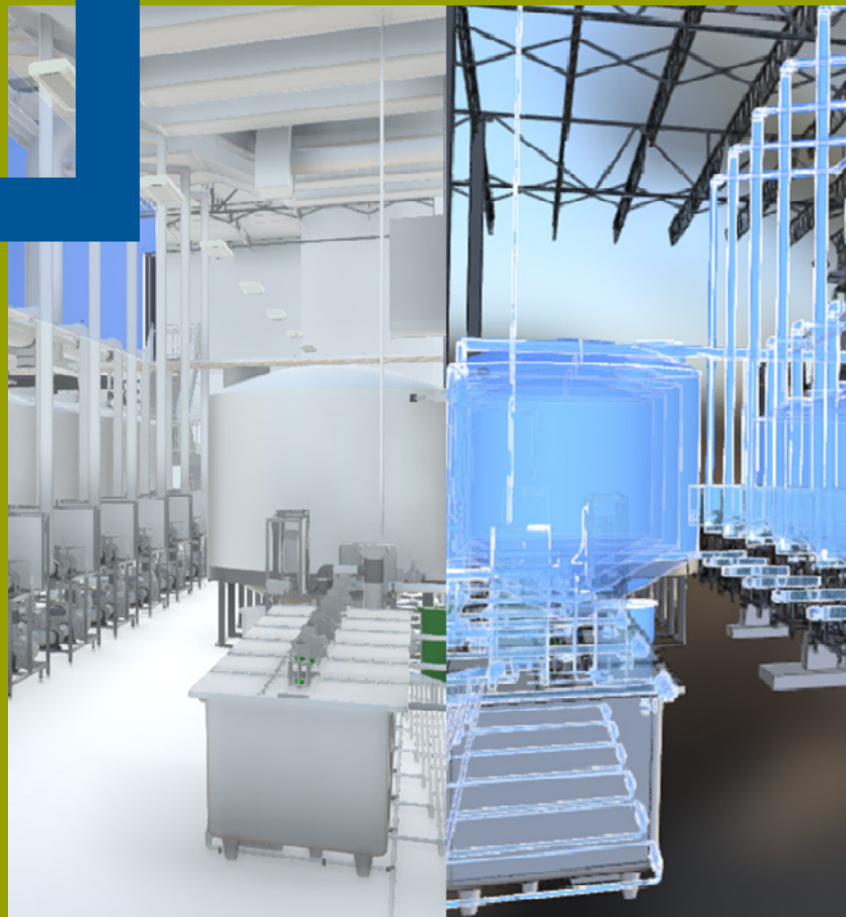


Digital twins offer real-time modelling for data centres

DIGITAL REPORT 2023



DIGITAL TWINS OFFER REAL-TIME MODELLING FOR DATA CENTRES

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Black & Veatch provides insights on digital twin technology and its impact on data centre development, including design, construction, and sustainability

Digital twin technology has gone from a futuristic ideal to a present-day reality for data centre developers and operators. This highly specialised virtual modelling can impact the entire data centre lifecycle, beginning with site due diligence and moving into design and construction, as well as measuring sustainability objectives and creating tools for operational excellence.

Black & Veatch is using its internal resources to develop real-time modelling for global clients. Digital twin technology eliminates geographical barriers in initial site due diligence and design phases. The entire team can virtually walk the “completed” project without leaving their desks. This provides great convenience, but the real value is evolving.

Digital twins are not simply simulation tools because they also provide a previously inaccessible depth and breadth of exploration of data. It allows clients to review a project in a virtual world before implementing it and allows developers to sell the project to stakeholders earlier.

The digital twin can also support operations of the data centre, where monitoring and other tasks are done remotely and the ops officer can review issues from any location to make decisions that have a significant impact on the enterprise.

This report features industry insights from key personnel at Black & Veatch who are invested in its activities and translate the company’s achievements into professional services for its core industries.

DUE DILIGENCE INSIGHTS BEFORE A SHOVEL GOES INTO THE GROUND

Digital twin modelling allows clients to design a site even before the land or building is purchased, says Black & Veatch's Shilpa Maganti and Greg Zalewski

Black & Veatch perform site due diligence for data centres and mission-critical facilities, collaborating with clients to assess greenfield and brownfield sites using the company's expertise in the power, water, telecom/fibre, environmental and data centre industries.

The company has the capability, scalability, and global resources to help clients select sites that will meet future capacity and sustainability requirements. This expedites challenging schedules and gives clients a competitive advantage by leveraging Black & Veatch's vast global internal resource pool, preferred sub-

“Clients know how large a data centre they're looking to build, so our team works with them to build a virtual master plan”

SHILPA A. MAGANTI, P.E.
PROJECT MANAGER,
BLACK & VEATCH

consultants and long-term relationships with utility providers in major markets worldwide.

