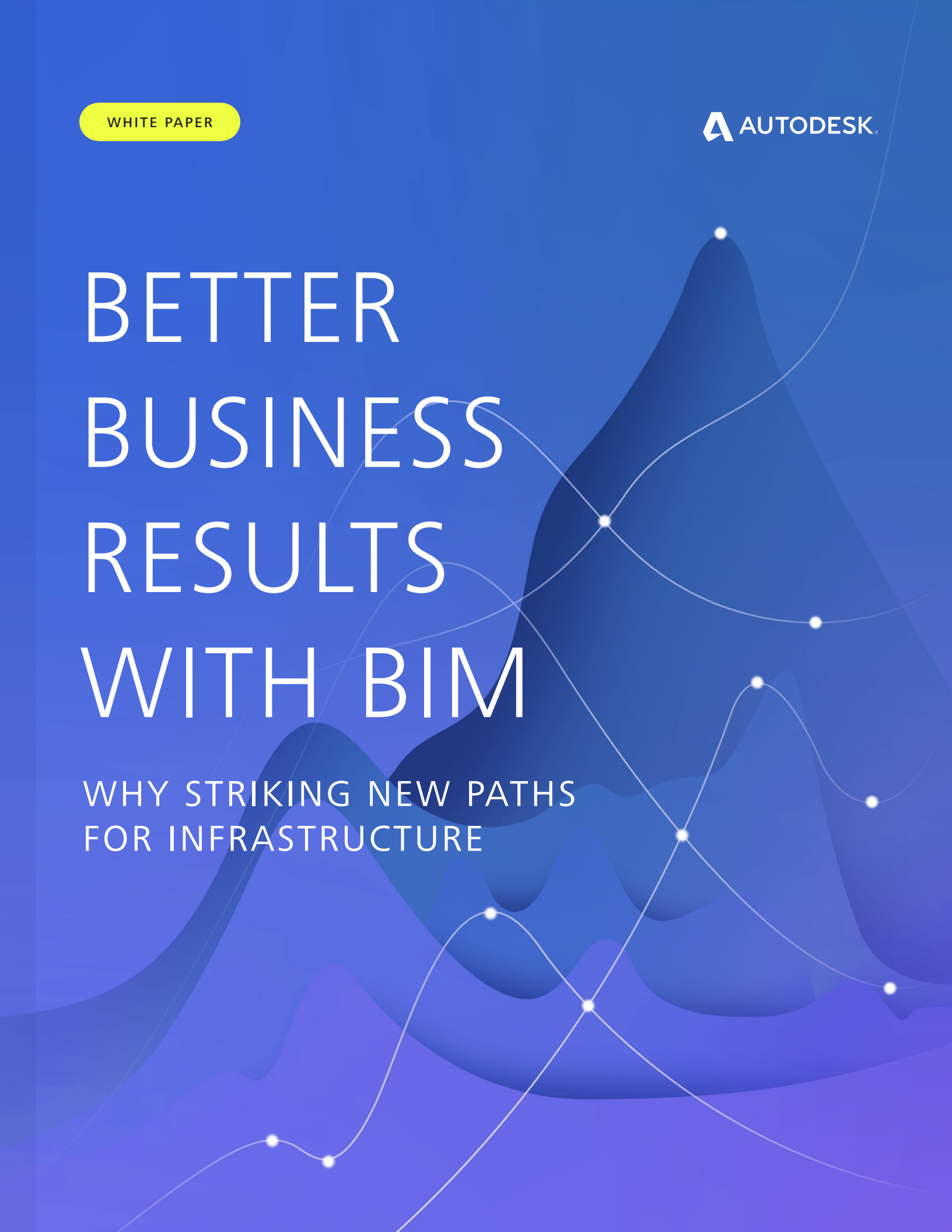
WHITE PAPER

AUTODESK.

BETTER BUSINESS RESULTS WITH BIM

WHY STRIKING NEW PATHS FOR INFRASTRUCTURE



TOPICS

COST AND TIME SAVINGS 5
ENHANCED PROJECT EXECUTION 9
VALUE CREATION BEYOND DESIGN AND CONSTRUCTION 13
ADVANCING BENEFITS 18

1 COST AND TIME SAVINGS

› Visualization as a Byproduct 6
› United Around the Model 7
› Streamlined Information Exchange 8

2 ENHANCED PROJECT EXECUTION

› Improved Safety 10
› Achieving Faster Buy-in 11
› Minimal Conflicts 11
› Reducing Liability 12

3 VALUE CREATION BEYOND DESIGN AND CONSTRUCTION

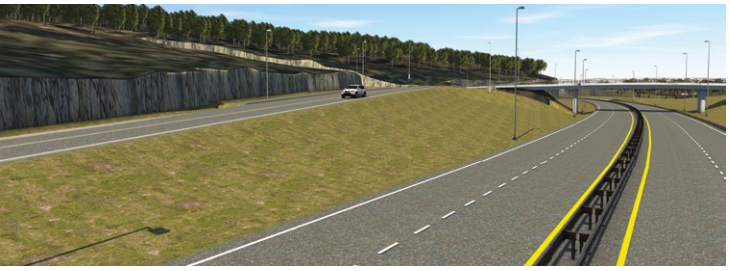
› Virtual Design and Construction 15
› Value Engineering 16
› Eye on the Long Term 17

4 ADVANCING BENEFITS

› Return on Investment 19
› Competitive Advantage 20
› Evangelistic Expansion 20

EXECUTIVE SUMMARY 3
SUMMARY 21
RESOURCES 22

Building Information Modeling (BIM) on civil-infrastructure projects is increasingly being adopted, with enabling technology on the market for nearly a decade and close to 50 percent of new projects using BIM at some level. Civil-infrastructure owners and the consulting firms that work for them are moving cautiously toward adopting this new way of working as are contractors and other stakeholders that also stand to benefit.



EXECUTIVE SUMMARY

BIM for civil infrastructure is being applied broadly across the globe for a variety of projects, with distinct advantages over traditional practice. The level of advantage that this provides often has to do with the ability to streamline workflows by having all players adopting a model-centric workflow. Below is a quick synopsis of the types of projects taking advantage of BIM as well as a short detail of the benefits gained:

ROADS: The model makes it much easier to calculate material quantities and estimate project costs. This happens at the touch of a button even as designs change, making old, time-consuming and inaccurate calculation methods obsolete. The model can be used throughout construction, to the point of driving machines for grading on through the precise application of the road surface. The resulting increase in precision and automation translates to cost savings and improved quality control.

