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Designing For Facility Management 2.0: Changing how digital systems are specified to achieve smart building outcomes

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Executive summary

Facility Management 2.0 is the Arup vision for the digital future of facility management (FM). This transformation will help FM teams operate more efficiently, improve facility performance, and create healthier, more productive work environments. The traditional design-build process needs to change and become more collaborative for FM teams to have digital tools to achieve these outcomes. This will enable FM use cases to be better understood by all stakeholders, smart building infrastructure to be purposefully designed for maximum usability and effectiveness, build costs to be optimized, and technical risk to be minimized.

This paper brings together industry thought leaders – representing facility design, construction, systems integration, inspection, insurance, facility management software, and smart building technology – to discuss a recommended path forward, including the tangible benefits to each stakeholder with proof of success.

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Introduction

"It's no secret that many buildings don't perform to their potential, and digital transformation certainly has the potential to address this. Building a business case for digital transformation needs to focus on an organization's facility management objectives, whether that's improving user satisfaction, reducing complaints, resilience of systems, comfort, air quality, or energy performance. Alongside the hard commercial benefits, it's important to recognize the softer benefits, such as improvements to health and well-being, recruitment and retention of staff."

–Arup, 'FM 2.0: Re-imagining Facility Management for the Digital Age' [1]

Arup's FM 2.0 report articulates a vision for which facility management (FM) teams can support the rapidly changing demands on facilities today and tomorrow. The report's insights align well with the Schneider Electric vision for 'Buildings of the Future' – commercial, industrial, and mission-critical – that are more sustainable, resilient, hyper-efficient, and people-centric.

However, we argue that for most global organizations, these "softer benefits" to which Arup refers have now become hard financial values. Facilities are no longer just structures: they are considered a major factor in the success of their users and have a significant impact on the environment.

As such, facilities – and the organizations that own or operate them – are now being scrutinized more closely. All dimensions of facility performance are increasingly crucial to attracting investors, tenants, and employees. This is often part of a broader evaluation of environmental, social, and governance (ESG) criteria for investors. In response, many companies are hoping to demonstrate how healthy, productive, and engaging the occupant experience is by seeking certification for their workplaces under the Well Building Standard. [2]

And while government emissions regulations and protecting stock value are compelling many corporations to announce 'net-zero' targets, organizations are increasingly being evaluated on their sustainability practices – including green financing and green buildings. For this reason, earning a green building certification continues to gain popularity worldwide. Some standards are even evolving beyond design and construction merit points to encompass commitments to sustainable performance during operation.

An example is the National Australian Built Environment Rating System (NABERS) rating system, intended to bridge "the performance gap between the design and in-use energy performance of offices … to provide investors and occupiers with the confidence that the facilities they own and occupy are aligned with their climate change ambitions."[3] In Australia, the NABERS rating system is now "required for all new buildings over 2000 square meters and buildings that are up for sale or lease."

It is not hard to imagine that similar regulations for operational performance will begin appearing in other countries and, in turn, affect asset value. Investors need to protect their reputations and avoid their facilities becoming stranded assets by not complying with minimum efficiency standards.

[1] "FM 2.0: Re-imagining Facility Management for the Digital Age", Arup
[2] WELL Building Institute (IWBI)
[3] "NABERS Launches in the UK," BRE Group

Finally, the cost of operating and maintaining a facility over its lifecycle is also considered a value indicator.

These different outcomes require better information on facility issues and performance. That information must be acquired, curated, and presented in simplified, customized, and actionable ways for each FM user: maintenance technicians, facility engineers, facility managers, and energy managers.

Smart goals need smart technology

"By 2025, data analytics will be critical for addressing costs and performance."

–CBRE

Achieving this greater scope of operational outcomes is the new end game for building investors/owners or owner/operators, and facility management teams are expected to support these goals. These expectations may find their way into FM contracts in the form of new service delivery requirements, such as condition-based maintenance.

However, whether facility management services are managed inside a company or outsourced, FM teams have limited – even shrinking – resources. It is also an industry with a high turnover of personnel. Organizations and the market are losing deep industry expertise as professionals move to other companies or retire. The result is less personnel, with less experience, and more responsibilities for delivering the same or greater value while keeping costs down.

Faced with this reality, the latest digital building technology is needed to optimize FM service models. Every facility is designed and constructed to include a complete mechanical and electrical infrastructure. However, even though a digital infrastructure has become just as important, it is still often overlooked. Digitalization is the 'smart' layer integrated with mechanical and electrical systems using connected meters, sensors, servers, controllers, and other devices that share data continuously with site-based or cloud-hosted software, mobile devices, and analytics-driven expert services.

Digital solutions include computer-assisted FM (CAFM: asset, maintenance, etc.), building management systems (BMS), energy and power management systems (EPMS), space management, microgrid management, security/access, and more. They deliver the deep visibility, alerts, and actionable insights that help save time by simplifying FM workflows, improve response times to improve resilience, reduce costs through condition-based maintenance, improve fire and workplace safety, optimize energy efficiency and sustainability, enable more fluid use of facilities post-COVID, and provide a better occupant experience through information services, personalization, and communication with FM teams.

Traditional design-build process neglects FM outcomes

> *"The Engineering & Construction sector has been hesitant about fully embracing the latest technological opportunities … the industry's future success will rely heavily on effective collaboration among all stakeholders."*
>
> **–*World Economic Forum*[4]**

The challenge facing all stakeholders in the facility lifecycle is to ensure the required digital infrastructure is adequately specified, designed, and integrated into the final build. Doing so will deliver the tools FM teams need to achieve the required outcomes. The many incentives noted above are urging organizations and FM services in this new direction, and facility design needs to anticipate this.

"When interests are aligned and aimed at well-defined outcomes, projects are more likely to meet schedule and cost targets. … the [construction] industry must move away from the hostile contracting environment that characterizes many construction projects to a system focused on collaboration and problem-solving."

–*McKinsey Global Institute*

Unfortunately, this is not happening for most of today's building projects. We believe there are several reasons for this.

1. FM use cases are often not fully understood by all stakeholders. Even within a building owner/investor organization, financial level management may not fully appreciate the impact of the FM team not having the right tools to help manage building performance. And even though digital systems can help achieve their goals, digital tools are often not understood or maybe ignored, delegated, or buried under more visible and immediate topics.
2. Due to the separation of budgets, if energy costs are not part of FM, the FM team may not be incentivized to want better tools to help manage energy. As a result, the required digital technology may not be fully specified at the outset of facility design.
3. If digital systems are part of the design, they may be reduced in scope or removed altogether due to project cost and schedule pressures.

