maintenance yards, residence halls, theaters, and so forth. An airport's portfolio includes terminals, indoor transportation, hangars, and control towers.

Keeping track of a wide range of property requires a powerful system to manage massive amounts of data. Real property files can include lease and ownership information, floor plans, operational systems documentation, energy usage, space allocation, maintenance history, and much more.

Mapping real property on a large scale reveals where facilities align with corporate objectives. GIS indoor maps show where problems exist and where action is required. Real property managers can tap on a map and bring up vital operational information about buildings wherever they are in the world. Indoor maps scale, allowing managers to deeply drill into a building's information, see KPI metrics, and visualize relationships that help them make data-based decisions.

Location intelligence becomes the basis for decision-making. Macro real property managers use GIS site evaluation tools to determine the business value of proposed acquisitions. Site-suitability analysis shows the best locations for adding satellite offices, building warehouses, and opening stores.

Locally, real property managers run GIS modeling tools to determine if built facilities are performing efficiently. Predictive models forecast workforce growth. This information helps office planners evaluate and redesign space usage to increase productivity and decrease the total cost of occupancy.
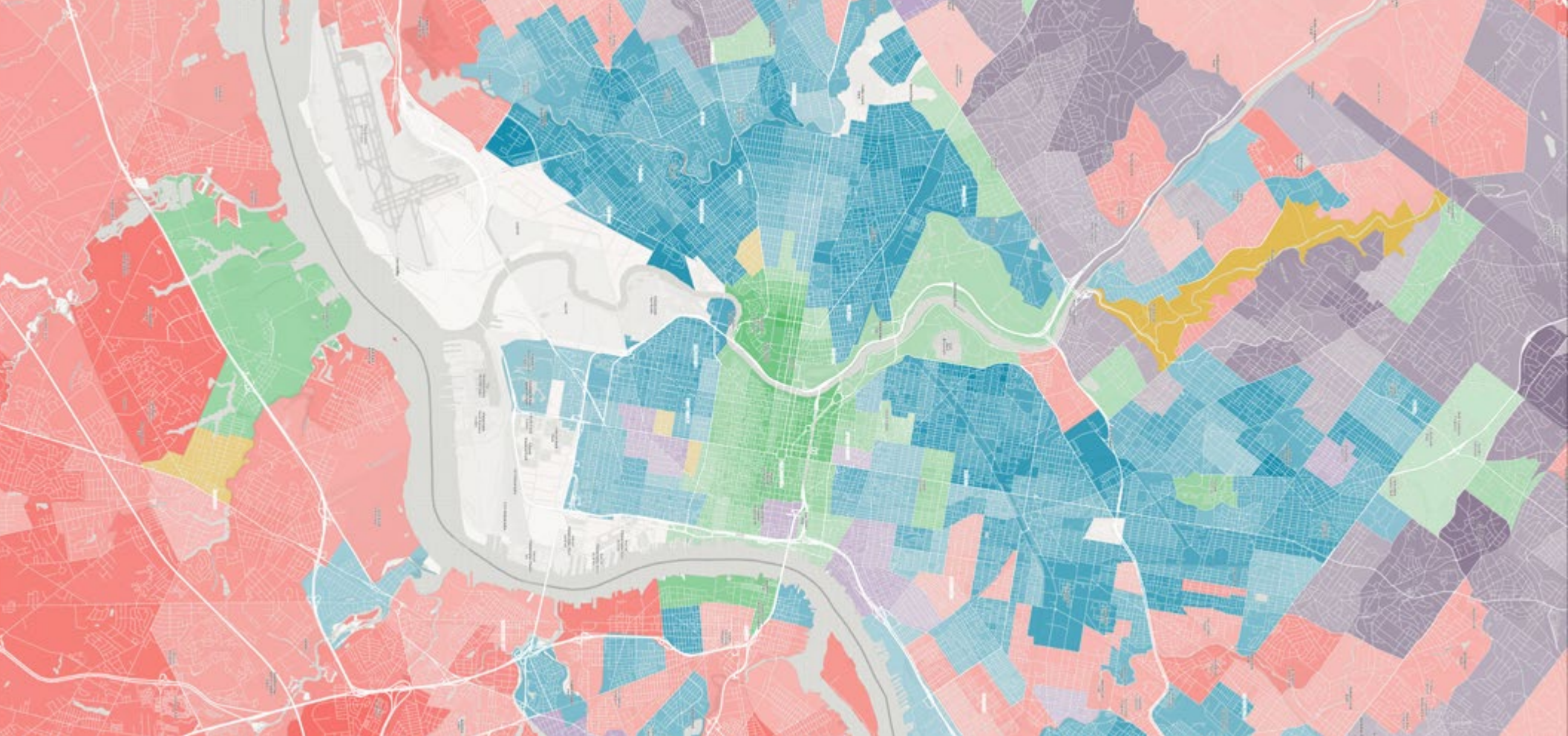
Sensor data drives smart operations

