DODGE DATA & ANALYTICS

SmartMarket Brief

Premier Partner AUTODESK

LEADING THE FUTURE OF BUILDING

# Connecting Design Insight

# Introduction



## ABOUT THIS SMARTMARKET BRIEF

A proven benefit of using BIM is the ability to create more well-reasoned designs. This includes bringing early-stage sketch concepts into robust modeling tools, generating multiple design options through parametric capabilities and incorporating contextual details from technologies like reality capture and geographical information systems (GIS). Equally critical is the ability to then analyze design options to determine the best solution, including analysis of building performance starting in the conceptual stage, comparing options not only to each other but also against industry benchmarks, and leveraging computational design algorithms to shed light on the impact of specific design choices.

The research presented in this report is based on two surveys of US architects and engineers to benchmark current awareness, usage and benefits related to a number of these types of BIM insight capabilities.

Information about the architects and engineers who participated in the research can be found in the Research Demographics section of this report.

## CONTENTS



## MESSAGE FROM AUTODESK

*BIM (Building Information Modeling), an intelligent model-based design process, provides a critical foundation to help designers, builders and owners gain a competitive advantage with the enhanced ability to access, share and use enormous amounts of information throughout the lifecycle of buildings and infrastructure.*

*Connecting Design Insight refers to the part of the BIM process that enables users to capture, create, and compute data and evaluate alternatives in a real-world context. The ability to access analytical insight early on in the design phase supports "best possible" as opposed to "best practical" project outcomes. Users can also learn from operational data gathered across the building lifecycle to support the continuous improvement of decision-making.*

*Autodesk is pleased to support the research on Connecting Design Insight presented in this report as part of the Leading the Future of Building series*

# Value of BIM for Improving Design Insight



## PERSPECTIVE OF HIGHLY ENGAGED USERS

Highly engaged architects and engineers (using BIM on more than half their current work) were asked about their agreement with several statements (shown at right) about BIM, cloud connectivity and data that facilitate design insight.

### VALUE OF BIM FOR CONNECTING DESIGN INSIGHT

The highly affirmative findings from these experienced users strongly confirm the power of model-based processes to provide superior insight, optimize design solutions and produce buildings that perform better for their owners. These core benefits are foundational to the value proposition of BIM as an effective means to gain insight during design that improves the design process and delivers higher-quality buildings.

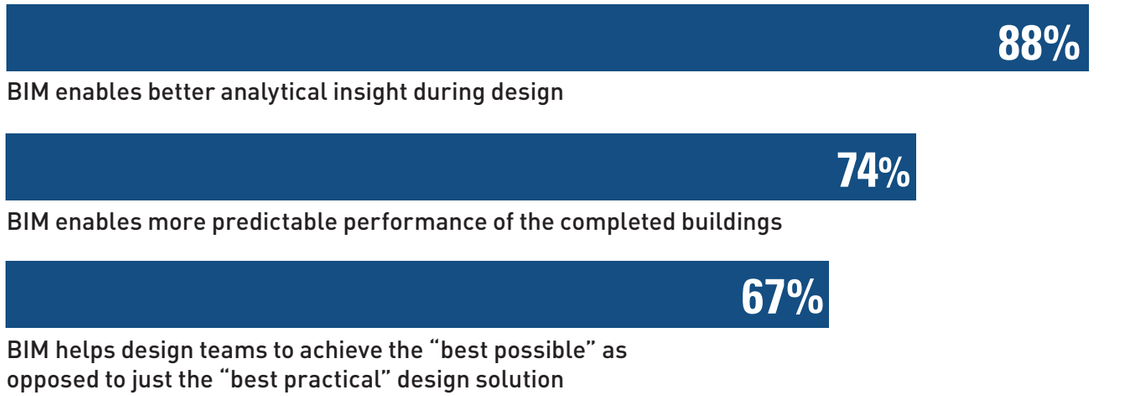
### RESOURCES TO SUPPORT CONNECTED BIM INSIGHT

These experienced users were also asked about specific resources that are required to continue the evolution of BIM insight capabilities.

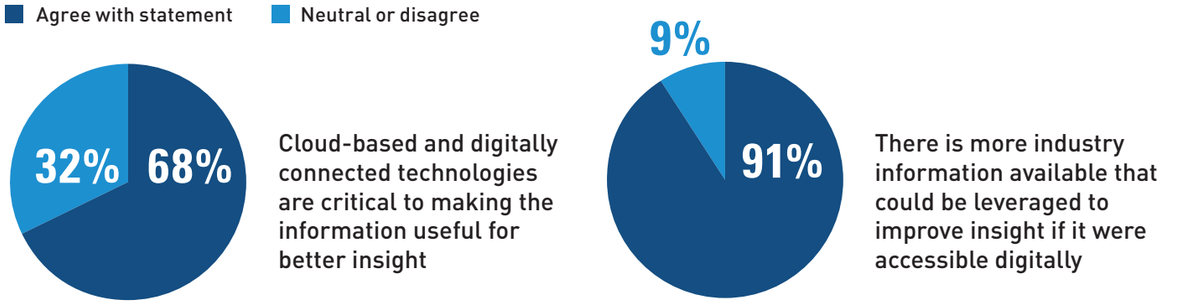
- Over two thirds (68%) consider cloud-based and connected technologies to be critical. This is very likely to increase as these functionalities become more widely known and used.
- Nearly unanimous (91%) support is expressed for enabling greater digital access to industry information as a valuable element of better BIM insight.

## Value of BIM for Connecting Design Insight

*Percentage of highly engaged users who agree with statement*




## Resources to Support Connected BIM Insight



# Generating Design Options



## INSIGHT CAPABILITIES FOR GENERATING DESIGN OPTIONS

A variety of BIM capabilities are enabling greater insight during design, and helping to generate more well-reasoned and contextually relevant design solutions.

This portion of the study focuses on six specific insight capabilities (shown at right) that help to generate design options more efficiently. The following pages reveal research findings for each of the six capabilities, in two areas:

- **Awareness:** How many BIM users are currently aware of each capability.
- **Use:** Among those who are aware, how many are currently deploying it on their projects.

### SPECIAL FOCUS ON GENERATIVE DESIGN

That analysis is followed by a closer examination of the fourth capability: Using generative design to cycle through thousands of design choices, testing configurations and developing more sophisticated solutions through multiple iterations. Aspects studied include:

- **Benefits:** How generative design improves the design process, design solutions, and downstream production, construction and operation.
- **Top Ways to Improve Generative Design:** Which improvements would most significantly add to the value and benefits of generative design.
- **Non-user Perspective:** Why BIM users who are aware of generative design are not yet using it.

## Insight Capabilities for Generating Design Options

| | |
|---|---|
| 1 | **Early-stage sketching that connects conceptual design to BIM with smart objects that flow into later stages of design** |
| 2 | **Early-stage sketching that uses constructability constraints and building-code requirements to drive geometry and behavior of design models** |
| 3 | **Creating visual logic to explore parametric conceptual designs and automate tasks** |
| 4 | **Using generative design to cycle through thousands of design choices, testing configurations and developing more sophisticated solutions through multiple iterations** |
| 5 | **Incorporating reality capture to document existing conditions more accurately** |
| 6 | **Integrating design options with GIS data to more fully represent the contextual environment** |

## EARLY-STAGE SKETCHING CAPABILITIES

Design is an iterative process. Successful solutions are produced in an evolutionary environment where early-stage alternatives can be quickly developed, compared against design parameters and progressively refined.