Clearly, more education, collaboration, and understanding are needed across all stakeholder groups.

[4] "Shaping the Future of Construction: A Breakthrough in Mindset and Technology," WEC, 2016

The purpose of this paper is to bring forward a discussion and recommendations for a path forward that will help ensure building owners, investors, and FM teams are armed with the digital tools needed to meet all of the new demands of their facilities and occupiers. The paper will cover the following topics:

1. **An industry catching up with FM 2.0.** How evolving standards and guidelines are encompassing many of the new FM challenges.
2. **A new business model for stakeholder success.** A discussion of the challenges faced by each stakeholder group across the building value chain and the tangible benefits of exercising a more collaborative approach.
3. **A new collaborative paradigm to deliver on FM outcomes.** A recommended set of new best practices, intended to help all players, large and small, around the globe move forward in helping make the FM 2.0 vision a reality.

An industry catching up with FM 2.0

Building codes are still primarily focused on safety, accessibility, fire, and structural protection. However, facility owners are now increasingly concerned with their property assets' sustainability, operational efficiency, resilience, and health. Building design needs to go beyond current standards compliance to address these needs.

In recent years, many standards and guidelines have been introduced that address some of these areas of concern. Some newer standards are directly supporting today's FM requirements. Many of these standards require ongoing, active monitoring of a wide variety of a facility's energy and environmental parameters. Digital tools make standards compliance achievable while reducing the impact on FM personnel. See **Table 1**.

Table 1

Selected standards and guidelines related to smart building technology

Standards	Description
ISO 50001	Provides organizations with an internationally recognized framework for implementing an energy management system (EnMS).[5]
Model electrical and energy standards	Examples include the International Energy Conservation Code (minimum efficiency standards for new construction), ASHRAE 90-1 (minimum requirements for energy-efficient design), and IEC 60364-8-1 (low-voltage electrical installations, energy efficiency).
Green building rating and certification standards	Examples include international standards (e.g., LEED and BREEAM), and country-based standards (e.g., Australia's NABERS, Singapore's BCA Green Mark, Japan's CASBEE, Abu Dhabi's Pearl, & South Africa's Green Star).[6]
WELL Building Standard	Measures attributes that impact occupant health, such as air, water, light, comfort, etc. Adoption is accelerating.[7]
ISO 55001, ISO 41001	"These standards provide a basis and a framework for organizations to ensure facilities, assets and services are effectively and efficiently managed…"[8] They also call out the importance of stakeholder engagement.
WiredScore, SmartScore	These standards determine how 'digitized' a building is and can decide which type of technology use cases need to be considered.

[5] "What is ISO 50001?", Better Buildings, US DOE
[6] "Green Building Standards and Certification Systems," Whole Building Design Guide, 2019
[7] "WELL Hits Major Global Milestone Supporting Healthier People and Better Buildings," IWBI, 2020
[8] "ISO 55001 & ISO 41001 Work Together …", ISO, 2018

Many of these standards may become mandatory as governments put more focus on fighting climate change and meeting international commitments. Even now, the financial and public image benefits of making facilities and businesses more sustainable, efficient, and healthy will continue to increase the adoption of such standards by building investors, owners, and operators.

"Especially in large sites, such as industrial zones, office parks, shopping malls, airports or seaports, IoT can help reduce the cost of energy, spatial management, and building maintenance by up to 30 percent."

*–**Bettina Tratz-Ryan, Research VP, Gartner***

However, most of these standards do not define the exact technologies and system architectures needed to deliver the required intelligence from the facility. This is why facility owners and FM teams need the support of design consultants and technology vendors. Consultation needs to occur early in the design stage so that the required digital tools and supporting system architectures are included in the project CapEx investment.

> It is much more cost-effective and less risky operationally to design and implement digital solutions in the CapEx phase than adding these technologies later in the OpEx phase via a retrofit project.

It is also important not to 'over-design,' as an overly complex and costly solution will often be considered a risk by a building contractor. They may add a premium to the project cost, encouraging parts to be removed through value engineering. Smart building systems should be specified to adequately meet the present use cases while being open and scalable enough to adapt as use cases evolve.

Beyond standards, there are generational changes to consider. Demonstrating the use of technology and innovation is a big part of how building owners and tenants need to attract young, millennial talent who are digital natives. Smart building technologies are quickly becoming a fundamental expectation of FM teams and building occupants.

A new business model for stakeholder success

The benefits of a smart building to the building investor/owner and FM team are made clear in the FM 2.0 paper, as summarized in the introduction. However, meeting new FM outcomes will require a shift from the traditional way smart building technology has been specified, designed, constructed, and operated for new facilities.

Change for any business can be difficult and disruptive. However, we believe that a new working model based on collaboration will offer significant business and financial benefits to all other building stakeholder groups.

Each section discusses each group's challenges and the payback each can expect to achieve by pursuing this new working model.

Park Hyatt embodies smart building sophistication

For their first project in New Zealand, developer Fu-Wah Group wanted to build a hotel in Auckland representing an 'international best practice.' This included a high level of sophistication and automation that would support specific FM outcomes, including efficient building and energy management, as well as an enhanced guest experience.

To ensure the required infrastructure was delivered, Caspiral Engineering was engaged to act as a detailed design consultant and master system integrator. Caspiral continuously collaborated with the developer, design firm, main contractor, and technology providers to carry the project forward. This helped optimize design, minimize risks, and keep the project on time and budget, from design through value engineering, construction, integration, and commissioning.

Design firms

> *"Design firms need to understand the connection between information and business outcomes over the whole lifecycle of building assets. We need to speak the same language as the client, defining specific FM objectives with SMART goals and recommending technology supporting them. Also, be aware that having more systems can simply mean more complexity for FM teams; it's important that solutions are open to enable sharing and unification of data to simplify tasks. For example, an alarm from an EPMS thermal sensor indicating a risk of fire should ideally generate a work order in an FM system."*
>
> ***–Conor Cooney, Arup***

Architects and designers will always design to meet current codes and standards. The new outcomes that FM teams need to achieve require technology that goes beyond these statutory requirements. Further, clients will not typically know what kind of technology solution to ask for. This is an opportunity for design firms to educate the building owners.

The challenge is the massive breadth of available digital technology on the market. There are also currently no codes or standards that provide a blueprint for how to design digital systems. This makes it challenging to choose the best-integrated solution to meet the desired FM outcomes specifically.