“We might have a client who has a piece of land and asks us, ‘Can we build a data centre here?’” explains Shilpa Maganti, Black

& Veatch's Data Centres Project Manager. “At that point, we would look at the site, look at the topography, even the soil conditions. We have to be able to answer the question of whether we can even build at that location.”

“We also need to calculate the civil and structural side issues related to a project – do we need to blast the site? How is the grading going to work?”

Black & Veatch also considers power and utilities during a site due diligence project, including an overview of potential cooling systems and water supplies.

“Then we move on to other investigations, including the environmental side and master planning. We investigate any environmental impacts. Most of the clients we work with know how large a data centre they're looking to build on that piece of land, so our team works with them to build a master plan.”

SHILPA A. MAGANTI, P.E.



TITLE: PROJECT MANAGER

INDUSTRY: ENGINEERING

LOCATION: UNITED STATES

» Shilpa Maganti is a Project Manager for Black & Veatch with more than 13 years of experience with a wide variety of auxiliary power system designs and arc flash hazard analyses associated with data centres, power plants and mission-critical industrial facilities.

Shilpa's experience includes design and specification of auxiliary electrical distribution equipment for new and retrofit data centre projects. She is experienced in performing power system studies, including load flow, short-circuit and arc flash hazard analysis engineering activities using SKM (Power Tools for Windows) or Electrical Transient and Analysis Program (ETAP) - PowerStation by OTI. She has developed procurement and design-build/ Engineering, Procurement and Construction.

EXECUTIVE BIO



“You can visualise what that project will look like before you ever put a shovel in the ground”

GREG ZALEWSKI
PRECONSTRUCTION MANAGER,
BLACK & VEATCH

GREG ZALEWSKI



TITLE: PRECONSTRUCTION MANAGER

INDUSTRY: ENGINEERING

LOCATION: UNITED STATES

Greg Zalewski is a Preconstruction Manager at Black & Veatch and has more than 14 years of experience providing project estimating services for data centers and mission critical facilities, including modular systems. He is responsible for the development of project cost models for opportunities ranging from Design Requirements Reports to At-Risk cost estimates for engineer-procure-construct (EPC) opportunities. He considers cost factors such as site investigations, the local labor market, availability of materials, quantities from design drawings, and quotations from suppliers. He also develops cost opinions for reports and feasibility studies and maintains procedures for quality control of cost opinions.

Digital twin tech gives real-time understanding of critical issues

Some developer clients may already have their own facilities, which requires Black & Veatch to carry out a facility assessment.

“Evaluating an existing facility requires more extensive detail. Do we need to make any structural improvements? Are there any permitting or zoning requirements that change the land use, or the use of this building? What are those implications?”

Greg Zalewski, Preconstruction Manager at Black & Veatch, says digital twin technology gives the client a real-time understanding of a broad range of critical issues.

“And it means you're not waiting for architects and engineers to come back and redraft; you can make a lot of those changes on the fly using that digital model of a digital twin,” says Zalewski. “It doesn't have to be a fully developed model – you can do some very rough block models and get an idea of how it will all work. From there you can visualise what that project will look like and what your facility will be, before you ever put a shovel in the ground.”



REGIONAL FOCUS: DATA CENTRES IN INDIA FACE UNIQUE CHALLENGES

India aims to secure much of the regional investment being made in Asia, which is expected to account for half of the global data centre market by 2025. The country reclassified data centres as “infrastructure” in April 2022, and this change in legislation is expected to attract investment from developers having access to capital at lower credit rates as a result.

With huge potential for demand growth, international data centre providers are

ramping up to secure market share. In recent years, many have acquired local players or entered into joint-venture arrangements.

Developers looking to fast-track construction face challenges including access to local teams at wage rates that retain reliable and high-quality outcomes, while also designing facilities that are sustainable within the Indian market, particularly with the country facing increased climate change impact.



Greg Zalewski

**“Our clients
are feeling
accountable for
sustainability and
making sure they
have sustainable
options in
their designs”**

ANGIE NYGREN
ARCHITECT &
EXECUTION MANAGER,
BLACK & VEATCH

SUSTAINABILITY IS CRUCIAL FOR THE FUTURE OF DATA CENTRES

Global business and society demand data centres – and sustainable designs are the future, says Black & Veatch’s Angie Nygren, Amol Samant and Drew Derrick

Black & Veatch is committed to continuous improvement for clients and communities, so sustainability is ingrained into the company’s strategy. Mitigating and adapting to climate change, decarbonising supply chains, and creating a more diverse and inclusive workforce are just some of the challenges the company is committed to addressing head-on.

Together with its clients, partners and employees, Black & Veatch’s work designing and building tomorrow’s infrastructure plays a powerful role in improving sustainable outcomes.

“Our clients are feeling accountable for sustainability and making sure they have sustainable options in their designs,” says Black & Veatch Architect Angie Nygren. “The need for data centres is not going away, so how can they not feel accountable?”