Unchecked operating systems are expensive. Air conditioning cools entire wings, even when only a few offices are occupied. Lights brighten corridors long after the business closes. Maintenance work orders are tied to human reporting, while unseen problems, such as a broken pipe in the basement, cause damage.

GIS integrates with sensor systems and IoT to show areas that are in use and to trigger light and ventilation systems for that space. A real-time map shows where water pressure drops in the basement, and the IoT triggers an alert to notify maintenance. Technicians can quickly investigate to see the cause, such as that broken pipe.

Work order management system

Indoor maps simplify work order management. Maintenance managers receive a request or see a remotely sensed problem pop up on the work order map as a red dot. The manager clicks the dot, sees problem and location information, and dispatches a work order to a technician.

The technician receives the work order on a smart device and sees the problem description. To accept the work order, the technician taps an icon. Back in the office, the work order status automatically changes, which is noted on the work order map as the red dot changes to yellow. When the technician enters the building, he or she opens the wayfinding app and follows its route to the problem's location. To begin the repair, the technician uses a mobile survey app
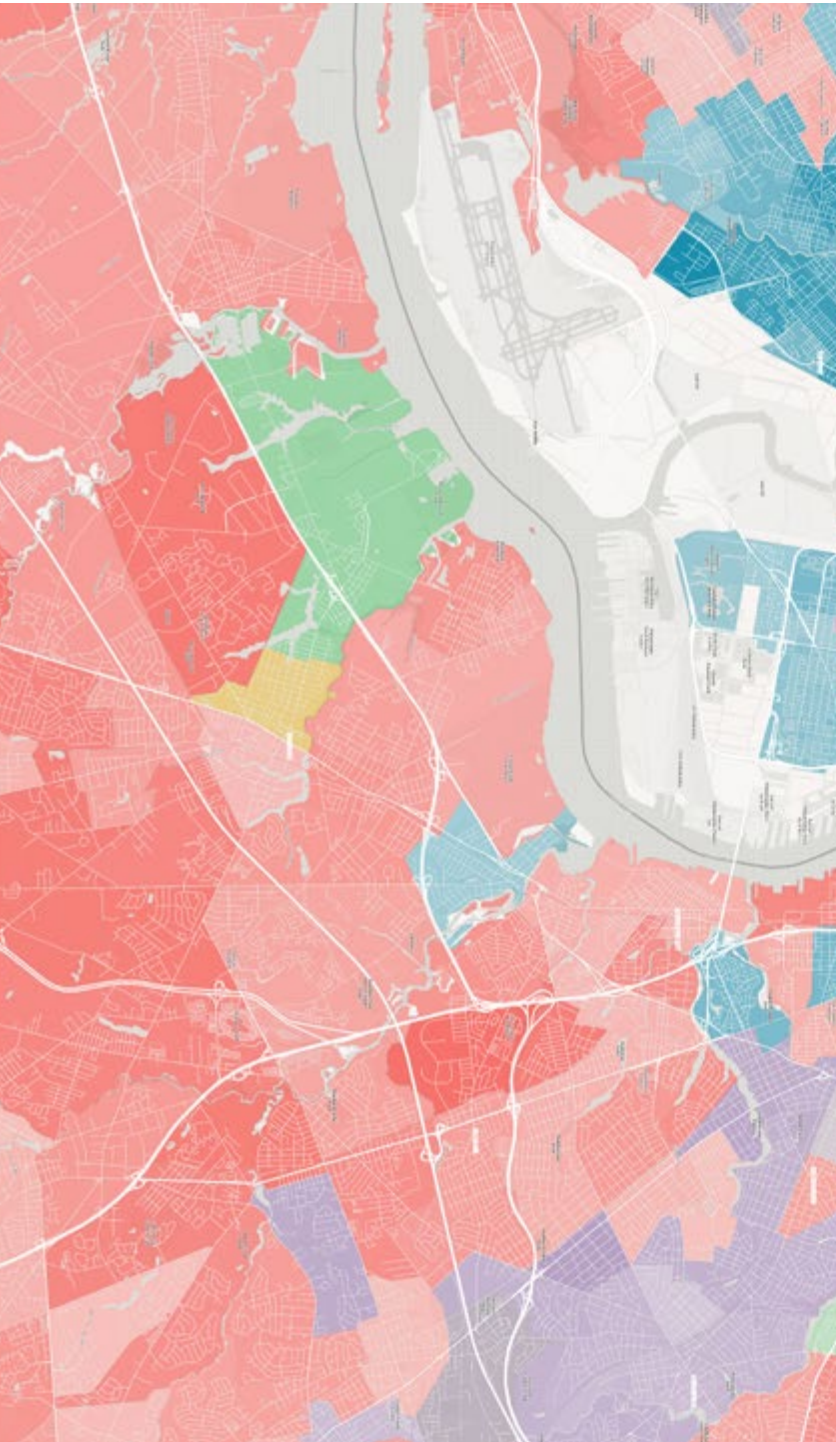
Work order management system (continued)