BRIDGES: A model-based design approach allows for seamless testing of bridge design strength and performance with integrated analysis. The model can be extended with the addition of time for construction sequencing, which is helping to advance the growing movement for rapid project delivery and minimal closures for the least amount of traffic and commerce disruption. The number of Design Issue Notices (DIN), which are changes to the design that become necessary due to conflicts or issues identified during construction, are also reduced when BIM is used to model general structures and bridges, resulting in significant cost savings.

WATER AND SEWER NETWORKS: The tools within the model for pipes and pipe placement can apply established design standards that include the characteristics of the pipe (e.g. size, thickness, material, etc.) to make sure they align and that the design will perform to the plan. This automation includes entire pipe-network modeling to monitor and improve performance.

STORMWATER: The ability to model stormwater networks and whole watersheds affords the opportunity to analyze existing conditions as well as try and test different retention and infiltration options for today's trend toward green infrastructure.

> Our clients were really focused on 3D models. They would go to a specialized company for renderings, and they just wanted construction plans from us. Then, when it became easier to present the design in 3D, we developed our own skill and presentations. It's really enhanced our process to present what things look like as we design.
>
> *Scott Reed, PE, associate, Huitt Zollars*

AIRPORTS AND PORTS: Increasingly, these highly managed hubs are turning to BIM for project work as well as enterprise operations and maintenance. The lifecycle-management approach improves on today's reactive facility management, allowing for predictive maintenance.

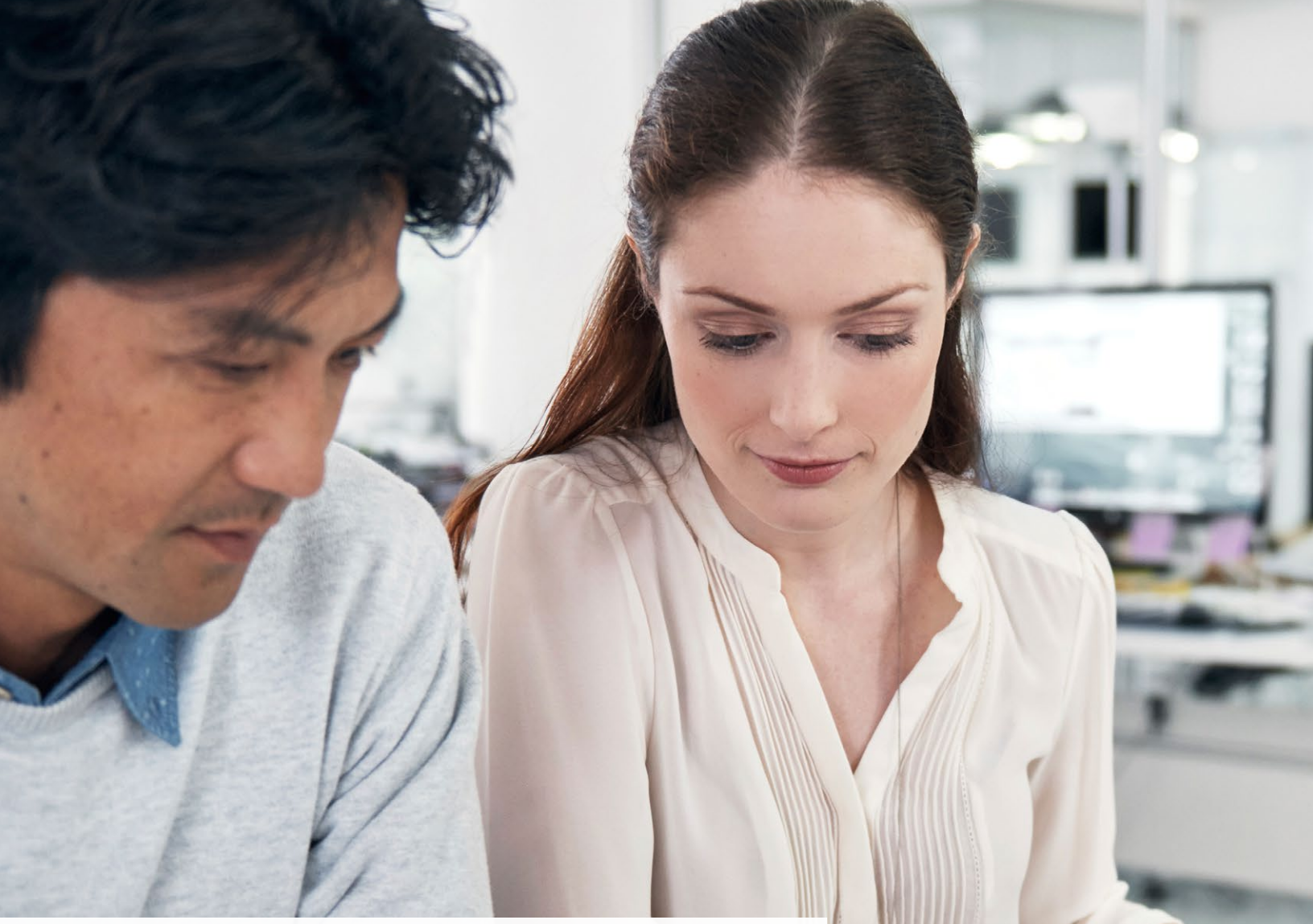
Despite all these documented use cases, and growing momentum, a question still being asked by many is: »should I change, and if so, why?« The reasons to be cautious are many, with trusted approaches that have proven to work well competing against a dramatic shift toward 3D digital models as the basis for all interactions. Although past practice has worked just fine, professionals working on civil-infrastructure projects are speaking out on compelling reasons to adopt BIM for infrastructure.

The move feels dramatic, but it's part of a continuum of advancements on the ability to model the real world, enhance human understanding with Big Data and new analytical tools, and create new designs centered on quantifiable performance improvements. We now have the means to easily capture more-complete existing-conditions information with engineering-grade accuracy, which enables teams to create digital models that can be used to try and test-drive new infrastructure designs before heading to construction. The model allows for analysis and simulation, ensuring that the changes made to existing infrastructure environments are well conceived.

Early adopters have made many inroads, and are advancing and leading the market while concurrently finding business rewards in a variety of areas, justifying their decision. The intelligent 3D model is at the center of the decision to move to BIM, because it's an intuitive means to communicate and interact, and it moves the engineer's work from a commodity to value-added engineering. The model fuels quicker collaboration as well as an all-digital workflow that can bypass the use of paper, saving costs on printing and distribution as well as resources.

The model forms the basis for added interactions that didn't and couldn't occur in previous practices which relied on drawings and plans. Through the intelligence captured in the model, there are opportunities to interrogate the model and extend its utility by adding such dimensions as the staging of construction or costs. These extensions add value and more internal beneficiaries that become advocates for greater adoption.