This situation requires a shift in how project requirements are defined by enabling more collaboration between all stakeholders:

1. Facility managers are often excluded from the building design phase. Designers need to reach out to the building's end users to understand use cases better. This includes determining who is responsible for using and acting on the data, what level of detail each user needs (e.g., asset manager or landlord versus FM team), and how that data should be presented (e.g., dashboards with KPIs). This group of end users should then be continuously engaged to review how their outcomes will be met and to provide feedback to influence the design as necessary.
2. The design firm should also engage technology providers to help fit digital solutions to the FM needs. This will enable a more precise and complete digital systems specification in the building design to drive better results at the project estimation and construction stages, with less rework.
3. The design firm should also include the key contractors and system integrators to help support further technical de-risking by having information on integration, compatibilities, testing, and configuration.

The value in these extended efforts includes:

- **Increased customer satisfaction:** Owners and FM teams have the tools they need to achieve accurate results delivered on time and on budget. This will inspire word-of-mouth promotion to industry colleagues.
- **Competitive advantage:** The design firm is positioned as a leader in offering future-proof smart building designs, which will help fill the sales funnel and maximize revenues.

- **New business opportunity:** Beyond the design phase, the design firm can offer to stay engaged in the project longer to essentially defend the design by overseeing its implementation throughout the construction and integration phases. The client will appreciate this oversight to ensure that the required digital systems are maintained in the final build.

> *"Many consultants have commoditized their services in an effort to compete on lowest cost designs with reduced risk. However, this limits innovation. Keep in mind that designing and constructing a building takes two years, while – buildings stay in operation often for 50 or more years. Designers should be engaging clients early to establish operational goals, discuss budget constraints, and work together to deliver the best value for the right price."*
>
> ***–Dominic Lauten, Caspiral Engineering***

Construction contractors

Mechanical, electrical, and plumbing (MEP) contractors often act as gatekeepers for the client's budget. As part of the typical contractor bidding process, the contractor will propose cost savings. This process of 'value engineering' – often performed by an integrated project delivery coordinator – is primarily focused on meeting time and cost goals.

In addition, a quantity surveyor (QS) will typically use a 'siloed' approach when evaluating project costs. Such analyses will not take into account the costs savings that can be achieved across categories. For example, a marginally higher investment in hardware technology can be partially or entirely offset by a significant savings in installation and configuration time for the integrator. Collaboration with technology solution providers will enable a more holistic approach that can identify such savings.

Traditional value engineering can risk detaching construction from operational value. Like the bricks in a building, engineering out too many pieces will eventually compromise important aspects of the original design, including the integrity and usefulness of the digital system.

The solution to this puzzle is twofold:

1. Early engagement and input into the client's *owners project requirements* (OPR)
2. Create a more comprehensive and detailed digital system design upfront so that it is clear how changes will impact the ability to meet the use case requirements.
3. Use FM use case requirements to guide the value engineering process.

To effectively implement this solution, the contractor should directly engage with the designer, technology providers, system integrator, and end user FM team to effectively implement this solution as part of the value engineering process. This will enable:

- Smart cost optimization aligned with digital system intent.
- Reduced technical and project timeline risk due to less redesign.
- Delivering the highest value to the building owner, which in turn will help position the contracting firm as a successful innovator in the marketplace.

System integrators

"A customer expects to see payback on their smart system, whether from energy efficiency, outage prevention, increased equipment life, or to meet billing needs. To ensure customer needs are addressed, the systems integrator should partner with the general contractor, other engineering teams involved, as well as engage with the customer. If there is a master system integrator, they need to be considered part of the GC's team when it comes to direct access to the owner. If planned correctly, the integration can optimize costs, for example, by sharing sensors across different systems."

–Matt Zabel, Faith Technologies

System integrators (SIs) have a deep understanding of smart building technologies for electrical and mechanical systems. This includes compatibility, integration, configuration, and testing requirements.

SI firms are typically the last piece of the puzzle to bring a construction project together. If there are incompatibilities due to a lack of detailed design, or the result of pure cost-based value engineering, the integrator bears the brunt of those missteps in the last step of the project. This puts everything at risk, which reflects poorly on all stakeholders.

An SI may find it challenging to deliver an accurate bid for integration work during the bidding process because the design does not provide a detailed enough scope of work. This requires many assumptions to be made without adequate risk provision.

For these reasons, including the SI earlier in the process with a seat at the design table is vital to de-risk early and limit rework and delays. In addition, collaboration with the designer, contractor, and end user will help to ensure:

- The specification for the final integrated solution is detailed enough to support the client's required outcomes.
- There is a crystal-clear scope to bid on for all stakeholders, eliminating assumptions.
- Rework is reduced due to design issues being caught earlier, which will limit last-minute change orders. As rework is typically 30% of building cost, addressing this pain point will significantly reduce project cost and risk.
- The SI establishes an image of advocating for the customer and their desired outcomes in collaboration with the design firm and general contractor. This can help differentiate the SI in winning more business.

"When designing and constructing a smart building, collaboration needs to happen not only between electrical and mechanical designers but also with other experts. This will result in a better specification with an optimized design that avoids duplication and allows digitization and integration to be delivered within near the same price as a traditional building."

–Dominic Lauten, Caspiral Engineering

Tenant drives the requirement for smart metering in high-profile high-rise

During the design phase of a greenfield project for a major downtown high-rise commercial building in the city of Atlanta, the largest corporate tenant asked the building owner that their leased space be separately metered for energy. Accurate sub-metering will support the tenant's sustainability goals to minimize its global carbon footprint. It will also help gain LEED credits for the tenant and building owner. The engineer-of-record approached Faith Technologies – already engaged as the project's electrical contractor but with deep expertise in 'connected buildings' solutions – to help specify a facility-wide metering and billing solution.

The selected Schneider Electric technology will deliver energy and power quality metering at the service entrance, on emergency backup generators, on busways and branch circuits on each floor, as well as differentiating energy usage between tenant spaces (office and retail), and each shared common area (e.g., elevators, lighting, cooling, security, parking including EV charging, etc.) Faith Technologies collaborated closely with all stakeholders to support owner and tenant outcomes with the most cost-optimized design and will be responsible for installation, commissioning, FM team training, and support integration and commissioning.

