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Multimodal AI

Making sense of smart building data

BY TED RITTER & JAMES WADDELL

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TECHNOLOGY

The modern edifice, bristling with sensors, cameras and the intricate web of building management systems, has ushered in an era of unprecedented data generation. This digital deluge is poised to expand exponentially, offering facility managers a formidable challenge: transforming this raw information into actionable intelligence.

While traditional building management systems (BMS) capably report on metrics like temperature and energy consumption, they often leave unanswered the fundamental questions of why.

- Why the sudden surge in energy use?
- Why the escalating maintenance requests for a particular piece of equipment?
- Why the persistent vacancy of a seemingly functional space?

The answers, it appears, lie beyond the confines of singular data streams, demanding a more integrated and contextually aware approach. Enter multimodal artificial intelligence, a technology poised to fundamentally reshape the FM landscape, moving beyond incremental improvements to offer a truly transformative lens through which to understand the built environment.

The architecture, engineering, construction and operations (AECO) industry, despite its considerable economic footprint, has long been plagued by a persistent productivity lag. A primary culprit, consistently highlighted in industry analyses, is the chasm that separates the various stages of a building's life cycle

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information models (BIM), frequently fails to seamlessly integrate with the information accrued during construction.

Critically, both these data sets often encounter a significant barrier when transitioning to the operational phase. This breakdown culminates in what FMs ruefully term "handover hell." Recent research by the IFMA IT Community and Autodesk revealed that more than half of facility teams endure a wait of more than six months to receive final project closeout documents. When these documents finally arrive, they are often incomplete, riddled with inaccuracies, relegated to outdated formats or structured in a manner incompatible with contemporary FM software.

The consequences of this fragmented reality are far-reaching, encompassing wasted man-hours spent searching for basic operational information – in some sectors, this can consume up to three hours daily – operational inefficiencies stemming from a lack of reliable as-built data and significant financial losses. The National Institute of Standards and Technology estimated that operations bear the brunt of the staggering costs associated with poor data interoperability in the capital facilities industry, a figure that likely surpasses US$126 billion annually on a global scale. This fractured ecosystem effectively stifles the potential for data-driven decision-making and impedes the adoption of truly transformative technologies like advanced artificial intelligence and functional digital twins.

Multimodal AI offers a paradigm shift from this siloed approach by mirroring human perception, processing and synthesizing multiple types of data concurrently. Unlike traditional AI applications that analyze text or images or sensor readings in isolation, multimodal AI integrates visual data gleaned from cameras and even BIM visualizations, auditory cues captured by microphones, textual information extracted from maintenance logs and tenant feedback, and the time-series data emanating from building management systems and IoT sensors.

By discerning the intricate relationships between these disparate data streams, multimodal AI cultivates a far richer and more contextually nuanced comprehension of the building environment. Instead of registering a high temperature reading, the system can correlate this with visual evidence of high occupancy, auditory indicators of an overworked HVAC unit, and textual data revealing a lack of scheduled maintenance, thereby enabling a more precise diagnosis and facilitating a more intelligent response. This multifaceted capability is akin to endowing buildings with enhanced senses, allowing them to perceive and interpret their surroundings with a depth far exceeding that of conventional systems.

The true transformative power of multimodal AI is realized when it is seamlessly integrated

channeling diverse data streams into a central platform, multimodal AI becomes the driving force behind a dynamic and perpetually evolving digital twin. This virtual representation transcends a static 3D model, offering a constantly updated reflection of the building's physical state, operational performance and environmental context.

This integrated methodology, often envisioned as a continuous "digital thread" or managed through standardized "building passports," ensures data continuity from the initial design stages through to ongoing operations. This holistic approach enables life-cycle-informed design, in which insights gleaned from operational data are fed back into the design process for future projects, fostering a continuous cycle of improvement. Furthermore, the digital twin empowers FMs to simulate the impact of potential changes, such as adjustments to HVAC schedules or the implementation of retrofit options, before any physical alterations are made. Ultimately, this facilitates holistic performance optimization, enabling decisions grounded in a comprehensive understanding of the long-term interplay between various building systems and influencing factors.

The integration of multimodal data empowers AI to revolutionize core FM functions. In energy management, AI transcends basic scheduling to achieve dynamic optimization based on real-time occupancy data captured visually and through sensors, weather forecasts, predictive load calculations, equipment efficiency analysis derived from audio and vibration data, and even fluctuations in energy prices. This enables sophisticated demand-response strategies, leading to significant cost reductions and the attainment of sustainability targets with far greater efficacy than traditional BMS. Predictive maintenance is also fundamentally transformed, with AI correlating sensor data on vibration and temperature with audio signatures indicative of equipment anomalies, thermal imaging and historical maintenance records to predict failures with enhanced accuracy and extended lead times, potentially reducing maintenance costs by a significant margin and minimizing disruptive unplanned downtime.