With the swelling ranks of those who have seen the benefit and now have extensive experience in BIM, the initial resistance is starting to pass. Many of the early adopters are happy to share their insights on why they moved to BIM and are energizing wider adoption through advocacy.



1 COST AND TIME SAVINGS

› Visualization as a Byproduct 6

› United Around the Model 7

› Streamlined Information Exchange 8

The desire to simplify processes and repurpose work performed at different stages of a project is influencing the decision by many to move to BIM, as the results tend to be time and cost savings. For example, presenting a design is seen by many as a separate process, with the visualization just a picture that doesn't tie back to the design. If changes were made to the design, the visualization process often needed to start from scratch.

Modeling removes many of these »dead ends«. Rather than visualization as a separate output, it becomes integrated and a direct extension of the model. Similarly, the model can be explored for engineering analysis within the toolset, rather than the information having to be entered into a separate software package where it becomes disconnected. Rather than going to specialized companies to visualize or perform specialized analysis each time the design changes, and each billing time for their service, it becomes an integral part of the workflow.

VISUALIZATION AS A BYPRODUCT

Project owners have always needed to see and share the context of their planned changes with authorities and stakeholders to get their approval and buy-in on project objectives. Creating renderings and visualizations from project plans and specifications had been a separate service for decades. Specialized visualization software and artistic skills were the means to create these models, but that has changed dramatically with a full 3D modeling workflow that makes such presentations a direct output from the plans.

Rather than a fresh start to interpret and present renderings, highly detailed, accurate 3D visualizations and simulations are part of integrated processes where users move seamlessly between 2D and 3D representations, and can enhance the 3D view with real-world embellishments such as sun shadows, realistic textures and animations.

With today's 3D workflows, the visualization is just another output from an intelligent model. The designer can work in a familiar 2D workflow, and then simply and seamlessly port that information over to a 3D view to visualize ideas in an intuitive and understandable form. Such integration allows for an easy back and forth that facilitates the fine-tuning of the design at the moment input is received.

This ability to share and make changes minimizes confusion and enhances the relationship the designer has with the client, with the ability to offer the view the client wants to see as well as respond to questions or concerns with design alternatives as the customer conceives them.

> If you just show stakeholders a schedule up on the wall, they're not going to stand up and say they don't know what that means. They are going to walk out of the meeting, and then when you go to close a road or shut off power and water, they complain that they didn't know about it. If you can visually show them what's going to happen, they get it much more easily, and they engage.
>
> *Mark Hughes, BIM program manager, AECOM USA Aviation*

UNITED AROUND THE MODEL

Large infrastructure projects with complex contracts involving multiple players with overlapping timelines also influence the decision to move to BIM, which provides the means to more-effectively keep all players on the same page. Rallying around the model rather than individual tools or proprietary processes ensures that a large team can cut through issues of individual preferences – or differing corporate cultures – and stay focused on the project.

Access to the model, and all players being synced on what's current, form the basis for improved communication. Each project stakeholder can see what they're responsible for, and external stakeholders are given the means for more-intuitive understanding of how different phases will impact them.

In the past, confusion with teams would arise when each member might be looking at different eras of revisions. Precious time is taken to discover who holds the latest version, and for each person who had a prior version to see what changed against what they hold in their hands. With a shared, synced model, each stakeholder should be holding the same point of truth, eliminating these awkward and sometimes infuriating moments of confusion or worse: constructing conflicting designs that often must be torn out and replaced.

The model-based design provides the means to explore design alternatives and to simulate traffic flow for a design that is optimized for performance.

> We would spend $1,200 on an iPad and some apps, and it was saving us $2,500 because we no longer had to publish the set of hardcopies and documents other than the official set that goes to the city. The savings on paper was huge.
>
> *Mark Hughes, BIM program manager, AECOM USA Aviation*