Technology providers

"All design and construction stakeholders need to understand that maintaining the digitized infrastructure elements of a building will ensure the delivery of the accurate and actionable information an FM team needs to support efficient operations and sustainability goals over the entire life of the building. Connected sensors, apps, and advisory services are also the key to improving resilience and user experience. A properly specified and integrated building, power, and FM services infrastructure should not add significant cost to a building's design and construction while delivering a large and continuous ROI to the owner and operator in reduced maintenance, energy, and equipment costs."

–Mathew Losey, Schneider Electric

FM teams need a variety of digital tools to achieve their desired outcomes. Smart building operating technologies will be integrated with building services applications, including intelligent building management and power management systems. This unified platform will enable more capable and comprehensive management of operating costs, sustainability, resilience, and workplace experiences.

Each technology provider will have deep knowledge of the capabilities and applications for its digital technologies and advisory services, and installation and integration requirements.

To ensure a building project includes the required technologies, there needs to be greater engagement between technology providers and the building owner/investor, the FM team, and the chosen design firm.

In this way, each solution provider will be able to:

- Better understand the requirements of the building owner and FM team, helping clarify the smart building element of the RFP to ensure end users acquire the digital tools they need to fully support their desired outcomes.
- Help reveal additional goals and present solutions, such as simple, affordable ways to take a building from LEED Gold to Platinum through the enhanced specification of the smart building elements.
- Help designers create more detailed, clear, and complete smart building technology final specifications that, in turn, help contractors optimize value engineering and reduce rework for integrators.

Brown University integrates BAS and IWMS to save cost and boost FM efficiency

Brown University is an Ivy League leader in research and educational innovation, with a campus consisting of 228 buildings. The university's FM organization uses a building automation system (BAS) to monitor, manage, and service thousands of field controllers that control HVAC, heating, hot water, and other mechanical devices.

The BAS has been integrated with the Planon Universe integrated workplace management (IWMS) platform, which now reliably automates the logging and creation of mobile service orders for each BAS alarm – over 4,000 a month. Not only is FM workflow greatly improved, but the removal of manual work order generation is also saving an estimated $38,000 annually.[9]

[9] "Brown University: Integration between Building Automation System and Planon streamlines and automates work order processes.", Planon

Penn Medicine pursues a vision for IoT-enabled hospitals of the future

Schneider Electric is working with the PennFIRST team to design and build a new state-of-the-art pavilion featuring smart building technology for power and building management systems for the University of Pennsylvania Health System (Penn Medicine). EcoStruxure™ for Healthcare, an IoT-enabled digital hospital architecture, will help Penn Medicine reduce costs, optimize energy use, increase staff efficiency, and much more, long into the future.

Schneider Electric has worked as a technology consultant for two years, reviewing LV systems, setting up technology vendor demonstrations, and conducting user group workshops. The company also built an LV integration lab that helped select and 'stress test' technologies and systems integration in collaboration with the design firm, contractors, and Penn Med team. This work enabled an estimated 5% CapEx savings across the total LV system's budget by sharing data across core systems in the hospital infrastructure and eliminating substantial duplication of equipment and cabling. The company will continue to work with the PennFIRST team to configure and evaluate the LV systems and use cases that leverage the technology backbone in the patient room for clinical and patient value.

"Smart systems deliver quantifiable value in life cycle operating costs. Value engineering may save on construction costs, but engineering out smart systems will add to the building's FM costs in an extraordinary way. Organizations have fewer resources and don't have the budget to hire the staff needed to keep up with manual planned maintenance inspections and repairs. Smart, integrated building systems provide the automated readings and advice to alleviate that human shortage. FM teams stay informed of all equipment conditions without having to send a technician out. The tech has a complete asset history at their fingertips, enabling data-driven decisions regarding repair or replacement. Work is made more efficient, equipment life is extended, and capital expenses are better managed."

–David Karpook, Planon

Construction inspection companies

"With emerging new regulations, we can imagine value-added inspection services that provide continuous performance verification to ensure codes and standards continue to be met during a building's operation phase. This will require digital infrastructures that allow a seamless transition of information sharing from construction into building operations. Such a feedback loop can then be used, for example, to support insurance requirements by checking thermal monitoring sensors in electrical panels to confirm fire risks. These kinds of services could evolve beyond the regulatory requirement to include voluntary requirements, such as continuous arc flash studies for the safety of maintenance personnel. We are a digital inspection company today, developing services for smart buildings. We will continue to respond to regulatory pressures as well as embrace digital opportunities that make us more efficient in delivering the services our customers need."

–Jacques Matillon, Bureau Veritas

Construction inspection services are third-party verification entities. They are often required to provide advice during the construction phase of a facility, primarily regarding the compliance aspect. This is specifically related to the safety-related systems of a facility (e.g., electrical, fire, etc.). However, in regions where there are new building codes for energy efficiency, the inspection service will be required to check that appropriate metering and monitoring systems are in place, and the correct loads are being monitored and connected to a data acquisition system.

When building information modeling (BIM) is used in the design phase, the inspection service will typically help validate the BIM models before the construction phase. After construction, the inspector will check that the final installation has adhered to the design specifications.

Digitalization can help inspection services work more efficiently. Digital as-built certifications help correlate that the model is conforming to reality. Analytic software is typically used to assess if the BIM model meets regulations for accessibility and fire risks. Augmented reality tools can project the BIM model over the physical installation to check ducting location within the building envelope.

The double-checking performed by an inspection service collaborates with the various facility value chain members. The service typically has limited influence on the design, acting more as a 'show-stopper' when non-compliance is identified. Following construction, the service helps to update the BIM model to ensure an accurate 'digital twin' for the facility.

"We find that healthy building effective rents transact between 4.4 and 7.7% more per square foot than their nearby non-certified and non-registered peers."

–MIT Center for Real Estate

Having a digitalized infrastructure within a facility can offer inspection services multiple benefits and opportunities:

- Digital systems may make it simpler for inspectors to validate all components are installed and operating properly.
- Digital systems will make it easier to retrieve inspection information many years after an inspection was performed.
- Smart building data may offer a future opportunity for new 'in operation' inspection. This would verify that the building is continuously performing per expectations, similar to, or in support of, a digital twin concept. This will also enable inspectors to help clients manage risks.