Black & Veatch Project Manager Amol Samant has also seen a significant increase in the number of conversations around sustainability in his work with clients. Some of the most important factors to consider

ANGIE NYGREN, NCARB,
AIA, LEED AP BD+C



TITLE: ARCHITECT & EXECUTION MANAGER

INDUSTRY: ENGINEERING

LOCATION: UNITED STATES

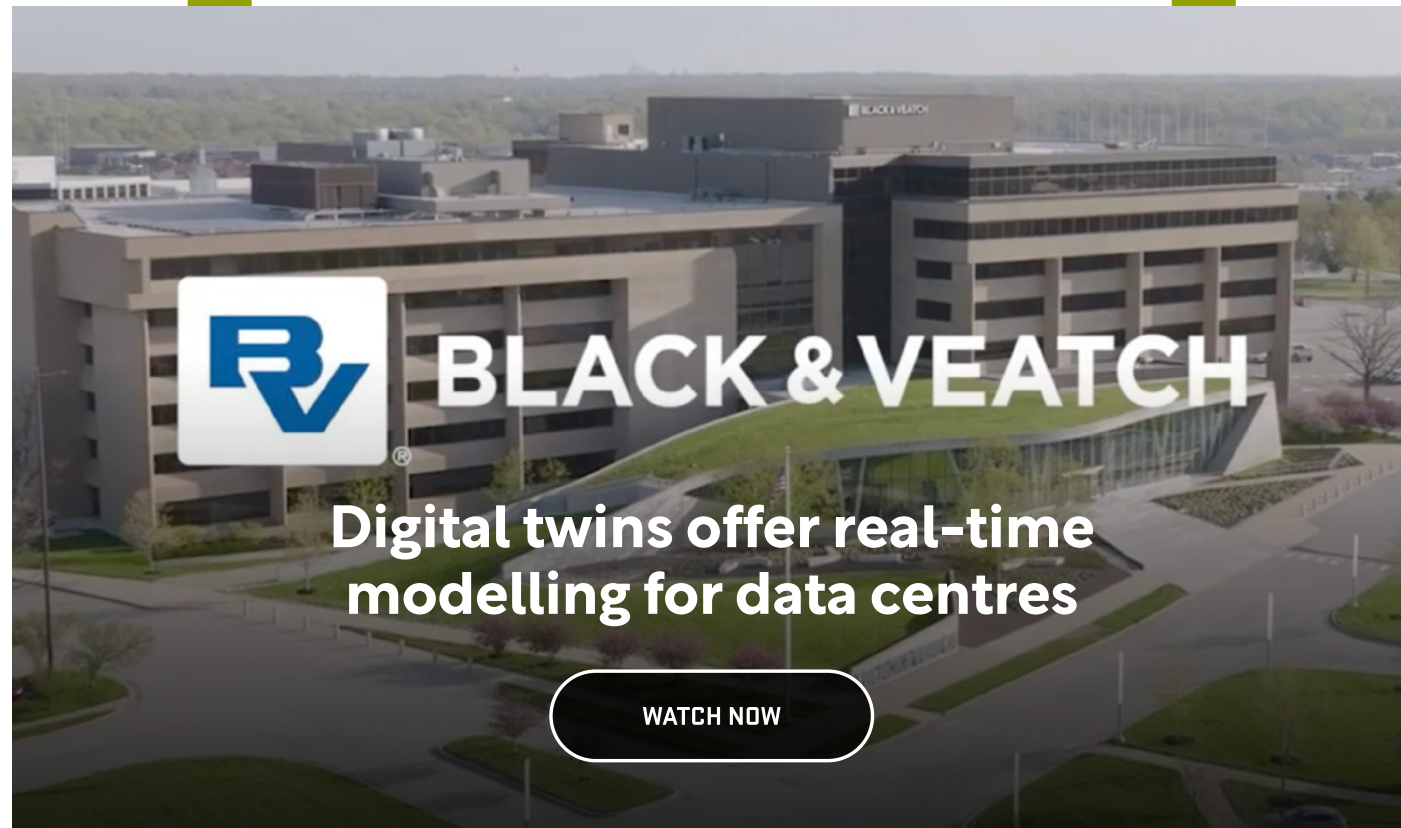


Angie Nygren is a licensed architect and Execution Manager for Black & Veatch with more than 13 years of experience in design of complex building types. Her expertise extends to several market sectors, including athletic training facilities, football stadiums, mixed-use developments, and data centres.

Angie is responsible for the cross-discipline coordination of the complex building systems within mission-critical facilities. She leads the design team through design and documentation and is responsible for coordinating across disciplines to uphold the client’s standards, design intent, and project schedule.

EXECUTIVE BIO





are water, heating and cooling, and noise pollution, all of which can present challenges for sustainability-minded clients regarding where a data centre can be placed.

“The city centre is where the infrastructures for utilities, like power, are available,” says Samant. “At the same time, there is a scarcity of water, and we cannot use the huge amount of water required for data centre cooling at the same location.”

**A technical “balancing act”
to save energy, power and water**

This can mean Black & Veatch has to work with the client to perform “a balancing act” to save energy, power and water while still ensuring data centre facilities are optimised.