### EARLY-STAGE SKETCHING THAT CONNECTS CONCEPTUAL DESIGN TO BIM

The ability to bring early-stage sketch concepts directly into powerful, full-featured BIM software effectively connects formerly separate processes, saving time and maintaining the integrity of the concept as it matures and as others engage with it.

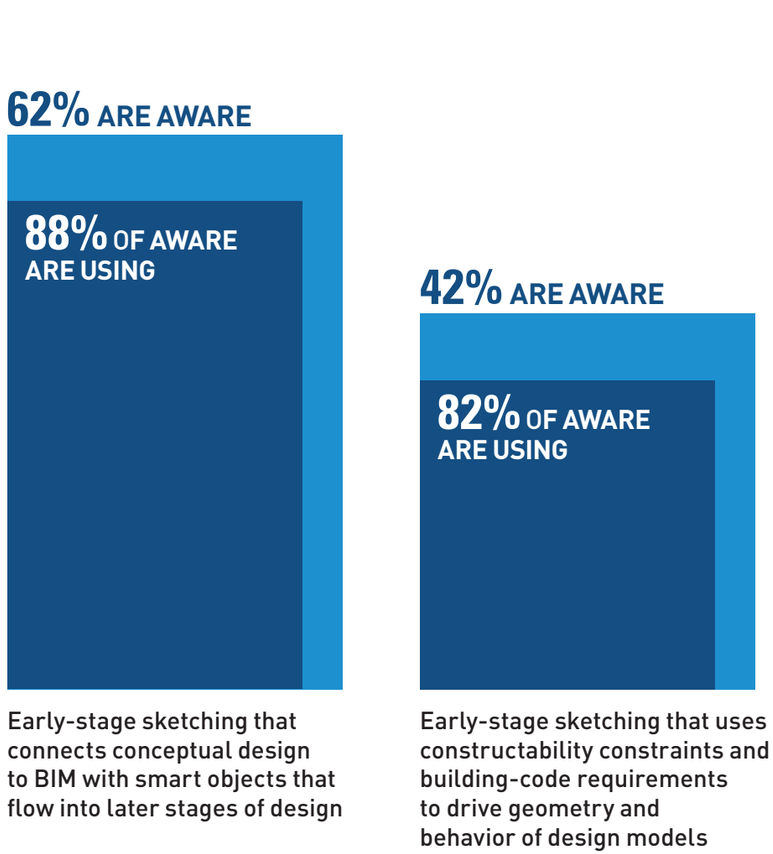
The high number of BIM users who are aware (62%) that they can connect early-stage sketching directly to BIM and the very high percentage of those who are doing it (88%) indicates that it is becoming a standard industry practice.

### USING CONSTRUCTABILITY CONSTRAINTS AND BUILDING-CODE REQUIREMENTS TO DRIVE GEOMETRY AND BEHAVIOR OF DESIGN MODELS

Designers can leverage digital workflows that drive the geometry and behavior of design models within constructability constraints and building code requirements.

Although less than half (42%) of BIM users report being aware of this capability, most of those (82%) who are aware are actively doing it, which foreshadows strong future adoption and increasingly frequent use.

## Awareness and Use of Early-Stage Sketching Capabilities




Early-stage sketching that connects conceptual design to BIM with smart objects that flow into later stages of design

Early-stage sketching that uses constructability constraints and building-code requirements to drive geometry and behavior of design models

## PARAMETRIC DESIGN CAPABILITIES

Designers can leverage digital tools to establish parameters and automatically generate numerous relevant, compliant options for consideration.

### CREATING VISUAL LOGIC TO EXPLORE PARAMETRIC CONCEPTUAL DESIGNS AND AUTOMATE TASKS

Powerful model-based tools can now help design teams to visually establish design parameters so that multiple parametric solutions can be generated that accommodate them.

Awareness of this capability is relatively low (37%) among BIM users, but the fact that almost all (85%) of those who are aware of it report actively using it on their projects indicates that significant growth in adoption is likely as more BIM users realize its benefits.

### USING GENERATIVE DESIGN TO CYCLE THROUGH MULTIPLE DESIGN OPTIONS

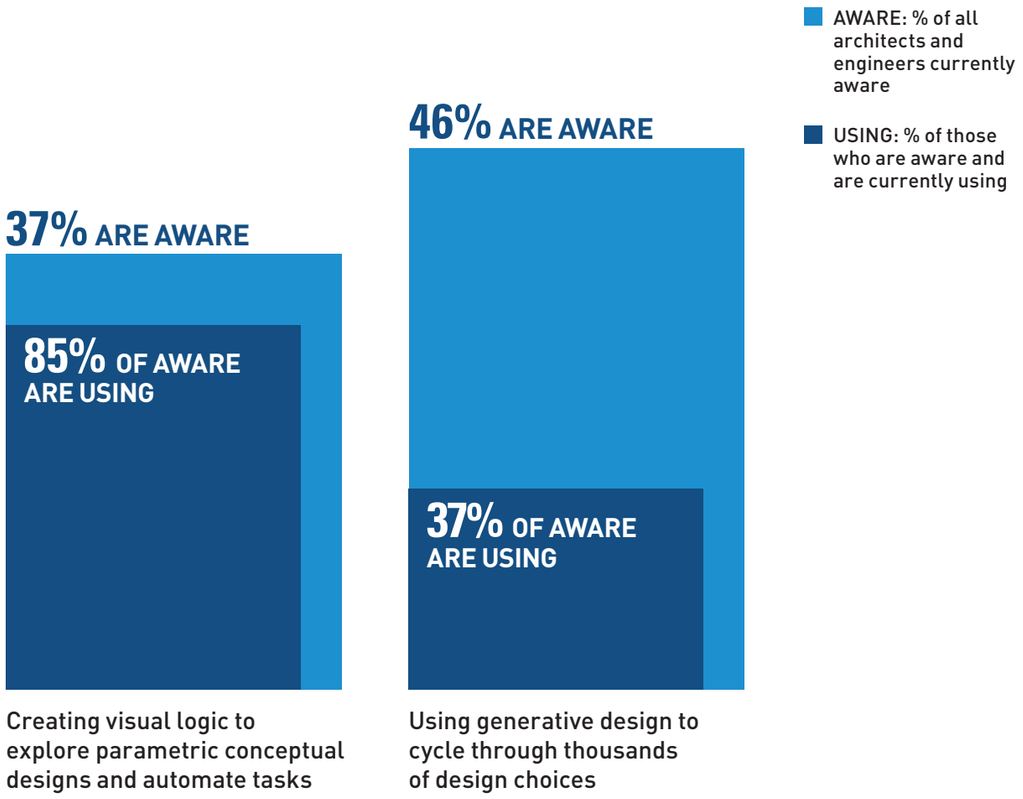
Generative design mimics nature's evolutionary process. With design parameters and constraints established, scalable computing drives generative design software to cycle through thousands of potential options, testing configurations and developing increasingly refined solutions through multiple iterations. Designers can now rapidly generate and evaluate far more options to arrive at effective solutions.

As the chart shows, 46% are aware, and 37% of those currently use, the generative design capability.

Among respondents, architects are more engaged than engineers:

- 52% are aware, and 44% of those are using.
- 75% of users say others in their offices are also using it, leveraging a viral effect.
- 90% of current users believe they will be using it on most projects within five years.