Insurance companies

> *"AXA XL insures around 6 to 7 million sites. Previously, we were only able to perform about 8000 audits every year. To fill the gap, we developed "Digital Risk Engineer", an IoT-powered platform that captures real-time data from energy, HVAC, and other systems from buildings around the world. This allows us to better assess our clients' risks and offer services that are more relevant and better tailored. In turn, our clients benefit from real-time risk management which enables them to know where to focus their investments to reduce their risk. In addition, AXA XL's "Risk Scanning" platform is designed to support an entire portfolio of sites, potentially delivering huge bottom-line savings. Our ambition is to support continuous risk assessment by offering customized 'a la carte' services, in line with a client's risk profile."*
>
> ***–Maxime Ambourg, AXA XL***

Insurance underwriters are responsible for ensuring all kinds of facilities against risks. In doing so, they perform field audits, consulting on protection and loss estimates for events such as fires.

Importantly, insurance companies work collaboratively with their clients to help them reduce their risk profile. In this role, they are typically invited to collaborate on building requirements to offer guidance on the insurability of the project specifically.

We believe that insurance companies will increasingly use actual facility operational data to help determine a facility's risk profile to set or adjust insurance rates. The data from a smart infrastructure will enable this in the following ways:

- Risk managers working for facility owners/operators can become frustrated by having their facility's risk assessment based on limited information. Auditing a building using operational data sources can help insurance underwriters improve risk assessment. Going further, data could consistently assess the customer's risk as it evolves over the coverage period.

"Predictive maintenance … can save time and money. With the Internet of Things devices keeping an eye on asset performance, it's easier than ever."

–Janelle Perry, Editor-in-Chief, Buildings

- Facility data can support risk consulting services that help customers optimize risk management over the life of their buildings.
- Risk engineering can leverage advanced technology that enhances customer safety, such as thermal monitoring to protect against fire. This may result in discounts on property and casualty premiums.
- In an event, the facility owner/operator will need hard evidence to prove that they were not at fault. Facility performance data that is continuously being recorded is an ideal source for that evidence.

It is becoming increasingly important for designers and contractors to understand the importance of how risk management data is driving more optimized building insurance profiles for clients. Facility investors/owners and operators will expect a digital infrastructure that supports this requirement. Insurance underwriters should be consulted early in the design cycle to discuss their smart system requirements for new facility designs and retrofits.

A new collaborative paradigm to deliver on FM outcomes

The previous sections have reinforced the need for digitalized facility infrastructures to support new FM outcomes. However, Schneider Electric has found that while 90% of facility managers expect that technology and connected systems will improve operations and deliver better value, only 17% have facility management technology in place.[10]

The discussions with industry thought leaders have clearly revealed that successfully delivering the necessary digital tools requires a deeper understanding of FM use cases and a stronger focus on user-centric design. This will only be possible utilizing a significant evolution in how facility design and construction are done.

The challenge is to bring the different facility stakeholders together to engage in a more collaborative approach. This will help projects progress toward mutual goals, benefiting facility owners and operators, designers, contractors, integrators, inspectors, and insurers.

To enable this collaboration, the following recommendations from this paper's contributors represent a set of steps that should be considered when embarking on any new smart building project.

Use case workshops

- Today, design firms often consider the client to be only the facility owner, but this now needs to include the operator (i.e., the facility's end user, including the FM team).
- Host 'use case' workshops with project stakeholders that focus on FM outcomes. Use these to define the journey and experience for different users. This will gain a shared understanding between stakeholders and, in turn, enable them to agree on the scope of the project.

[10] White Paper - "Transforming smart building technology," Planon

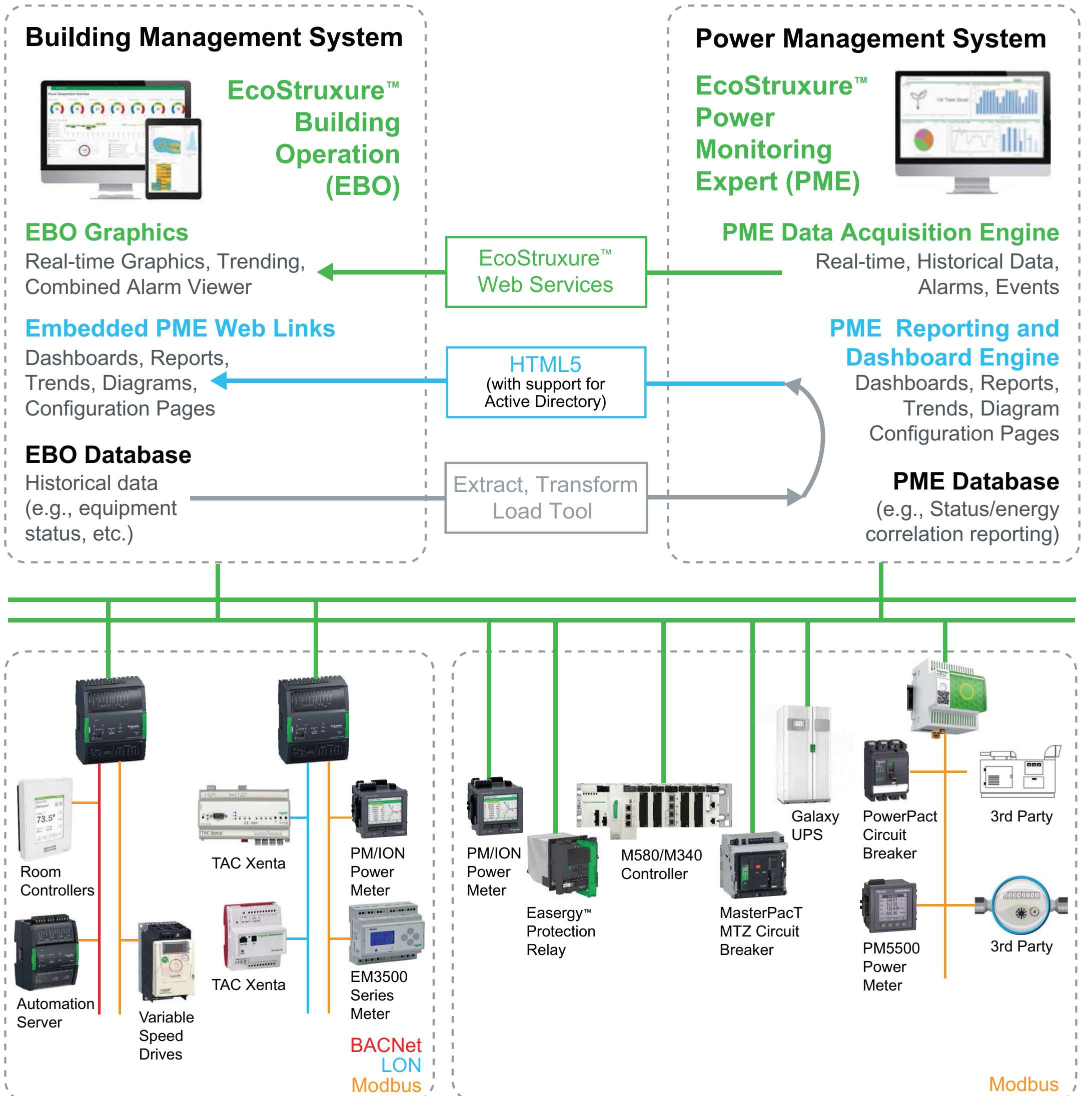
- These workshops should include at a minimum: the designer, the owner, project manager, architect, quantity surveyor, specialist technology consultant, and technology provider(s). Depending on the scale and complexity of the project, other collaborators may include the system integrator, general contractor (GC, i.e., the main builder), building services contractor, specialist-commissioning engineer, and facility manager (operator).
- This team of collaborators will help to:
  - Clarify the smart building element of the RFP.
  - Reveal additional goals and present solutions.
  - Determine the required training requirements for the FM team to use new digital tools effectively.
- The result of this collaboration should be an agreement on expected project outcomes (e.g., mandatory versus like to have) and other metrics such as budget limits, level of documentation required, timeline, quality, etc. This may identify some aspects of the project that can be staged or deferred until later.