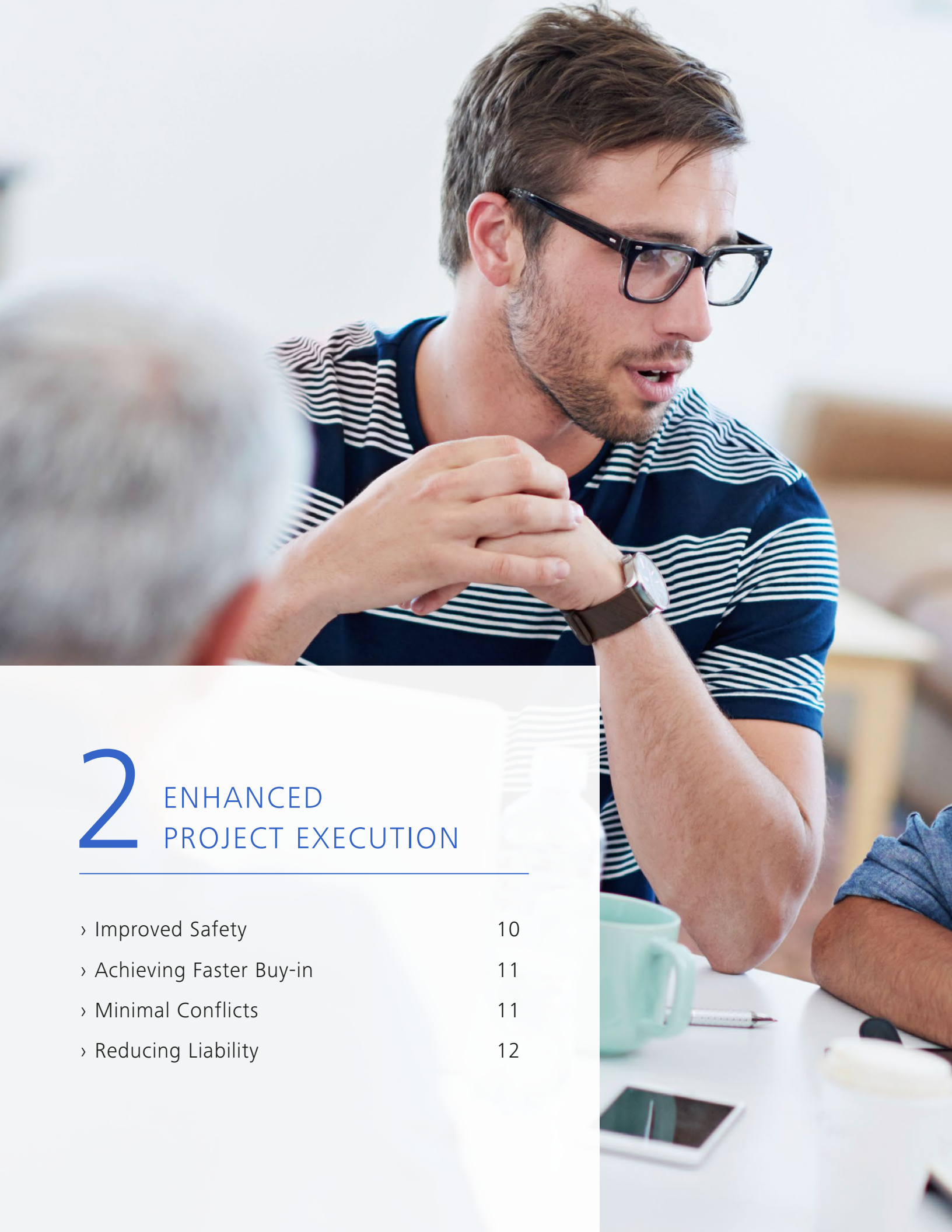
STREAMLINED INFORMATION EXCHANGE

For infrastructure owners and private engineering service providers, the desire to move to an all-digital workflow is accelerating the drive to BIM. An all-digital workflow now is possible thanks to advances in modeling and cloud-based computing, a proliferation of high-bandwidth wireless networks, and a variety of high-performance handheld computing choices. Computing now is everywhere, with modern phones or tablets providing the ability to access the model alongside additional supporting details such as installation instructions.

Having information at your fingertips certainly beats the need to hike to a trailer and find the correct set of plans. With the upcoming explosion of connected devices, a new communication pattern is developing with an »Internet of Things« [IoT] spreading into the civil-infrastructure industry. Instead of spending time and energy to locate hardcopy plans, handhelds provide a means to access information directly and call up details in the context of work that needs to be done. If a question arises, these same handhelds provide a means to communicate a question with pictures or video calls while onsite to greatly increase stakeholder understanding and speed resolution.

The reality of ongoing revisions during construction work, coupled with today's easy means to send files via e-mail, has meant an explosion in shared plans. These plans pile up and are difficult to track if they're static files. With a shared model, the files get absorbed, and the model cuts out the clutter.

Eliminating the cost of printing and distributing paper copies can provide considerable cost savings that easily justify the investment in tablets and software.



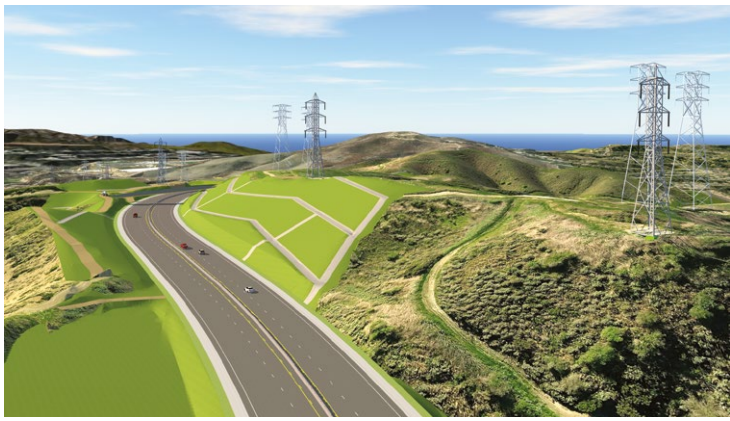
2 ENHANCED PROJECT EXECUTION

› Improved Safety 10

› Achieving Faster Buy-in 11

› Minimal Conflicts 11

› Reducing Liability 12



This complex roadway project in California runs through an operating landfill. With the detailed model, Huitt Zollars was able to do value engineering for the client, trying various options to match program objectives and budget.

Beyond cost and time savings, one of the main benefits driving BIM adoption is the ability to use a shared model to improve project execution on many levels. The value of such information access and sharing extends to the overall project goals as well as across the project's different contracted entities.

The model can be used to improve operations of different stakeholders, as the intelligence can be extracted to drive daily work and ensure that everyone stays informed about what's upcoming. Each discipline can take the model and add their own details. These enhancements allow them to sequence their individual tasks and share details with workers to delegate and monitor the efficient execution of work.

IMPROVED SAFETY

The added benefits of a collaborative model, delivered down to the individual worker, are significant in many areas, but one of the most important is improved safety. The construction industry has improved its safety record with ongoing advancements, but it continues to suffer from high rates of injuries and fatalities. Although the work can be inherently dangerous, the causes can be addressed.

Some of the primary reasons for added risk include poor planning and supervision, insufficient communication among workers and supervisors, and lack of safety training. Each has been proven to be addressable with a model-based approach and devices that inform each worker, track their whereabouts, and provide a means to deliver training as well as communicate and alert individuals about safety concerns. Sharing visualizations rather than written communication cuts through language barriers or issues of illiteracy to ensure each worker understands the risks and areas to exercise greatest caution.

The model provides the means to execute safety plans linked to project tasks, identifying areas of risk and putting in place the necessary safety elements where and when they're needed. The model also can be analyzed for areas that pose safety hazards by comparing incidents on similar sites, making sure we're learning from the past.

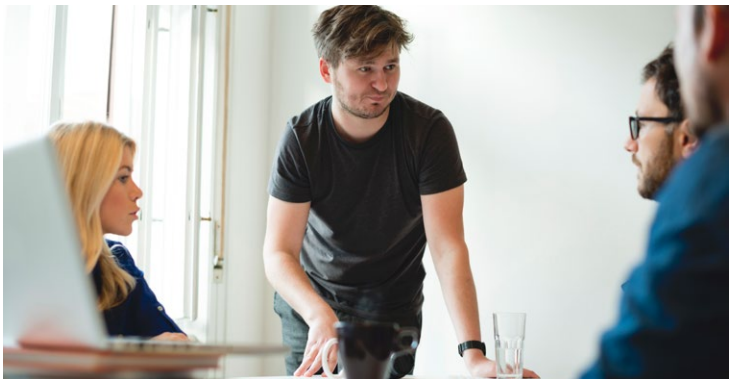
> We recently completed a return-on-investment investigation on a complex project that used traditional 2D plans. We have cut back 25–50 percent on change orders using BIM.
>
> *Lance Parve, senior project engineer/hydrogeologist, Wisconsin DOT*

ACHIEVING FASTER BUY-IN

With one model as the point of truth across a project, considerable time is saved not having to recreate data at different project phases. Often after the tender phase, a different team may be awarded the contract to design and construct the project, and then another team wins the operations and maintenance contract. With a model-based approach, the model and data can move across the phases without the need to recreate, saving time and money as well as adding intelligence to the model through all phases.

With increasing intelligence and realism, the model provides an important means to communicate plans and gain approvals. The ability to show the model, depicting what exists now vs. planned changes, achieves faster buy-in from decision makers who control the budget.