## Awareness and Use of Parametric Design Capabilities



## CONTEXTUAL INTEGRATION CAPABILITIES

Reality capture and geographical information system (GIS) technologies, which are well established in civil and industrial uses, are rapidly proving their value to inform the design process by enabling integration of proposed design solutions with existing conditions.

### INCORPORATE REALITY CAPTURE TO DOCUMENT EXISTING CONDITIONS MORE ACCURATELY

Reality capture processes such as laser-scanning, LIDAR and photogrammetry allow teams to generate highly detailed digital representations of existing conditions that can be integrated into model-based design processes, ensuring far greater accuracy than traditional measuring methods.

About half (48%) of users are aware, and of those three quarters are using these capabilities. As the cost of reality capture technologies continues to decrease and emerging formats like digital photogrammetry become simpler to implement in modeling environments, usage is certain to increase.

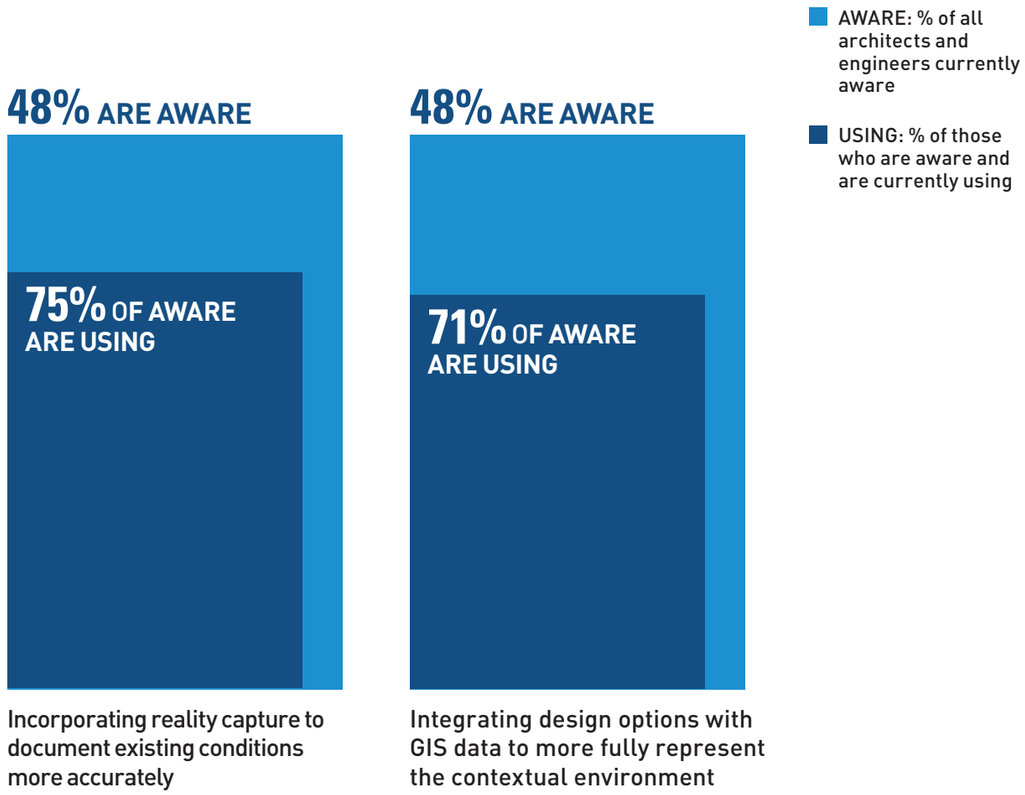
### INTEGRATING DESIGN OPTIONS WITH GIS DATA TO MORE FULLY REPRESENT THE CONTEXTUAL ENVIRONMENT

GIS data is becoming ubiquitous as a reference for existing geological and surface conditions all around the world.

Similar percentages of BIM users are aware of and are using GIS on projects compared with reality capture. The quantity and quality of GIS data is expanding every day.

Together these tools allow teams to generate new design solutions within an existing context with a high degree of confidence that the alignment is accurate. This further allows a design solution to be sensitive to

## Awareness and Use of Contextual Integration Capabilities



## BENEFITS ACHIEVED BY USING GENERATIVE DESIGN CAPABILITY

As the chart at right shows, while awareness of generative design as a capability is relatively high among BIM users (46%), only about a third of those who are aware of it report current use. But importantly, the value that its users report receiving is extremely compelling.

This section of the report provides specific findings from its current users about the positive impact of generative design on:

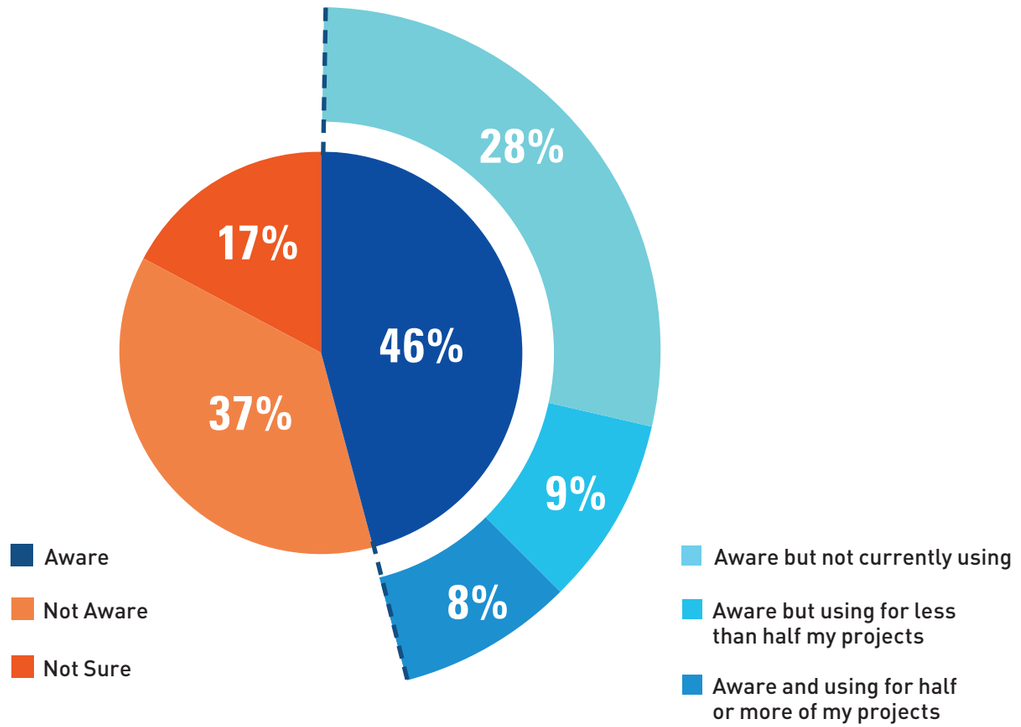
- Improving the design process
- Improving design solutions
- Improving downstream production, construction and operation

### ADDITIONAL FINDINGS RELATED TO GENERATIVE DESIGN

In addition to showing the benefits being received by users, this section of the report explores two other important sets of findings related to generative design:

- The improvements that would add most significantly to the value and benefits of generative design.
- The perspectives of BIM users who are aware of generative design, but are not yet using it.

## Awareness and Use of Generative Design



## IMPROVED DESIGN PROCESS

Those who report using generative design tools and practices were asked about the degree to which it improves their design process.