Earlier, more detailed design

- The design consultant should understand the different digital systems – EPMS, BMS, etc. – and the integration details for each. To facilitate both a broad and deep understanding, technology specialists should be included.
- Start early with detailed design discussions, even during the preliminary design stage.
- Design with details, including the 'why.' This will ensure that the use case outcomes remain visible as a constant reminder that the digital technology must service these end goals.
- Show the client demonstration systems that highlight the functionality and outcomes supported by the technology.
- The designer should ensure they have all of the inputs necessary to determine what data is needed (e.g., energy, power, HVAC, etc.), who would need to use it (e.g., maintenance, help desk, energy manager), and how will they use it. Bring in technology and integration specialists to support the digital design in the early stages to help:
  - Ensure that the digitization objectives are not left to the last minute, leading to extensive change orders and 'value' engineering due to cost overruns.
  - Ensure the final specification is clear and complete.
- A digital solutions provider with experience in both electrical and mechanical systems can also help the design firm save time by providing optimized, detailed designs for the digital layer. This can include pre-tested, validated 'reference' designs, such as those offered in a Schneider Electric partner program. Refer to the hospital smart infrastructure example in **Figure 1**.

Figure 1

Example of predesigned, pre-validated smart architecture for a hospital

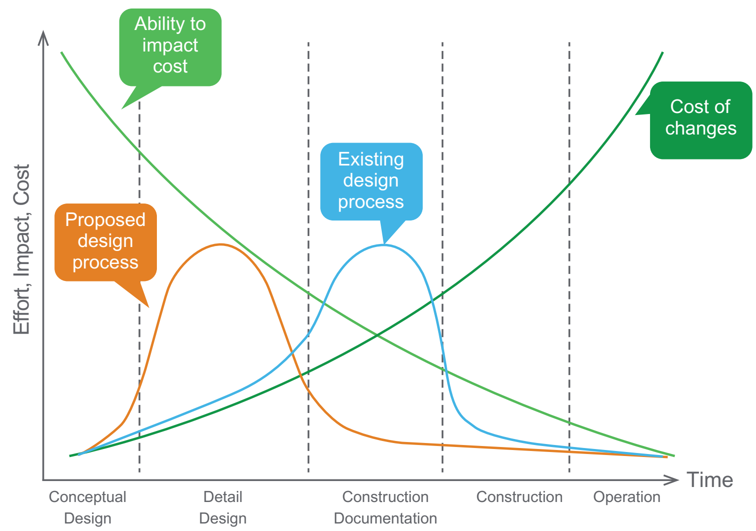


- If the design firm uses a BIM application, the building model should include a digital layer, which will then be maintained accurately through to the final 'digital twin' used by all parties, including the FM during operations, to help save time and money.
- Ultimately, a better specification reduces risk because costs are controlled, capabilities are retained, and contractors can compete on cost while still meeting the specification, see **Figure 2**.

Figure 2

Effect of earlier, more detailed design stage on overall project effort, impact, and cost

Source: Patrick McLeamy



Stress test the digital design

Acting as the last part of the detailed design phase, stress testing helps validate that the proposed design will meet the defined use cases established in the workshops. It will also help optimize expectations for the construction budget and timeline.

It is recommended that stress testing is done using a laboratory environment that allows use cases to be mocked up, tested, and validated. All stakeholders should be invited to contribute at this stage, including the design consultant, technology specialists, integrator, GC, and – most importantly – the building owner and its users (e.g., facility managers).

This collaboration enables different lenses to be put on the design and its intended functionality. This helps keep the client's needs in focus and ensure that the smart building tools have been put in place; they are what the end user asked for and will operate as expected. Early GC engagement is essential at this stage. As they are construction experts, they will be able to validate the buildability aspects of the project.

Stress testing offers five benefits to each stakeholder:

1. **Create a tangible, real-world operating scenario.** The lab will generate physical and visual components representing user workflow, interface, and report (e.g., energy management KPIs, tenant sub-billing) mock-ups to support review and approval by the client. In addition, hardware, communications, software, and system integration and interoperability issues will be identified and resolved while user personalization requirements are defined and tested. Particular attention should be paid to non-traditional use cases, where IoT or digital operational aspects may be outside the 'norm.'

2. **Reveal gaps and potential issues.** Stress testing will also reveal missing pieces or miscalculations. It also helps avoid the introduction of elements that may create unanticipated problems with integration or functionality. Integrated solutions are different from traditionally siloed systems. It is important to fully understand all integration requirements to ensure that parts of that work are not sacrificed at the value engineering stage. It is much more efficient to pre-validate the plan for a digital design rather than have all parties spending extra time 'fighting fires' during the build and commissioning stages.
3. **Identify opportunities to future-proof.** Opportunities should be identified to build in features that prepare a building for the future expansion of its smart infrastructure. By planning for scalability, upgrades can be done to minimized disruption and cost. For example, by including pre-wiring for additional metering points, those devices can be installed and configured without the need for a power shutdown. Including this in the initial construction can result in three to four times lower costs than retrofitting later.
4. **Optimize costs and budget.** Working through the above steps will help refine key elements of the digital design, including validation of the budget estimate. Leveraging the procurement and pricing experience of the GC will improve the accuracy of estimates while working collaboratively with the designer, client, technology providers, and integrator will help uncover savings. In this way, innovation is exercised in finding practical avenues to explore to reduce component, integration, or configuration costs. Optimization should aim to deliver the complex aspects of a project in the most straightforward way possible. This will, in turn, simplify delivery during construction (which will help gain buy-in to the vision from the builder) and simplify building operation (which will ensure the FM team will use the resulting smart infrastructure).