Space utilization is optimized through the analysis of camera feeds and sensor data, providing granular insights into actual space usage, identifying bottlenecks and underutilized areas, and informing optimal layouts for evolving work models. This data-driven approach allows FMs to become strategic partners in workplace design and real estate portfolio management. Security and safety are enhanced through the fusion of video analytics, audio detection of unusual sounds, and access control data, leading to improved situational awareness and faster, more reliable differentiation between false alarms and genuine threats. Occupant experience is elevated through the analysis of tenant feedback from diverse sources, correlated with building sensor data to identify recurring issues and sentiment trends, enabling faster resolution, proactive communication, and improved

Perhaps most significantly, multimodal AI empowers FM professionals by automating routine data analysis and report generation, freeing up their time to focus on strategic planning, managing human-AI collaboration, enhancing sustainability initiatives and fostering stronger tenant relationships.

Despite the compelling advantages, the implementation of multimodal AI presents notable challenges. The integration of diverse data types from potentially disparate legacy systems often represents the most significant hurdle, necessitating a vendor-agnostic integration strategy grounded in open standards and robust application programming interfaces, also known as APIs. The expanded scope of data, particularly visual and auditory information, amplifies the critical need for stringent data governance, robust cybersecurity measures adhering to zero-trust principles, and strict adherence to privacy regulations.

Demonstrating a clear return on investment beyond simple cost savings requires the definition of precise key performance indicators related to energy efficiency, maintenance effectiveness, space utilization and occupant satisfaction. Furthermore, facility management teams require comprehensive training in data literacy, the interpretation of AI outputs and effective collaboration with AI tools. The consensus among researchers and early adopters underscores the importance of initiating carefully selected pilot projects focused on specific, high-impact challenges, rigorously measuring the outcomes, learning iteratively, then scaling strategically with dedicated support and change management.

The sheer volume and diversity of data emanating from intelligent buildings necessitate a more sophisticated analytical framework than traditional BMS can provide. Multimodal AI emerges as the key to unlocking the rich contextual information embedded within these varied data streams. By seamlessly integrating visual, auditory, textual and sensor data, it facilitates a truly holistic understanding of building performance, driving substantial enhancements in energy efficiency, maintenance protocols, security measures, space utilization strategies and occupant satisfaction levels.

This evolution signifies a fundamental shift for FM, transitioning the role from a reactive discipline focused on addressing problems to a proactive and strategic function centered on optimizing performance and enriching human experience within the built environment. While the successful implementation of multimodal AI demands meticulous planning, strategic investment in data infrastructure, robust security protocols and comprehensive workforce development, the potential benefits are immense. By embracing data standards, fostering collaborative partnerships, initiating with targeted pilot projects and harnessing the transformative power of multimodal AI, FMs are poised to lead the charge in creating buildings that are not merely smart, but truly intelligent, sustainable and acutely responsive

Ted Ritter, *IFMA Fellow has worked and travelled extensively throughout North America, Europe and Asia. He is the Principal of LMI360, a company that solely supports organizations that support the built environment. He is the global chair of the IFMA Technology Community, past president of the Greater Phoenix Chapter and a past chair of IFMA Americas' Advisory Board. He has more than 30 years of experience in facility operations and project management. He is a co-author of "The Facility Manager's Guide to Information Technology," author of multiple articles and has contributed to more than 100 presentations on best practices regarding the use of FM technology, sustainability and brand management.*

James Waddell *is president, CRO Cognitive Corp and is a seasoned technology and engineering leader with more than 30 years of experience. As the driving force behind Cognitive Corp, he spearheads strategy, growth, and innovation, leveraging AI/ML, IoT, and data analytics to revolutionize how businesses operate. Waddell's passion lies in creating sustainable, efficient and human-centric built environments of the future.*

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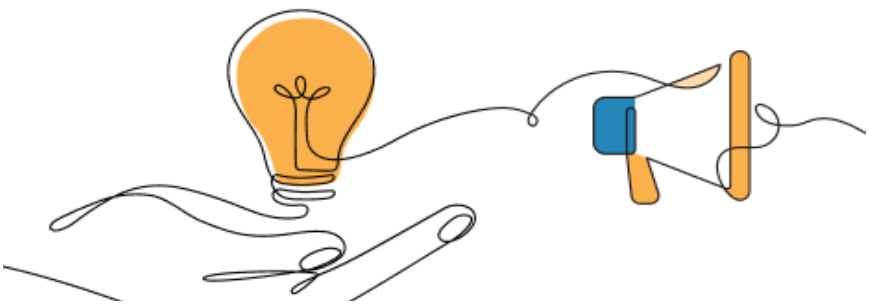

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