“We’ve had a client come to us recently and tell us they want to use air-cooled chillers, which are not necessarily the most efficient cooling option available,” says Black & Veatch Mechanical Engineer Drew Derrick. “But they’ve made the

AMOL SAMANT



TITLE: SENIOR PROJECT MANAGER

INDUSTRY: ENGINEERING

LOCATION: VIKROLI, MUMBAI, INDIA

» Amol Samant is a senior Project Manager with more than 25 years of diverse experience with multiple complex projects like IT parks, shopping malls, health care facilities and data centers. His project activities have included condition assessments, feasibility studies, design and construction administration. Amol has served as Project Director for mission critical data center projects which include complex electro mechanical installations, centralized chilled water systems, hot aisle systems, thermal energy storage.

“The city centre is where the infrastructure for things like power are available, but there is a scarcity of water”

AMOL SAMANT
PROJECT MANAGER,
BLACK & VEATCH



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“After you've built it, it's much more expensive for the client to make changes”

DREW DERRICK
MECHANICAL ENGINEERING MANAGER,
BLACK & VEATCH

decision that they want to use cold chillers so they can save water.

“We have that discussion with the client, bringing their requirements and preferences to the forefront. Then we can design a system around their values for sustainability – and that can be an interesting topic of the conversation if the client hasn’t thought of it before.”

Derrick predicts that, in the next decade, the data centre construction industry will see more liquid cooling options – both direct-to-chip or immersion-type technology – but this will require



DREW DERRICK,
PE, CXA, DCEP, ATD



TITLE: MECHANICAL
ENGINEERING MANAGER

INDUSTRY: ENGINEERING

LOCATION: UNITED STATES

» Drew Derrick is a Mechanical Engineering Manager with more than 20 years of experience with heating ventilating and air conditioning (HVAC) and plumbing systems for mission-critical facilities, including data centres. His project activities include condition assessments, feasibility studies, design, construction administration, value engineering and commissioning.

Drew has engineered and served as certified commissioning agent for mission-critical mechanical systems subject to client reliability criteria, redundancy, and single-point vulnerabilities. He has experience developing mechanical systems for sensitive compartmented information facilities (SCIF) subject to DCID 6/9, and is an Accredited Tier Design (ATD) by Uptime Institute.

EXECUTIVE BIO



clients to make upfront investments in the technology to reap the rewards of its better functionality over time.

Digital twin technology also allows clients to quickly determine how sustainable their new data centre would be using different materials for construction. “From a rough design of the

structural system using different materials, we can pull those quantities and materials from the model and give them a carbon factor,” says Nygren. “Then clients can know whether a concrete structure, a steel structure, or a timber frame might affect the carbon footprint of these different structural systems.”



DIGITAL TWINS MEAN CLIENTS CAN DESIGN TWICE, BUT BUILD ONCE

Data centre virtual models mean contractors can work together with perfect precision, says Black & Veatch's Angie Nygren, Drew Derrick and Greg Zalewski

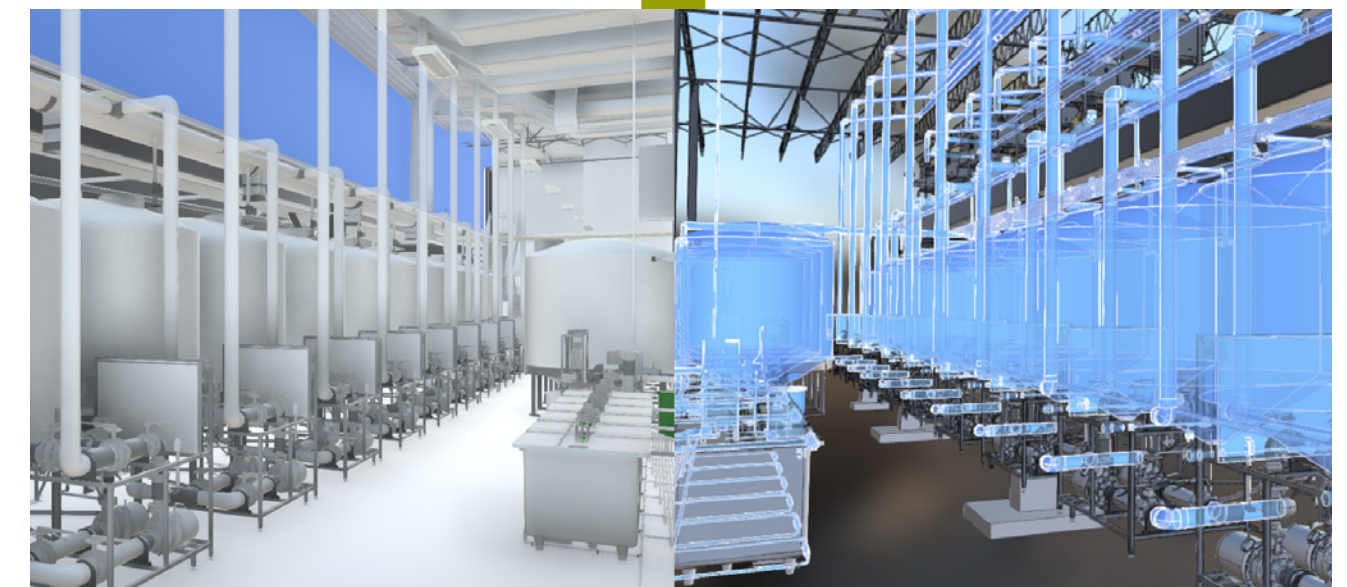
Black & Veatch's integrated design, engineering, and construction approach increases project performance while ensuring cost and schedule certainty for critical infrastructure. As clients' single point of contract responsibility, Black & Veatch works in a collaborative team to maximise return on investment and deliver projects of the highest value possible. The company's design-build teams identify and implement creative solutions through a contractor-led, construction-driven model.