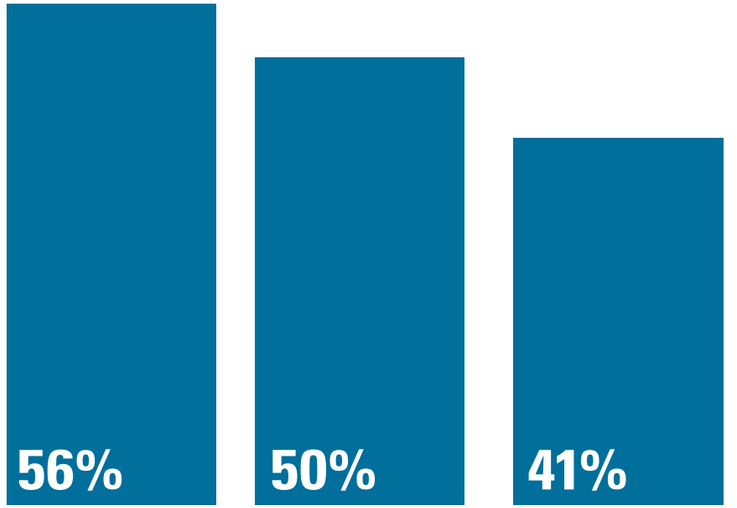
Client engagement is necessary to understand their needs, ensure clear conveyance of proposed design solutions, and effectively align expectations of quality, appearance and performance prior to the start of construction. It is encouraging that well over half (56%) of respondents currently using generative design report this benefit at a high or very high level.

Digitally capturing certain successful aspects of a design process for later reuse can help to standardize best practices and reduce time spent "reinventing the wheel." Although half (50%) of current users report getting this benefit at a top level, many more structural engineers (57%) report this than MEP engineers (23%).

Cross-project-type solutioning is less common, but as these practices mature, innovative practitioners will explore more opportunities for creative repurposing.

### Impact on Design Process

*Percentage of users reporting high or very high level of benefit*



## BETTER DESIGN SOLUTIONS

Previous Dodge research* has validated that owners believe BIM is generating better design solutions and more affordable, constructable projects. Design professionals in this study agree.

Solid majorities report high or very high improvements to quality control and constructability from generative design, and nearly half (44%) cite increased sustainability. Structural engineers (71%) are most emphatic about constructability, and civil engineers (88%) about quality control.

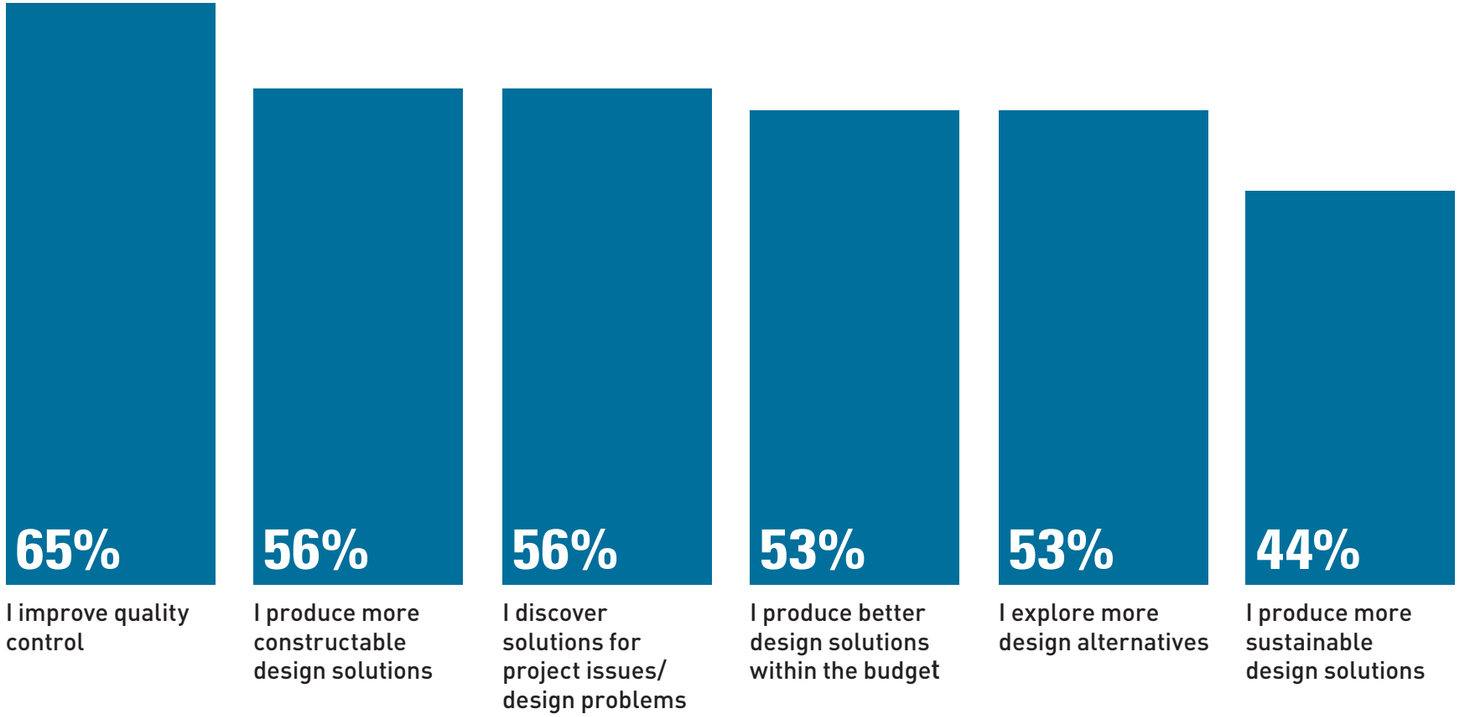
Architects (75%) lead in producing better solutions within budget because of generative design, which is a long-standing challenge. Scalable progress on this benefit can be transformative to the entire industry.

Discovering design solutions and being able to efficiently "optioneer" (explore more design alternatives) are great benefits reported by more than half of respondents. Structural engineers (71%) in particular are exploring more alternatives, which can greatly expand achievable design options for architects.

**The Business Value of BIM for Owners SmartMarket Report, 2014*
**Measuring the Impact of BIM on Complex Projects SmartMarket Report, 2015*