> We do conceptual modeling to show senior management how it will look and feel, and we're getting a lot more approvals while we're presenting than we used to in the past when we just brought plans.
>
> *Mark Hughes, BIM program manager, AECOM USA Aviation*

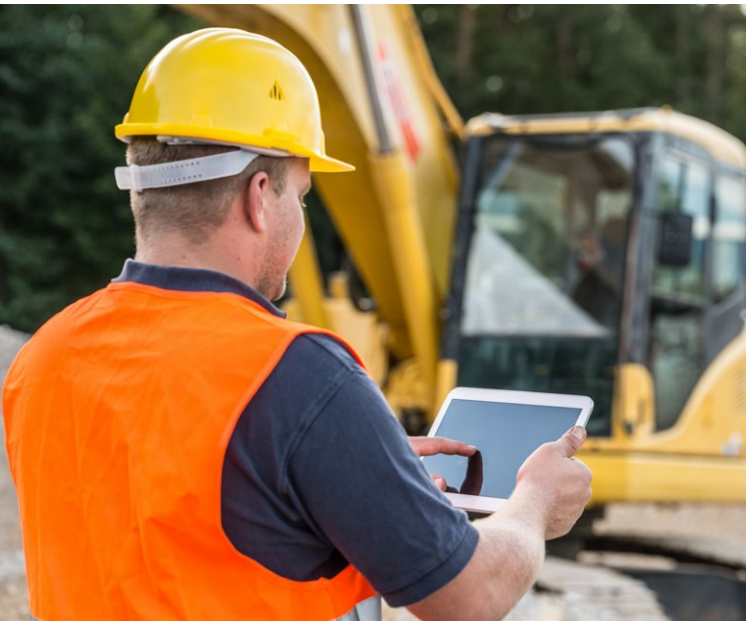


MINIMAL CONFLICTS

By modeling above and below ground in 3D, BIM provides the means to identify conflicts, such as water pipes that clash with electrical utilities; issues with signals, lighting signage and drainage components that can't all occupy the same exact location; or structure-size limitations. By modeling and staging the work prior to construction, infrastructure owners and engineering service providers can eliminate these conflicts and better plan the sequences in logical order for tight areas where many elements need to occupy a small space, including coordinating teams from different companies.

The process of clash detection is an automated output from the model that rapidly locates problems that would cause a work stoppage and costly change order to repair if they happen during the construction phase. BIM converts often talk about the one clash they found that paid for the entire effort to transition to BIM.

> The beauty of BIM is that we can get rid of the walls between design, engineering and construction. We have to get the governments to understand and contracts to include shared risk all through the project. We're trying to educate people, because that's where we're going to really unlock the value of BIM.
>
> *Neil Evans, director, Strategy and Business Development, SMEC (Australia)*

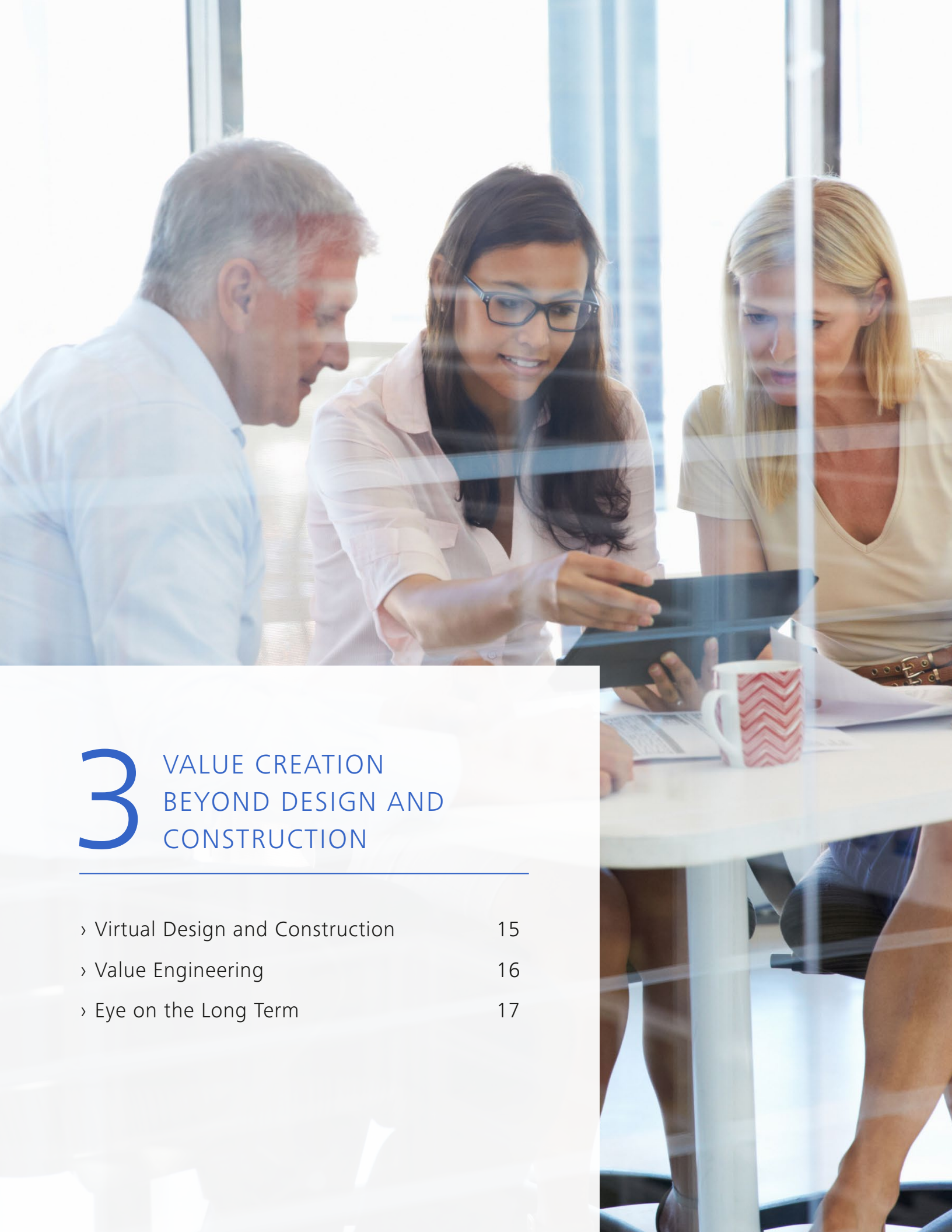


REDUCING LIABILITY

Sharing the model and design process with contractors and subcontractors early on also shares the responsibility and rewards of more-streamlined design processes. With this added input into design, specialists improve the model and design with their expertise. They also benefit from the added time to optimize the design for greatest efficiency, saving costs on materials and labor thanks to the ability for detailed pre-planning.