"With the 3D fly-throughs we can offer, the client knows what they're getting, knows

that operationally it's going to function for them," says Black & Veatch Architect Angie Nygren. "So, in a sense, we're really designing twice."

CFD modelling is used to build interior and exterior twins, which allows Black & Veatch to work with clients to fine-tune master plans. "We had a project where the client was using direct evaporative units on the exterior of the building, sucking in large volumes of air," says Black & Veatch Mechanical Engineering Manager Drew Derrick. "Diesel generators for the project were sitting relatively close. We found that when the generators were on, the exhaust fumes came back into the building."

"We ran the model and had to extend the stacks, moving the generators a little farther away, so we could make those modifications before it became a problem in the field," says Derrick. "After you've built it, it's much more expensive for the client to make that kind of change."



REGIONAL FOCUS: NEW GROWTH FOR DATA CENTRES IN ASIA PACIFIC

» The data centre market is set to grow across the Asia Pacific region over the next five years, with many sources projecting a double-digit growth. This demand growth – for data locally and regionally – could see significant capacity development beyond traditional regional centres, such as Singapore and Hong Kong.

Investment flows could shift to locations such as India, Indonesia and the Philippines with low existing capacity alongside promising demographics and projected economic growth.

Countries like Singapore have only recently lifted moratoriums on data centre development, with government

officials citing the intensity of water use and electricity as a key factor behind the previous moratorium. Such circumstances highlight the looming issue facing new development, as our hunger for data competes for energy and water resources.

Well-planned and calibrated growth is required at a national level, while on a project-level, best-in-class technologies and practices for energy and water efficiency must be considered early to ensure long-term viability of projects. This must be considered alongside making sure adequate and reliable utility interconnection infrastructure is in place or developed in parallel.



Digital twins do away with “first-come, first-served” approach

A fully coordinated model provides a clear understanding of where systems should be placed, says Greg Zalewski, Preconstruction Manager at Black & Veatch, which didn’t always happen in a time before digital twin technology. “When people weren’t coordinating their work, they may not know how they’re going to arrange their systems, whether it’s electrical conduits or mechanical piping, or sprinklers.”

Digital twin technology does away with this “first-come, first-served” approach, replacing the need for subsequent

contractors having to make allowances around the first to start work.

Clients in different regions may also have very different requirements – for example, Black & Veatch has carried out studies to explore options to recycle data centre cooling water for irrigation or other purposes.