## Impact on Design Solutions

*Percentage of users reporting high or very high level of benefit*



## DOWNSTREAM BENEFITS TO PRODUCTION, CONSTRUCTION AND OPERATION

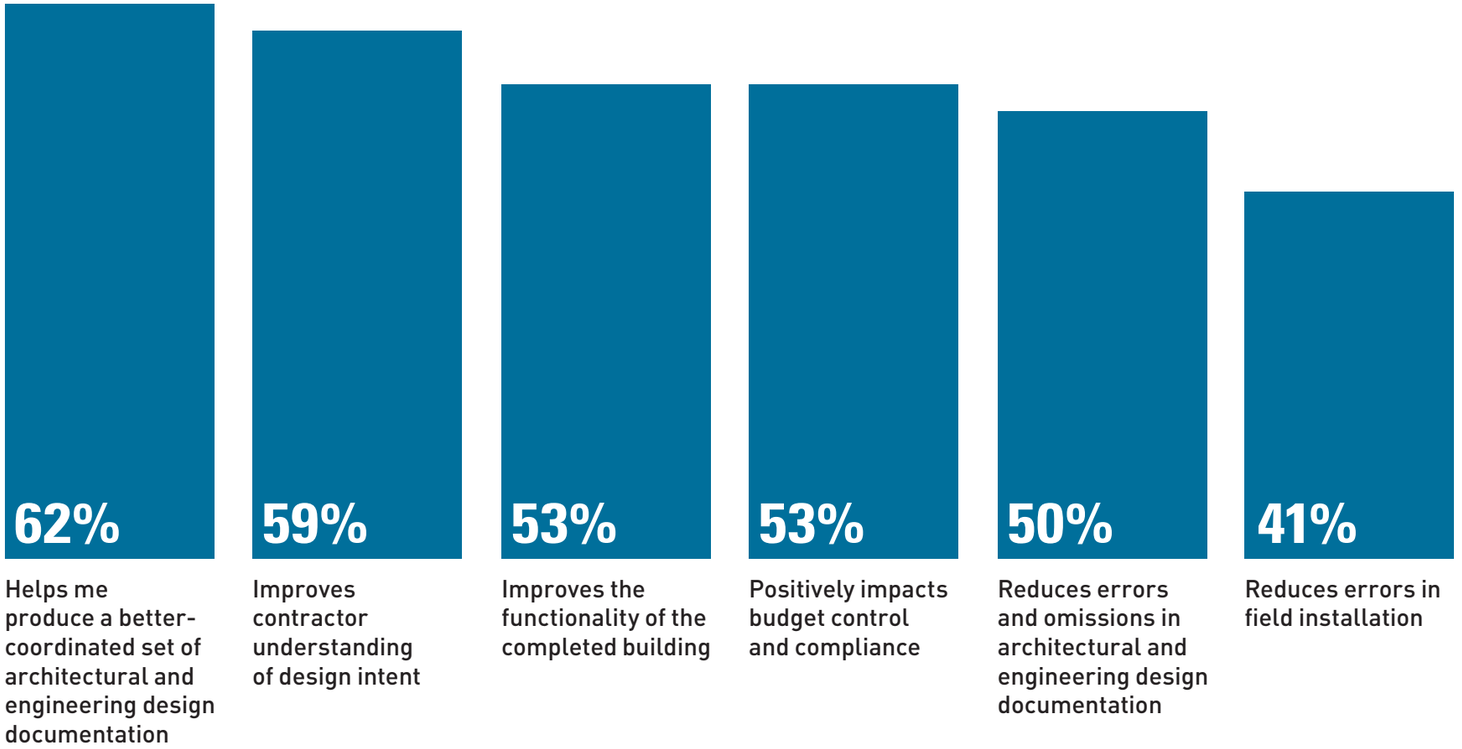
Previous Dodge research* establishes the positive impact of better coordinated documents with fewer errors/omissions on reducing field errors, and improving contractor understanding of design intent, budget control/compliance, and ultimate quality/function of the completed building. A powerful finding of this study is that large percentages of architects and engineers are tying generative design directly to that interrelated stream of benefits at high or very high levels.

The two highest-scoring outcomes (better coordination and contractor understanding) are fundamental building blocks of improved implementation. As these continue to advance with more use of generative design, benefits like budget control, reduced field errors and improved final quality will naturally follow.

** Managing Uncertainty and Expectations in Design and Construction SmartMarket Report, 2015*

## Impact on Production, Construction and Operation

*Percentage of users reporting high or very high level of benefit*



## WHAT WOULD MOST IMPROVE GENERATIVE DESIGN

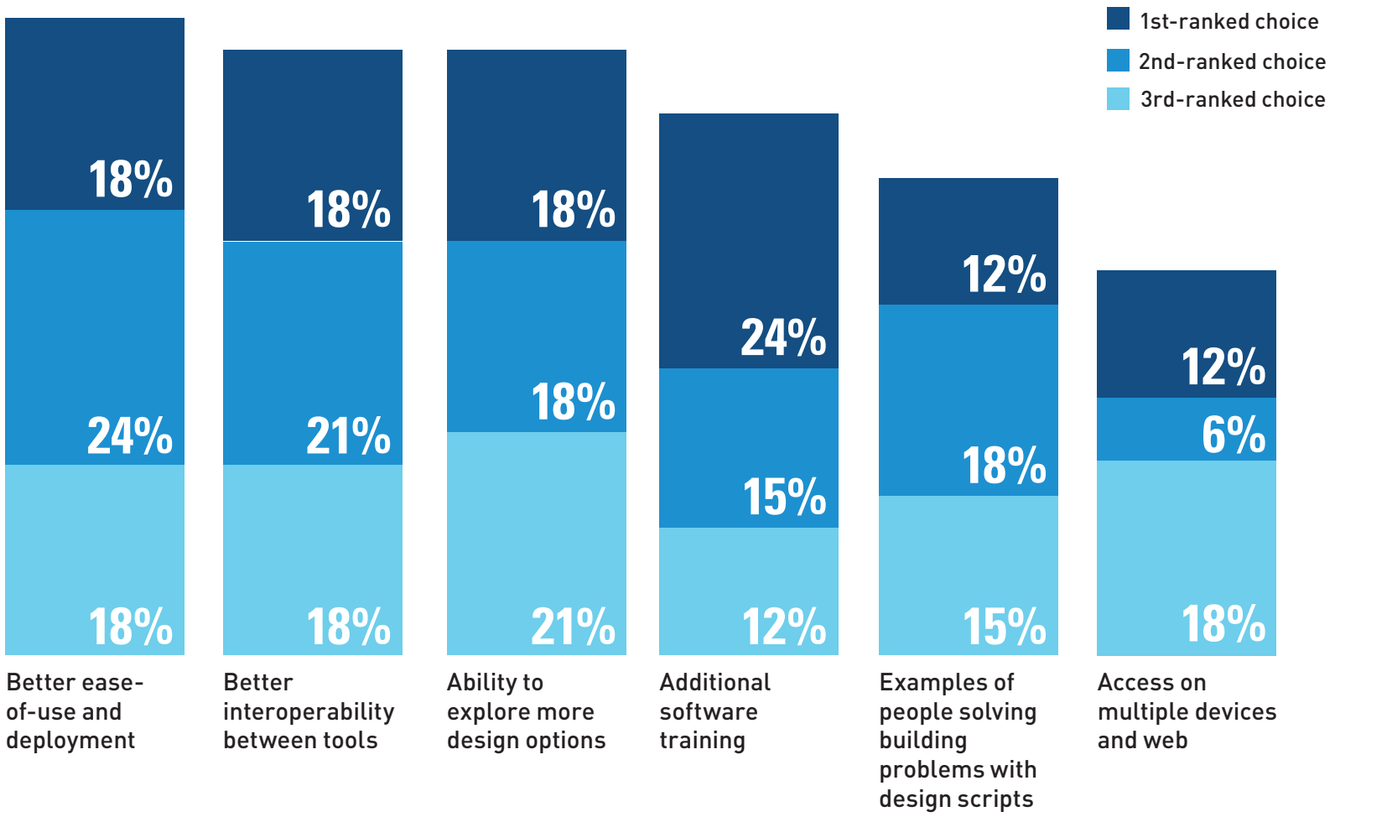
Current users of generative design tools and processes were asked to select, in order of importance, three changes or resources that would most improve its value.

Training is the most frequent first choice, especially among civil engineers (50% rank it first). Related technical issues of deployment and interoperability top the overall list, with MEP engineers being most vocal (43% and 29% of them rank those first, respectively).