Although contractors and subcontractors are more involved in design, they don't hold liability. Instead, design transparency allows for close review and discovery of issues before work is undertaken, with liability resting with the lead contractor or architect. This process is in contrast to prior workflows, where detailing would solely reside in the contractor's hands, and work details wouldn't come out until after construction with the sharing of as-builts.

A shared model ensures a new level of communication and collaboration that's very different from prior arrangements, and new contractual models of shared risk are taking hold to take advantage of benefits and streamline workflows. There are contractual mechanisms that need to be worked out to fully solidify the shared risk and determine liability, but the hope is that with a more-transparent and collaborative process there will be far less need for litigation.

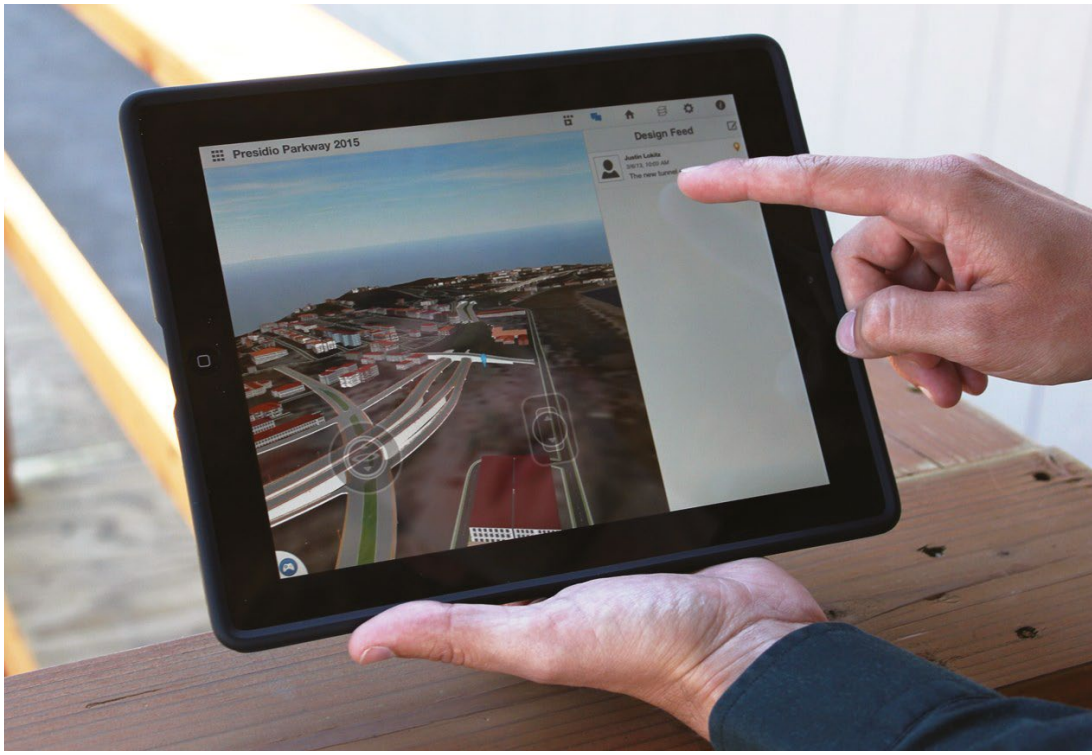


3 VALUE CREATION BEYOND DESIGN AND CONSTRUCTION

› Virtual Design and Construction 15

› Value Engineering 16

› Eye on the Long Term 17



The mobility of the models allow multiple users and stakeholders to navigate and manipulate the model for better understanding and improved communication.

With a model-based approach, there are several improvements to previous design and engineering processes that add value to the information engineers create as well as additional business opportunities. Some of these benefits are intrinsic with the replacement of 2D plans and drawings with 3D (and added dimension) models, and center around a streamlined all-digital workflow, beyond construction and into operations.

Modeling dimensions have quickly progressed beyond simply three dimensions to include elements of construction scheduling (4D), cost (5D), sustainability (6D) and operations (7D). These added dimensions use the 3D model as the base, relying on its accuracy and completeness to extend the model with added predictive analytics to simulate all project phases.

The results achieved by early adopters are clearly showing that their decision to move to BIM was correct. Process benefits previously only dreamed of now are becoming routine. Although many benefits were anticipated and expected, some were a surprise. The following are additional benefits made possible by BIM.

> We are getting traction doing laser surveying with the use of drones and vehicle-mounted sensors. At the tender stages, we are excited about the amount of information that we can obtain much more easily and quickly than before. It immediately takes out an enormous amount of risk, because we have so much more information.
>
> *Neil Evans, director, Strategy and Business Development, SMEC (Australia)*

VIRTUAL DESIGN AND CONSTRUCTION

With the ease and quality of modern data capture, and the high accuracy of the model that results from such data, we're able to get a very detailed understanding of the existing project site before any conceptual work takes place, which minimizes risk for the design team.

Improved reality-capture capabilities are critical to BIM success from project start. The rich and intelligent 3D data can be captured and ready within hours instead of weeks. This fits in nicely with accelerated project timelines. Where historically it had been difficult to gather any information for tight tender timelines on projects, laser scanning affords a low-cost and high-resolution capture of the project site that informs better design and engineering.

Extracting survey data into a detailed model, the design is performed on a true representation of what exists, and the model's high accuracy ensures that what's designed digitally fits back easily into built environments.

Adding the fourth dimension (4D) of time offers the ability to plan out project phasing and sequencing of construction. With the model as a place to test staging, you can input details about the equipment used to erect the structure, giving all stakeholders an understanding of the choreography needed to fit all the pieces together along a timeline where access is assured and everything progresses more easily by anticipating and visualizing bottlenecks well in advance of crews working and machines running.

Analysis of stormwater helps to accurately model infiltration of rainwater to plan green infrastructure for optimal retention and infiltration.

> We enhance the model by putting shadowing and photorealistic textures and then add projected real traffic. The model can be helpful and more useful in stakeholder meetings where the public can see what it will be like right away as well as 20 years ahead.
>
> *Lance Parve, senior project engineer/hydrogeologist, Wisconsin DOT*

VALUE ENGINEERING

The fifth dimension (5D) adds costs to the model and introduces the concept of value engineering to built infrastructure. This term comes from the manufacturing world, where the value of goods is carefully weighed along with function, materials and manufacturing costs. With cost factored fairly early, the bids to build projects have a better chance of delivering the program on budget, and with desired functions and aesthetic value.