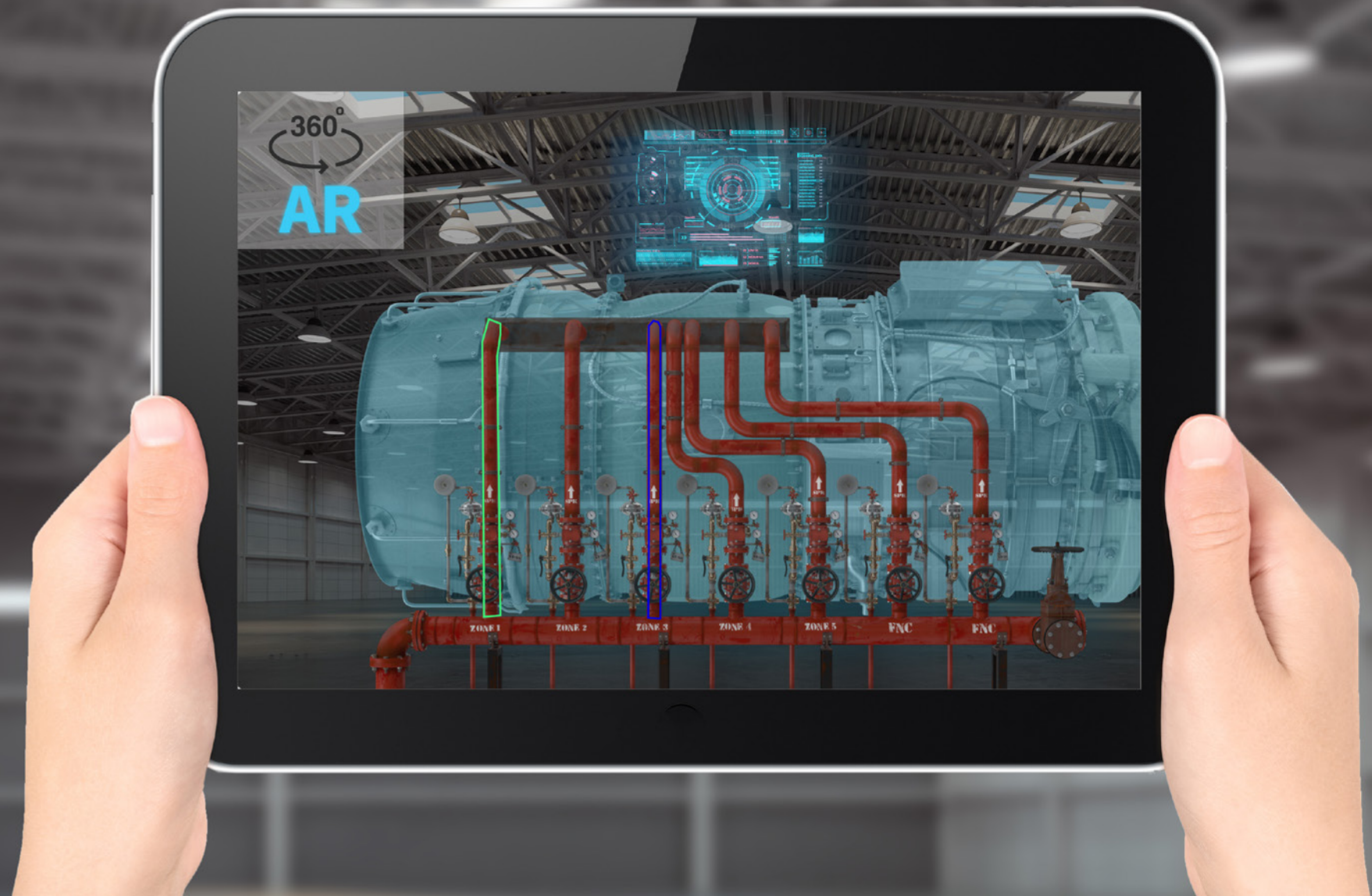
“This is designing twice and building once, because you can coordinate all those systems in the virtual world before you actually get into the field, and then your contractors can build from the model. They know exactly down to the inch where they need to be and how close they should be from one system to the next, and this saves a lot of time in the field.”



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OPERATIONAL INTELLIGENCE BOOSTS RELIABILITY AND EFFICIENCY

Digital twin technology leverages drones and specialist software to give an overview of operations, says Black & Veatch's Julia Guerra and Anthony Taylor

Operational intelligence provides insights that help optimise day-to-day operating and maintenance practices to boost reliability and efficiency. This can include important monitoring and diagnosis services that provide a dashboard for clients to see deeply into their systems

via the cloud. Adaptive planning focuses on the future, using scenario analysis and predictive analytics to better inform asset management, long-term capital expenditures and other planning decisions.

Black & Veatch also prepares clients with well-defined procedures, such as lock out/tag out and confined space instructions, to optimise day-to-day operations and maintenance. Other services include: preparation of facility-specific operations manuals; process control optimisation and troubleshooting; onsite technical support for completion of facility start-up and commissioning; assessments, including facility operations, of staffing

and maintenance; laboratory design and onsite laboratory reviews; and equipment specification development.

"Recently, we've been leaning towards something called DroneDeploy," says Black & Veatch BIM coordinator Julia Guerra. "This is a very exciting piece of software that very easily shows with one click that a client representative in the field doesn't need to be an engineer to be able to use a drone. It's about simplicity, scalability, and how everybody can get their hands on it – from the owner to the surveyor or an engineer, it doesn't matter, everybody can use the same data. We're taking the fear away from drones and simply making it a tool like

JULIA CAROL GUERRA



TITLE: **BIM COORDINATOR**

INDUSTRY: **ENGINEERING**

LOCATION: **UNITED STATES**

» Julia Guerra works in technology construction for Black & Veatch. Her background includes reality capture technology including Drone services, 360 cameras and laser scanning. Julia has extensive experience in BIM technology, including 3D modelling, and model management for field teams. She has previous experience in founding a drone programme that accelerated to 10 pilots in under a year. Her experience in reality capture includes execution and strategy of laser scanning, and 360 capture walks. Julia can help provide a clear picture for communication between all teams, and client to ensure quality, clarity, and consistency.