   Some examples of optimizations include:

   - Duplicate metering and networks specified for the mechanical and electrical systems can be eliminated if systems share data from the same acquisition system.
   - The EPMS and BMS solutions chosen should offer the out-of-the-box capability to communicate with connected devices, with support for all associated data types. This will simplify integration at the network level and data integration at the user interface level (see **Figure 1** for example).
   - Reduce the electrical contractor's complexity, time, and cost by organizing electrical circuits by measured load types. This will reduce the number of sub-meters required by metering at a higher level which, in turn, reduces the number of CTs and associated CT wiring while simplifying the communication system design.
   - Reduce wiring by leveraging IP communications and integrate at the software level.
   - Ensure the digital solution chosen is open to integration with other systems, e.g., HVAC, lighting, security, fire, edge data center.

   NOTE: This work should also establish components of the design that are non-negotiable, as well as those that are flexible (i.e., potentially replaceable) at the value engineering stage when further cost or delivery efficiencies may be found.

5. **Reduce risks.** It has been typical for digital architectures to greatly drift in scope during the construction phase. However, if the digital design is stress-tested against the required use cases, costs will be optimized, and it will be validated that outcomes can be met within budget. Design documentation will be more detailed, resulting in less need for interpretation by the MEP sub-contracting firms. And as stress testing has confirmed the required technology is available and proven, a contractor will find less reason to add a hefty premium during the tendering phase to cover the technology-related risk. Overall, the risk buffer will be optimized for all involved. With margins that can be maintained due to greater clarity on agreed work and budget and less budget or time spent on unforeseen/unexpected problems (e.g., scope or design gaps, drift in expectations, etc.)

Simply put, stress testing the digital design validates technologies and integration, gains efficiencies, and enables the next stage: purposeful value engineering. It also helps keep user outcomes top-of-mind during the construction phase, further ensuring the owner and FM team get the functionality that meets their expectations while being delivered on scope, on time, and budget. An example of successful stress testing can be found in the Penn Med story found in this paper.

Purposeful value engineering

At this stage, MEP contractors are brought in during the bid process. Leveraging the results of design stress testing, value engineering can now be performed more purposefully by finding further savings while achieving the same results. By having more detailed design and budget requirements and clear guidance on design elements that are non-negotiable versus flexible, contractors should now compete over 'value,' not over technology capabilities.

It is recommended that the following steps be used during value engineering:

- Enable collaboration between disciplines to reveal savings opportunities, for example:
  - Other technical validators, including the panel builder and systems integrator, should collaborate to help optimize architectures.
  - Keep the designer and owner representative involved to ensure any changes to the project delivery will still meet the required outcomes.
- Further optimize the design where possible to achieve additional savings.
- Choose service providers that can provide installation, configuration, and long-term support.

With different stakeholder groups working together, contractors should deliver a project with digitization and integration for near the same price as a traditional facility. This collaboration will also help build trust across all parties. The more detailed design will also help contractors shrink the contingency part of the budget and reduce duplication.