Exploring more design alternatives is a core benefit of generative design (see page 9). Its third place ranking among needs is a strong demand signal from users. Structural engineers lead in requesting this among all respondent-types (29% rank it first).

Examples of design scripts and multi-device access rank lower but are likely to increase as more examples become available and as information mobility continues to advance.

### Greatest Needed Improvements to Increase Benefits of Generative Design



## AWARE BUT NOT YET USING

Dodge typically surveys non-users in its research on emerging technologies and trends to understand resistance. For this study, respondents who are aware but haven't begun using generative design could select up to five of the reasons shown in the chart.

Nearly half believe that generative design doesn't apply to their projects, which may be a legitimate perspective in this early stage of its development. Structural and MEP engineers lead in holding this view.

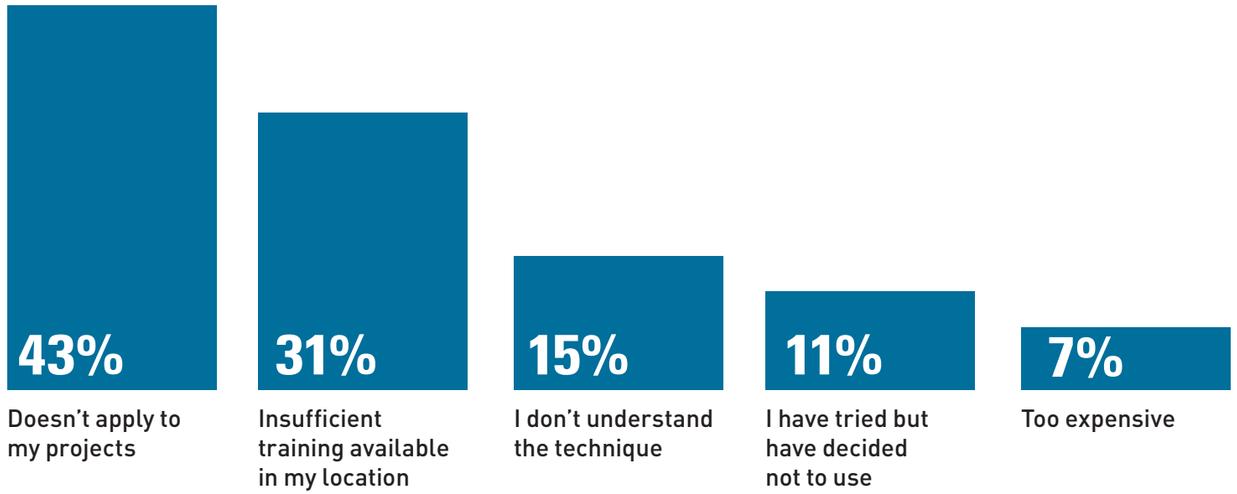
Insufficient training indicates interest and can be addressed, as can a lack of understanding. A small percentage tried it already, but that indicates willingness to experiment, so they may well return.

### NON-USER PLANS TO ADOPT

Overall, 24% of non-users say that they plan to adopt, led by structural engineers (38%). Among those future adopters, half state they will do so within the next 12 months.

## Top Five Reasons Those Aware of Generative Design are Not Using It

*Percentage of respondents who are aware of generative design who cite these reasons for not currently using it*



# Analyzing Design Options



## CURRENT ENGAGEMENT LEVELS

In addition to helping design teams generate multiple relevant design options, several BIM insight capabilities also enable fast and effective analysis of the options to identify best-possible solutions that drive value throughout the design process and to the performance of the completed building.

This portion of the study focuses on five specific insight capabilities (shown at right) that help design teams to analyze design options more quickly and effectively. The following pages show research findings for each of the five capabilities, specifically:

- **Awareness:** How many BIM users are currently aware of each capability
- **Use:** Among those who are aware, how many are currently deploying it on their projects

The last page of this section has additional findings related to the fifth capability: Using computational design to algorithmically model [simulate] the behavior of a design option. Aspects studied include the positive contribution of computational design to:

- Automation of Routine Tasks
- Improved Interoperability

## Insight Capabilities for Analyzing Design Options

| | |
|---|---|
| 1 | **Analyzing building performance during conceptual design stage** |
| 2 | **Accessing a comparison building-performance workflow allowing you to run millions of design scenarios, ranges and specifications, and see energy savings with immediate, interactive cause and effect feedback** |
| 3 | **Running performance analyses in the cloud, including whole-building energy simulations, daylighting analysis, heating and cooling load calculations using EnergyPlus, simulated solar radiation and photovoltaic energy production** |
| 4 | **Evaluating design options against industry building-performance benchmarks** |
| 5 | **Using computational design to algorithmically model [simulate] the behavior of a design option** |
| 6 | **Integrating design options with GIS data to more fully represent the contextual environment** |

## BUILDING PERFORMANCE CAPABILITIES DURING EARLY-STAGE DESIGN

Designers have effective workflow tools to incorporate analysis of building performance into early-stage design processes.

### ANALYZING BUILDING PERFORMANCE DURING CONCEPTUAL DESIGN STAGE

Traditionally, building performance analysis is conducted on a fully developed design, and resulting changes can impact the original design intent. Concept-stage analysis reduces this risk.

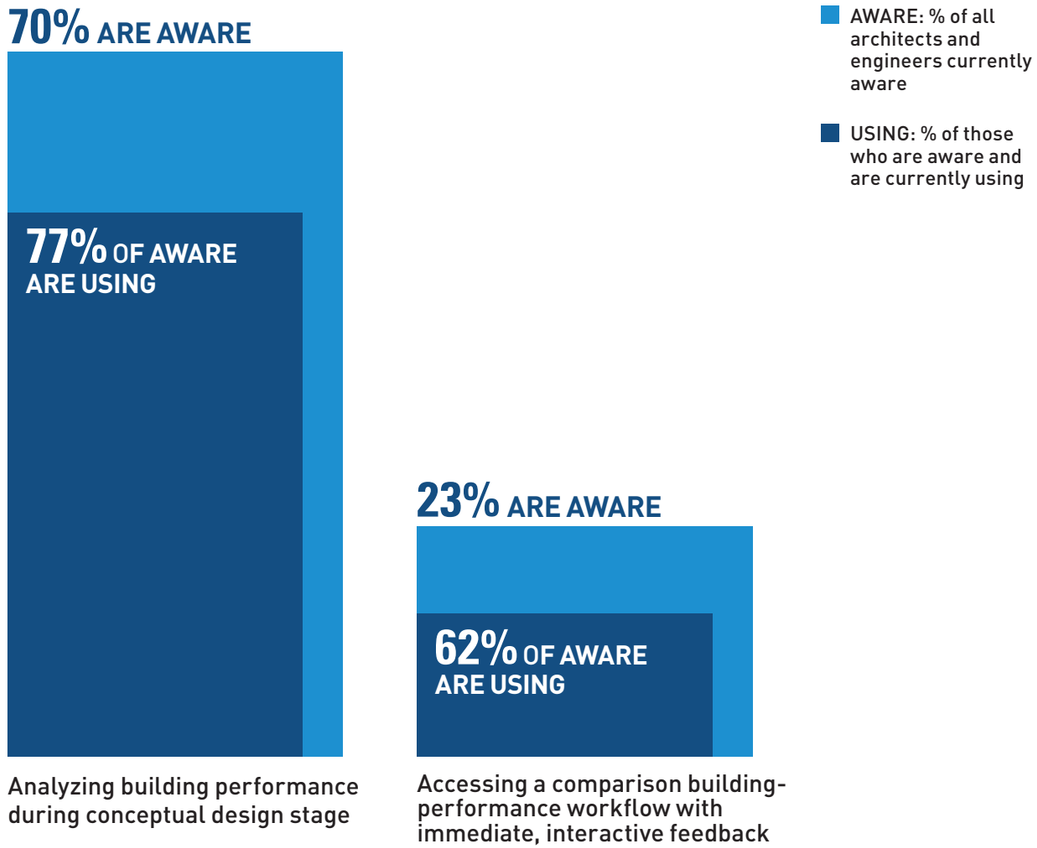
The high levels of awareness (70%) and use (77%) by those who are aware speak to its proven value and suggest that it is fast-becoming a standard practice.