to confirm the problem, take photos, and add notes. When finished with the repair, the technician taps the Complete icon. The app instantly streams the information to the GIS database, and the map's status dot changes to green.

The indoor tracker records when the technician arrives and leaves the site. The manager uses the record to see if the invoiced price is the contracted price. The GIS shows a repair for a single event or the overall costs by area or by work order type. A hot spot map that shows repair frequency throughout the facility is an insightful cost analysis report.

Predictive modeling reveals where operators should implement preventive maintenance. This means the maintenance department can target services to at-risk areas rather than service areas whether they need it or not. Targeted services include scheduling maintenance according to warranty dates to ensure that needed repairs are covered during the warranty period. This practice increases the life of the asset rather than simply running it until it fails.

The bottom line

- Facility managers decrease their time spent searching for documents, locating inventory, and assembling the right drawings for completing a work order.

- Efficiency research shows that the cumulative time saving of the work order management system averages 11.6 minutes per work order.

- Maps that show asset activities and status give operations managers total visibility into facility performance so that they can monitor factors included in total occupancy costs.

- Maintenance insight helps managers mitigate problems and implement sustainable strategies.

- Location information modeling keeps executives up-to-date on facility performance value, changes over time, and property acquisition opportunities.

- Predictive modes project staff growth rates and operations cost increases so that the company is prepared for the future.

Pat Wallis

Pat Wallis, AICP, GISP, Assoc. AIA, LEED AP, has led Esri's indoor GIS practice since 2011. He develops the methods and processes to create and use indoor location information to meet the needs of employees, visitors, students, and business operations worldwide. After graduating from Tulane University with a master's degree in architecture, Wallis began his career as an engineer officer in the US Army, serving in various roles before leaving the service with the rank of captain. More recently, he worked as a senior asset manager for the United States Coast Guard, overseeing a real estate portfolio of over 4,000 assets measuring a total of more than 8.6 million square feet, with a value exceeding $3 billion.

Bernd Gruber

Bernd Gruber was the founder of indoo.rs, an indoor positioning software company acquired by Esri in 2019. indoo.rs was a leading provider of professional real-time indoor positioning and navigation solutions for mobile apps. Working at Esri as global market development manager, he is defining the voice of Esri in the Indoor GIS market. Gruber has an academical background in international business and information technology. He also has gathered experience as a project manager and IT consultant. As an advocate of getting things done, he loves straightforwardness and fast decision-making.

Learn More

Esri solutions are used by 90 of the Fortune 100 companies, all 50 state governments, more than half of all counties (large and small), and 87 of the Forbes top 100 colleges in the US, as well as all 15 executive departments of the US government and dozens of independent agencies.

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