EXECUTIVE BIO





“We’re making it so people in the field are just as comfortable using a drone as they might be using a hammer”

JULIA GUERRA
BIM COORDINATOR,
BLACK & VEATCH

ANTHONY TAYLOR



TITLE: **BIM COORDINATOR & TECHNOLOGY MANAGER**

INDUSTRY: **ENGINEERING**

LOCATION: **UNITED STATES**

the use of BIM on complex regional and global BIM projects including setup, establishing objectives, providing technical direction and support. Anthony has design capabilities in multiple software applications including Globally Positioning for projects and Global Mapper, AutoTurn for vehicle specific space control, grading and drainage design through Civil 3D and/or OpenRoads (Power Inroads SS4), and mission-critical facilities utilizing BIM 360, Revit, VEO, CADworx, NavisWorks.

» Anthony Taylor is BIM Coordinator & Technology Manager for Black & Veatch. He is responsible for the strategic development and implementation of Black & Veatch’s BIM initiative using BIM related tools and platforms including BIM 360. Anthony specialises in

everything else so that people in the field are just as comfortable using a drone as they might be using a hammer.”

BIM 360 connects workflows, teams, and data for clients and contractor

Black & Veatch’s digital-twin work makes extensive use of BIM 360, part of the Autodesk Construction Cloud designed to connect workflows, teams, and data. This software – along with an extensive line of modules designed to extend and focus functionality – reduces risk, improves

quality, and helps deliver projects on time and on budget by predicting safety hazards, proactively managing quality, automating tasks, and reducing rework so that clients can control costs and stay on schedule.

“With BIM 360, not only are you able to have your team on a single platform, you’re seeing data throughout the project lifecycle from design to construction,” says Anthony Taylor, BIM Coordinator & Technology Manager in Black & Veatch’s Data Center Group.

“You have the ability for your clients to see the same data from any device that has Internet service. That could be a computer or a tablet or a phone – as long as there is Internet access, you can access these files anywhere in the world.

“BIM 360 also has security layers, so if you only want certain roles like project managers or admins to have access to certain folders, it’s really great for management and security,” says Taylor.



“With these new technologies, not only are you able to have your team on a single platform, but you're seeing data throughout the project lifecycle”

ANTHONY TAYLOR
BIM COORDINATOR & TECHNOLOGY
MANAGER, BLACK & VEATCH

3D, 4D AND 5D DIGITAL MODELS SHED NEW LIGHT ON CONSTRUCTION

Traditional paper plans used by construction contractors have been replaced by digital twin technology, says Black & Veatch's Angie Nygren and Greg Zalewski

Black & Veatch has been leading the construction industry since its earliest days of building infrastructure in America's heartlands and worldwide. The company delivers the highest standards of safety, quality and efficiency and adapts its diverse construction solutions to mitigate risk and suit client budgets.

The company's construction experience extends across all industries they serve, benefitting from a holistic view of infrastructure lifecycles. Black & Veatch has experience with multiple contracting approaches as a prime contractor, design-builder, construction manager at-risk (CMAR), major subcontractor, joint venture partner, or consortium member. The company also self-performs construction trades as a direct hire, as a construction manager of multiple subcontractors, or a combination of both.

“I'm seeing a couple of trends in digital twins in construction,” says Black & Veatch Architect Angie Nygren. “The first is much more client interaction. Historically, we used to give 2D plans to the client; they would approve the plans, and we would build it, and then it would be something of a surprise when they saw the end result after construction.”



2D plans and drawings are not enough for clients anymore, says the Black & Veatch team, with clients instead calling for 3D and digital twin models. “They want to see the building in three dimensions before we even stick a shovel in the ground,” says Nygren. “The client is going to be the end user, so they want to know things like how are they going to load the racks? How are they going to access the cable tray? Will they have a clear space for a ladder to get to areas that will be required in the future?”

Modelling catches issues long before they become problems

Black & Veatch goes further than this and ensures clients can assess the smallest details, which can then attract interest from other departments such as marketing and brand management. “Clients can discover how the finishes we've chosen interact with their brand,” says Nygren. “How is the flow of the space from break rooms to offices? Increased client interaction means they're looking for that 3D fly-through.”