Government agencies and engineering firms are moving to BIM so they can understand costs at the conceptual stage, allowing designers to factor in the cost of different scenarios from the start, rather than cutting costs and functionality later due to budgetary issues. Such cost cutting is found in construction, materials and operation. Looking across all three areas can result in significant savings, and having the model ensures that design intent is maintained.

As the design develops and planning of construction phasing begins, understanding costs helps prioritize the best approach. There are always competing interests on any new project, and conflicts with existing infrastructure, so knowing the costs of these tradeoffs can help find amenable solutions.

Everyone understands that cost is the most-important driver, and they're more willing to comply when they see each option was weighed when design challenges surface.

> Instead of hearing someone say our sewer doesn't move, our road doesn't move, our drainage doesn't move, we actually have the ability to come up with a decision on what to move based on what is most efficient and the best value.
>
> *Chris Steer, BIM manager, SMEC (Australia)*

EYE ON THE LONG TERM

With embedded intelligence combined with pervasive analytics only possible with a BIM workflow, the seventh dimension (7D) now becomes reality for owners and operators, and this utopia is driving BIM standards and mandates. 7D centers on ongoing maintenance with a lifecycle-management approach that looks at the needed steps to maintain performance, while avoiding huge spikes in operational costs. This idea of holistic lifecycle management is helped by the release of ISO 5500, the global standard for Infrastructure Asset Maintenance and Management, now being adopted by many agencies.

The continued explosion of connected devices and the rise of smart systems within the transportation realm help inform conditions on an ongoing basis. Transportation, whether an airport, railroad or highway, stands to benefit from this ongoing and constant condition assessment given that they all need to be up and running at all times.

Previously, asset information wasn't easy to extract from plans and specs. The amount of data entry is onerous, and the owner typically was taking possession and ownership of the project at least six months prior to the time traditional as-builts are delivered by contractors. Within this gap, the owner needs to make uninformed maintenance decisions and figure out how to operate and track changes they've made while they're making them. The real-time operation decisions leave little time for data entry of as-built data when they finally arrive.

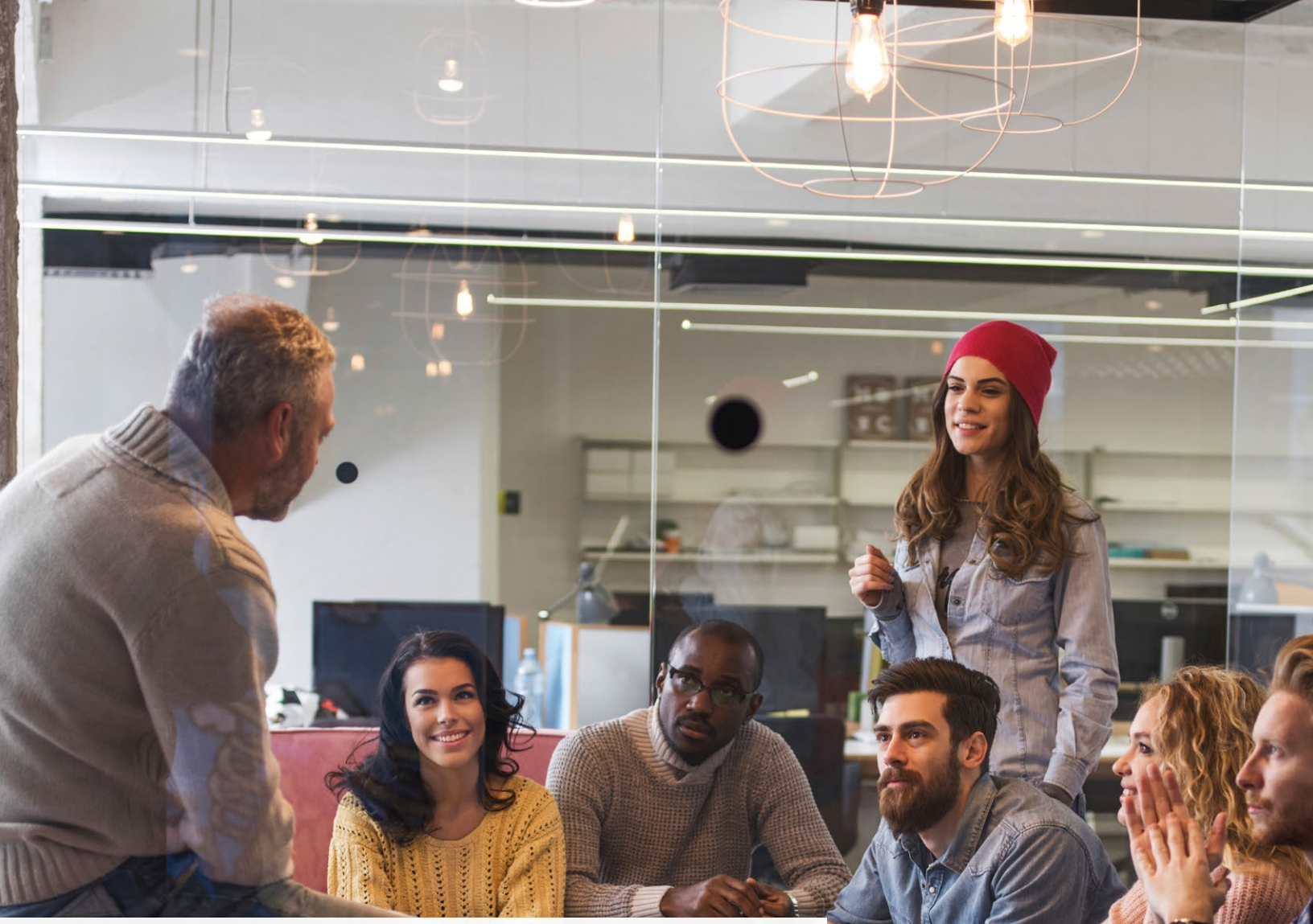
A new phrase is »sustainable operations«, where the goal is to transition data from BIM into the ongoing maintenance system at the time of handover. Driven by advanced embedded analytics in every application, it's becoming critical to understand short- and long-term impacts of a particular design approach socially, economically and environmentally (the triple bottom line).

The sustainable infrastructure rating system (ENVISION) is a tool for public policy and provides a holistic framework for evaluating and rating the community, environmental and economic benefits of all types and sizes of infrastructure projects. It evaluates, grades and gives recognition to infrastructure projects that use transformational, collaborative approaches to assess sustainability indicators over the course of a project's lifecycle, while providing insights into resiliency planning for natural and manmade disasters.

Building new infrastructure from just an engineering perspective no longer is good enough, and all engineers will be asked to assist in long-term maintenance planning for a particular infrastructure asset as well as its ability to react and recover from stressor events. With engineers' help, owners can make informed decisions from the start, and the operations team can move from fixing what's broken to planning replacements as specific components reach the end of their lifecycle to resiliency preparedness for a potential stressor event.