### ACCESSING A COMPARISON BUILDING-PERFORMANCE WORKFLOW

Model-based capabilities now enable designers to access a comparison building-performance workflow to run millions of design scenarios, ranges and specifications. For example, a designer can see energy savings with immediate, interactive cause-and-effect feedback.

Even though awareness of this powerful workflow capability is low (23%) among BIM users, it is being used by nearly two thirds (62%) of the aware professionals, and even more frequently by highly engaged firms (those that do more than half their work with BIM). This points to a robust future level of implementation as awareness grows.

## Aware of and Using Building Performance Capabilities During Early-Stage Design



## BUILDING-PERFORMANCE ANALYSIS AND BENCHMARKING CAPABILITIES

### RUNNING PERFORMANCE ANALYSES IN THE CLOUD

This capability enables a design team to run computing-intensive performance analyses far more quickly and efficiently in the cloud. This can include analyses such as whole-building energy simulations, daylighting analysis, heating and cooling load calculations using EnergyPlus, or simulating solar radiation and photovoltaic energy production.

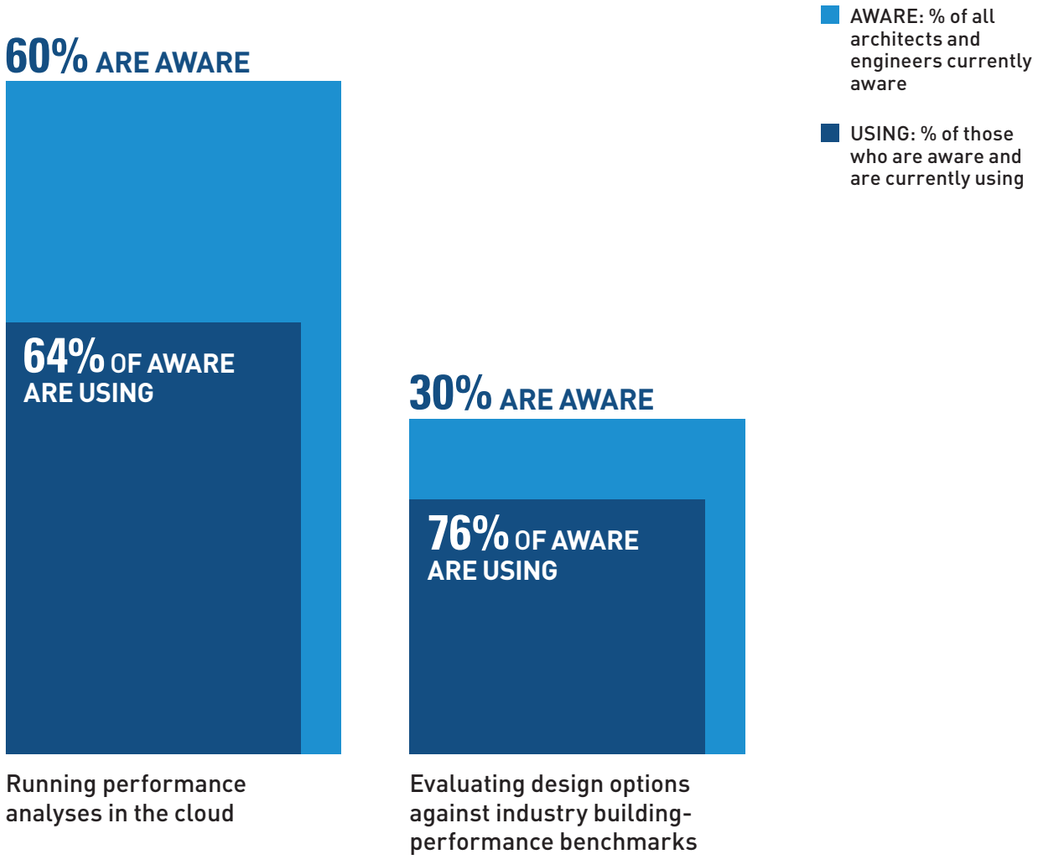
Awareness exceeds half (60%), and nearly two thirds (64%) of those who are aware are currently using it, which indicates that it is making good progress toward becoming a standardized practice.

### EVALUATING DESIGN AGAINST INDUSTRY BUILDING-PERFORMANCE BENCHMARKS

Relatively few BIM users (30%) are aware that they can leverage their model to compare a proposed design solution to industry performance benchmarks, but among those, over three quarters (76%) report doing so. The more highly engaged BIM users are also more active with this capability.

Though still an emerging capability in terms of awareness, its devoted usage by those who are aware points to likely strong growth of this valuable capability.

## Aware of and Using Building-Performance Analysis and Benchmarking Capabilities



## AWARENESS, USE AND BENEFITS OF COMPUTATIONAL DESIGN

Within the capabilities that analyze design options, an important set of practices known as computational design is gaining traction with users and providing uniquely powerful benefits.

Computational design employs explicit rules to algorithmically model and simulate the behavior of a proposed solution. Instead of focusing on static geometry or a singular image, the designer can model systems that represent multiple possible outcomes to understand the effects of design choices.

Often taking advantage of sophisticated automated analyses, computational design provides a means to create and evaluate realistically represented design options within expected simulated conditions.

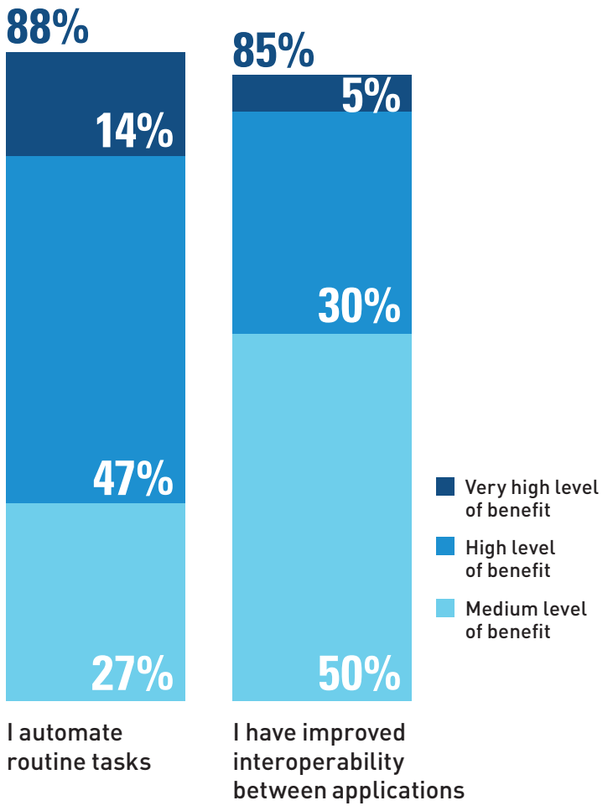
Among respondents, about two thirds (64%) express specific awareness of this set of techniques and practices, and over half (52%) of those currently use them, especially architects (61%) and structural engineers (55%).