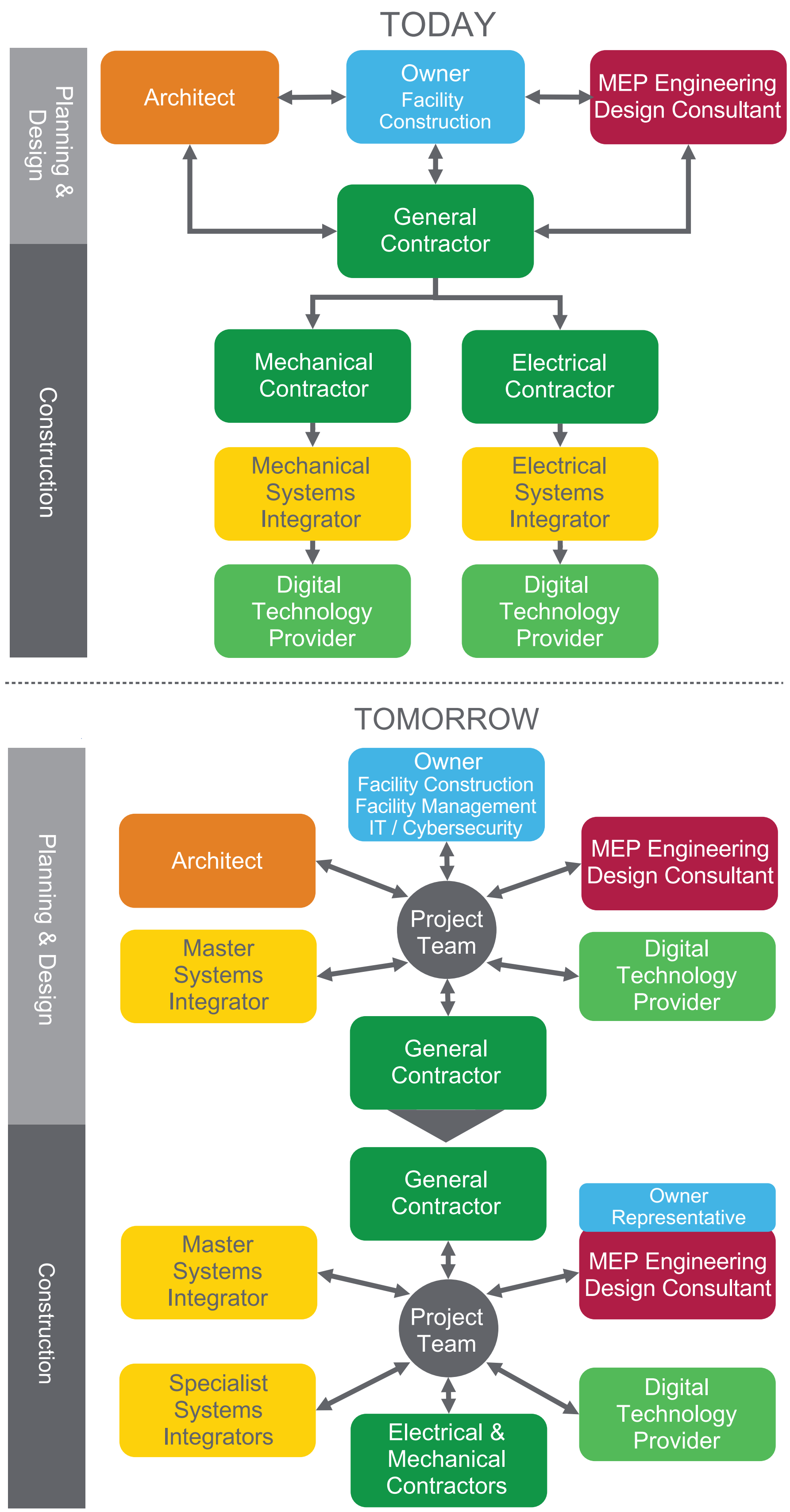


Figure 3

Comparison of design-build process supporting smart building systems, today versus tomorrow

Smart building infrastructure design will help large office building project achieve LEED Platinum

A premier, multi-use residential and commercial building project on the U.S. east coast will ultimately include nearly 2 million square feet of office space. During specification for one of the largest office buildings, Schneider Electric supported an integrative design process that included the building owner/developer, the site operations FM team, the MEP designer (Arup), the architect, the LEED consultant, and the general contractor. This close collaboration resulted in a proposed smart building infrastructure specification that meets FM use cases and exceeds sustainability goals. While the Owners Project Requirements (OPR) initially targeted a LEED Gold rating, the proposed design will increase the score from 63 points to 84 points to achieve a LEED Platinum rating.

Key areas where credits will be gained included: controls to reduce light pollution, enhanced commissioning, energy performance, BMS energy modeling, controls enabling demand response, vehicle-to-grid and BMS control for 'green vehicles,' and enhanced indoor air quality strategies through demand control ventilation.

The intelligent EcoStruxure Building architecture will also support: flexible office space using the Connected Room Solution to enable app-based auto-reconfiguration of services, helps reduce FM requirements for BMS actions, and provides KPIs to support the building owner's corporate mandate for green certification and ESG reporting. This enhanced smart infrastructure will not increase the CapEx of the project, and a number of the LEED points would be gained through efficiency or by providing provision.

Establish a new mindset for all stakeholders

Similar to smartphones and smart vehicles, the digitalization of facility infrastructures has become democratized and needs to be included for today and tomorrow. Owners and operators are now setting their requirements based on available digital capabilities.

For those owners and operators that still do not appreciate the value of a digital infrastructure, design, construction, inspection, and insurance firms – and technology providers – need to help 'normalize' smart building technology for clients. They need to realize that connected technology gives them more resources, improves tenant satisfaction, and reduces OpEx.

Codes only address past requirements, whereas FM teams need digital solutions to meet today's outcomes while having the flexibility to adapt to tomorrow's requirements. Consider the analogy of cybersecurity: a cybersecurity solution must address today's threats but be adaptable to future threats.

The executive team of each stakeholder discussed in this paper needs to help transform their business model to evolve with new outcomes needed. They need to be more open to collaboration and help break down silos in the industry. This is critical to supporting their businesses to survive and thrive.

Conclusion

New FM outcomes need digital solutions.

Designing digital infrastructures into facilities will help facility owners and FM teams reduce energy and maintenance costs, improve occupant experience, and reduce risks during the entire operational life of the building. The right data from the right places, presented in simple and customized formats, will give FM personnel the answers they need to take efficient action.

Smart technologies need to be embraced.

In the early days of smart building technology, technology was adopted for its "cool factor" instead of applying technology to a real business outcome. It was also common for misunderstandings throughout the entire design-construction value chain regarding the benefits and risks of integrating smart technologies and a lack of appreciation for the actual value of that asset in terms of its ability to enhance the bottom line. In fact, there is still often a fear factor associated with new technology, with its perceived difficulty causing some stakeholders to avoid embracing it.

The design-build process needs to change.

The processes and organization of the design-build industry today need to change to support new FM outcomes with digital infrastructures. This requires a fundamental shift in mindset in which all facility stakeholders collaborate more closely and earlier. Stakeholders need to understand FM outcomes and use cases. This will inform more detailed and stress-tested digital designs that, in turn, enable purposeful value engineering. This new workflow will result in cost- and time-optimized smart buildings, with reduced risks that deliver the required FM outcomes. And for the building owner and operator, having digital solutions integrated at the CapEx stage is far more cost-effective and less disruptive than retrofitting those capabilities afterward.

Collaboration will benefit all stakeholders.

Moving from the traditional siloed model to a collaborative one – in which all parties make equally important contributions – will also enable shared benefits. A more detailed, optimized design allows projects to be delivered on time and budget. A better building is delivered for a good price that meets the needs of investors, owners, and tenants. The new building will become a showcase, with owners and operators spreading the word that they worked with forward-looking partners on this project. This will generate free word-of-mouth promotion and a growing list of smart building project opportunities.

Adapt and succeed.

Ultimately, we believe that all professionals supporting the design-build process will be forced to adapt to this more collaborative model as smart buildings become the norm, not the exception. Innovative companies that begin this transition soon will succeed and grow. Those that do not may risk becoming irrelevant.

Resources

Report: "FM 2.0: Re-imagining Facility Management for the Digital Age," Arup

Video: EcoStruxure for Healthcare: The Pavilion at Penn Medicine, September 2019

"Brown University: Integration between Building Automation System and Planon streamlines and automates work order processes.," Planon

Schneider Electric – Customer Success Stories

White Paper: Designing electrical systems for future-proof, energy-efficient green buildings

White Paper: The next normal in construction, McKinsey & Company, June 2020

Technical Guide: Schneider Electric, EcoStruxure Power Digital Applications

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David Kidd joined Schneider Electric in January 2006. He has been working with digital IoT technologies for electrical distribution systems for over 20 years, and he is focused on driving the adoption of these technologies in the market. His goal is to help facility management teams improve their ability to safely and efficiently operate, maintain, and optimize the electrical distribution system with the goal of increasing availability, reducing operational risk, and supporting sustainability initiatives.

Stacy Van Dolah-Evans joined Schneider Electric in October 2013. He is responsible for developing a new GSA driving growth in business through learning and development of technologies available to the industry. He has an engineering background with a specialty in OT/IT convergence and how it impacts M&E design and construction of digitally ready smart buildings.

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