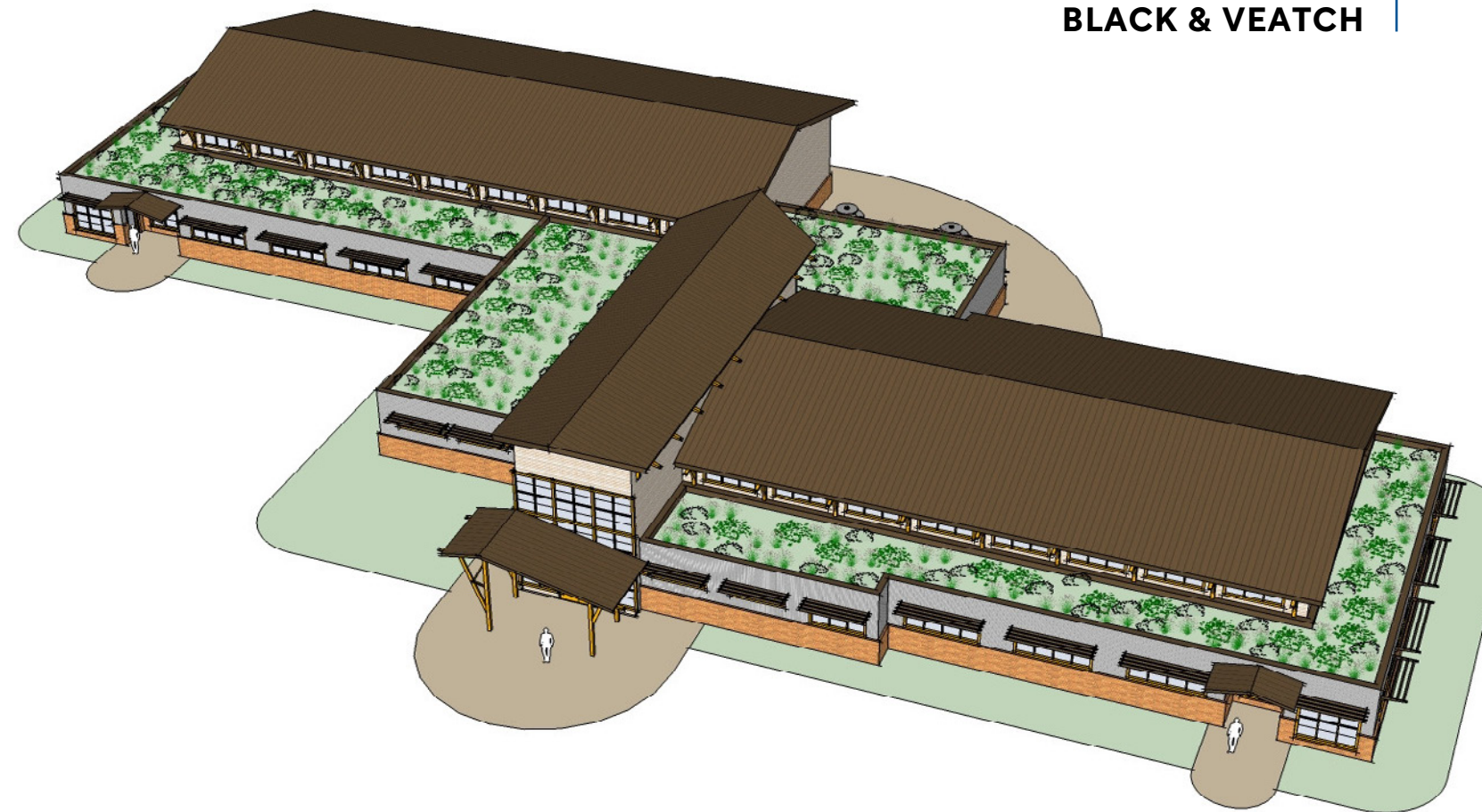
This approach to construction means even the smallest efficiencies can be identified or discovered in the digital twin environment. “We model everything,” says Nygren, “so that we know if there's a picture that's going to clash with a duct from our model long before this is an issue in the field.”

Beyond the third dimension, Black & Veatch is also seeing trends extend into the fourth and fifth dimensions of those digital twin models. These take into account not only what the project or product will look like, but also how it looks over time as well as the costs involved in its operations and maintenance.

“While you're evaluating a project, you can look to custom construction sequencing to see how this project is going to be built, and you can look for

opportunities there to either accelerate or – if you're considering phasing – how you would implement that throughout the project by using that 4D aspect,” says Greg Zalewski, Preconstruction Manager at Black & Veatch

“On top of that, we're starting to see a lot more focus on the fifth dimension, which is adding cost to that,” he says. “While the fourth dimension takes the model through time, the fifth dimension adds cost to that time factor. From an owner's perspective, you can actually get a very reliable picture of what your capital expenses are going to be throughout the course of that project and how you need to finance and fund it.”



As digital twin technology becomes the industry standard, data centre owners and operators will benefit from more reliable, efficient and sustainable facilities. Traditional paper plans used by construction contractors have been replaced by digital twins, which allow clients to design a site even before land or buildings are purchased.

Digital models presented in 3D, 4D and 5D will impact not only site due diligence and design, but also construction, budgeting, modernisation and operations. Modelling catches issues long before they become problems and Black & Veatch goes further to ensure clients can assess the smallest details. This can then attract interest from other departments such as marketing and brand management.

Black & Veatch is ever-evolving and leading the industry in applying these

tools and technologies to leading-edge data centre development. The company has the capability, scalability, and global resources to help clients select sites that will meet future capacity and sustainability requirements.

This expedites challenging schedules and gives clients a competitive advantage by leveraging Black & Veatch's vast global internal resource pool, preferred sub-consultants and long-term relationships with utility providers in major markets worldwide. [▶](#)

References:

- What is a digital twin?
- Mission-critical facilities/data centers



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