Operations – with perhaps the largest opportunity for savings as it represents the highest costs of a facility or infrastructure over its lifecycle – is motivating many to consider BIM. The ability to catalog components and their specifications along with their locations is a huge leap forward. Maintenance crews go from reacting to a problem and struggling to find it to a proactive approach where they know where all elements are, when they were installed, what operational tolerances each piece of equipment has, and when it needs service.

This progression to a constantly updated operational understanding needs to start with the model. You have to first put the investment into the model and BIM processes to be able to take advantage of this added business advantage.



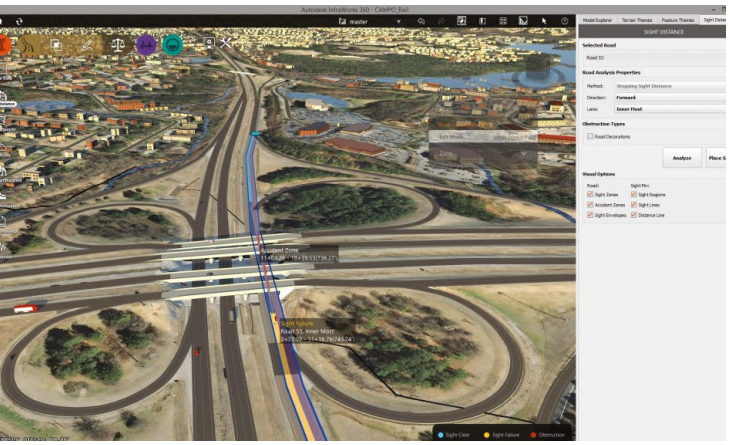
4 ADVANCING BENEFITS

› Return on Investment 19

› Competitive Advantage 20

› Evangelistic Expansion 20

Professionals worldwide are moving to BIM for infrastructure partially due to a constantly evolving software environment and high-impact projects that have mandated its use. Software vendors are continuing to add capability that improves automation, streamlines collaboration and facilitates a holistic lifecycle approach. High-profile government-led mandates, such as those in Singapore, United Kingdom and parts of the Middle East, have dictated a model-based approach to save money and enhance accountability.



A contextual model created with Autodesk InfraWorks 360 is highlighted with site obstructions and other impacts of a proposed design.

RETURN ON INVESTMENT

The motivation for BIM is all about the bottom line. It's not enough to achieve improvements on the quality of work. There needs to be a compelling cost savings as well, otherwise the advantage won't be enough to change entrenched practices.

There are gains in efficiency to be had by doubling up processes that used to be more painstaking and manual, but with the latest technology are quicker and cheaper. Today's software also has improved individual productivity, with software intelligence helping less-experienced workers achieve better designs.

As mentioned, the added time spent in project pre-planning and discovering clashes before they cause delays is a huge payoff. It can form the sole basis for BIM adoption at the enterprise level.

> We started out by piloting BIM, then applied BIM to project work, and quickly moved to an enterprise approach when we saw the success on return on investment. For us, it's a standard operating procedure now.
>
> *Lance Parve, senior project engineer/hydrogeologist, Wisconsin DOT*

COMPETITIVE ADVANTAGE

Engineering firms, contractors and consultants are making the investment to train their teams based on their belief that the skills will earn them new work and command higher dollars. This belief is playing out, with more projects mandating BIM use. It's also paying off for individuals who take the time to train themselves as their skillsets also are in high demand.

Adopting a BIM approach and institutionalizing it with streamlined workflows and a team-based approach isn't only good for projects, it's good for business. The skillset takes time to develop, and there are upfront costs, but this is an investment firms are increasingly willing to take for the long-term payoffs.

EVANGELISTIC EXPANSION

Perhaps the most-important reason government agencies and private consulting firms are moving to BIM for infrastructure is that those who have adopted the model-based approach are quick to share successes and help others through the transition.

Project owners who have adopted BIM point to improvements on project delivery, with a better product at a lower cost. They're increasingly offering more details on the advantages that they've realized as they stand to gain a lot from broad BIM adoption and extension of a BIM-based approach to operations. With more people using the tools and approach, more projects will mandate BIM, and more resources will be devoted to extending the tools' functionality.

> Our aim at the end of the project [the $8B North West Rail Link project in New South Wales, Australia, where BIM is mandated] is to have a group of fully trained BIM designers who we can then go to the market with in the future. Once we crack it, we can deliver a product far more efficiently. There's no more work involved in designing in BIM, but there are far more benefits.
>
> *Neil Evans, director, Strategy and Business Development, SMEC (Australia)*

SUMMARY

SUMMARY

The benefits of BIM for infrastructure play out across projects and an improved enterprise approach. BIM provides a more-streamlined replacement for past practices, and improves project coordination and value delivery.

Firms are realizing that they gain control and add value by owning the modeling process and extending the ability to quickly visualize designs during client interactions. The enhanced feedback loop in the design-review stage enhances a client's feeling of engagement while improving the speed to consensus.

With large projects mandating a BIM approach to better coordinate project delivery, many firms are changing to BIM out of necessity. The sharing of models rather than plans provides a single point of truth, and cuts through confusion and conflicts in design and schedule that could cause costly delays. Greater awareness of the project sequence, and shared responsibility for model execution, means a more-streamlined construction process with fewer change orders and cost overruns.

The model has become a starting point that's being extended to four dimensions with project sequencing, five dimensions with financial details and on to six and seven dimensions with sustainable, holistic lifecycle asset management. The growing momentum for sustainable operations means that more owners will be looking to a BIM-based approach for daily operations, with an informed understanding of when infrastructure components need replacement as well as how best to plan and mitigate against manmade and natural disasters. This growing focus on resilience has implications for firms wanting to win traditional project work, but also holds potential to win extended work throughout the lifecycle of their projects.

With so many firms finding BIM to be a differentiator that can be extended to other areas to provide value, those not yet on the BIM bandwagon will find it more difficult to catch up the longer they wait to engage. That, for some, is reason enough to make the move.

RESOURCES

This whitepaper is an adaptation of a document produced for Autodesk, Inc., by V1 Media, 8421 E. Oregon Place, Denver CO 80231 – info@informedinfrastructure.com

»3D Engineered Models for Construction: Understanding the Benefits of 3D Modeling in Construction«, U.S. Department of Transportation, Federal Highway Administration, TECHBRIEF

»A BIM-based Approach for Communicating and Implementing a Construction Site Safety Plan«, Associated School of Construction, 49th ASC Annual International Conference Proceedings

ISO 55000 Standard for Asset Management

AUTODESK.