Users of computational design report some valuable benefits from their engagement:

- 88% are successfully automating routine tasks by leveraging computational design, particularly MEP engineers (92%).
- A similar percentage (85%) report improved interoperability, particularly architects (89%). All users should see interoperability improve as integrated software platforms and common data environments that support and enable

### Awareness and Use of Computational Design


### Benefits of Computational Design



# Industry Leaders



## INSIGHT CAPABILITY EXAMPLES

The following pages show a variety of dynamic ways that BIM insight capabilities are generating value on projects.

### GENERATIVE FACADE DESIGN

Gensler has launched a firm-wide generative facade design initiative with the goal of equipping their staff with three key capabilities:

- Rapidly generate alternative building facades that meet specific project parameters
- Perform valid comparative analysis of the alternatives
- Effectively explain the performance of those alternatives to clients to help them select the most appropriate option

### ENVIRONMENTALLY RESPONSIVE FACADES

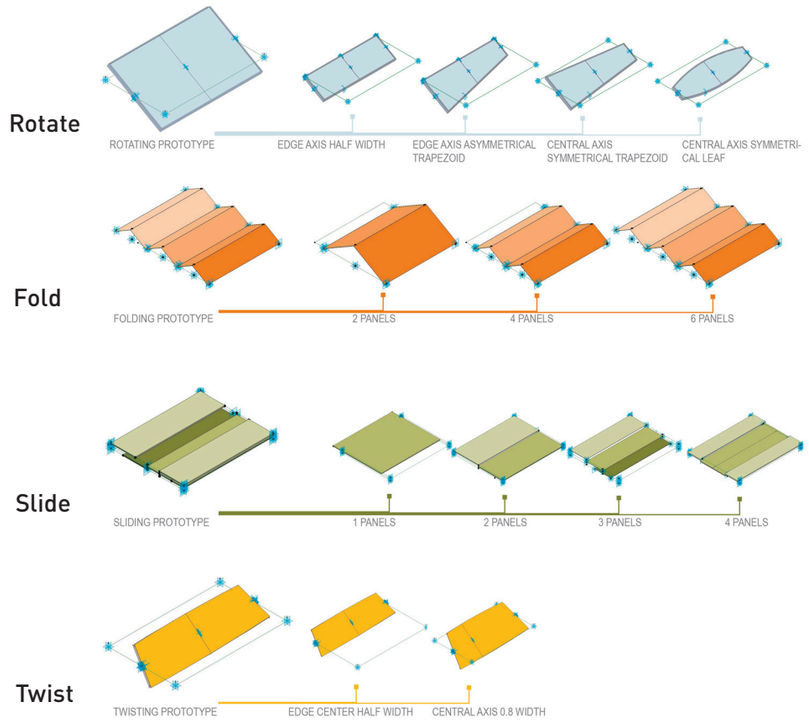
Within that initiative there is a specific focus on environmentally responsive facades, which quickly react to environmental stimuli in two ways:

- **Dynamic:** components of the facade move in response to the environment's impact on the building
- **State changing:** a material in the facade changes in a way that better positions the building to accommodate its immediate environmental situation

For the dynamically responsive case, Gensler has adapted modeling technology to rapidly generate digital panelization models and simulate individual panel movement through parametric analysis. For comparative analysis the firm's toolset analyzes solar insolation (a measure of solar radiation energy received on a given surface area in a given time) and the above-referenced panels dynamically respond to changes in the sun's position in the sky.

*Source: Gensler*

## Sample Capabilities of the Panel Generator



## INSIGHT CAPABILITY EXAMPLES

### DYNAMIC DESIGN GENERATION

MT Højgaard is part of MTH GROUP, a leading engineering and construction firm in the Nordic region that is deeply committed to virtual design and construction. As an example, they connected several software products (e.g., Revit, Dynamo, FormIt, Project Fractal and others) to create a data-driven design solution for parking structures that goes from early conceptual design to construction documents and object-based estimation.

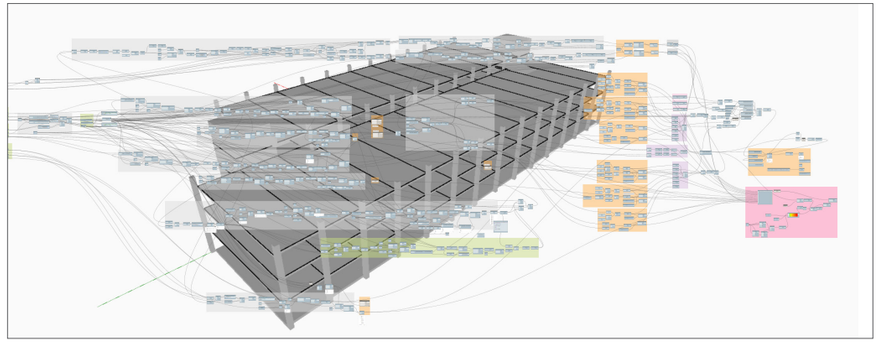
### CONCEPTUAL DESIGN OPTIONS WITH COST

Their team used Dynamo for rule-based parametric concept definition, encompassing levels, lengths, number of parking spots, total cost and average price per parking spot. From this they generated a conceptual model where price can be estimated in real time while iterating alternative design solutions.

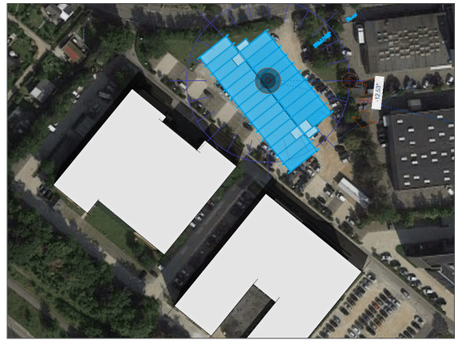
*[Continued on the next page]*

*Source: MTH GROUP*

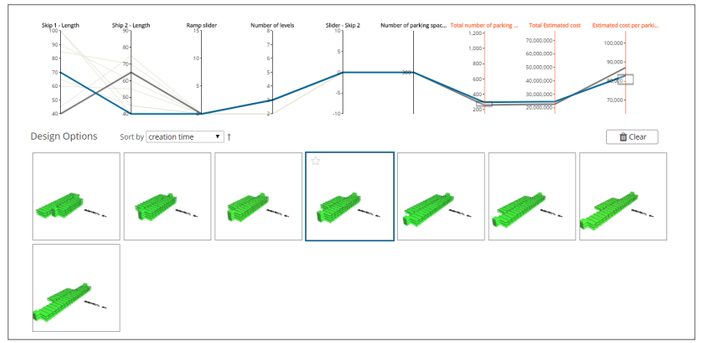
## Dynamic Design Generation for Parking Structures



Use Dynamo to create a dynamic model



Use Formit to create a content model and drop the dynamic model into it




Generate estimates via the cloud

Find the best fit with the client

## INSIGHT CAPABILITY EXAMPLES

### PARKING GARAGE GENERATOR

MTH GROUP also leveraged an alpha version of Project Fractal to run Dynamo in the cloud, analyzing an extensive number of possible inputs to generate multiple configurations, and automating the optimization process to identify a select few for client review.

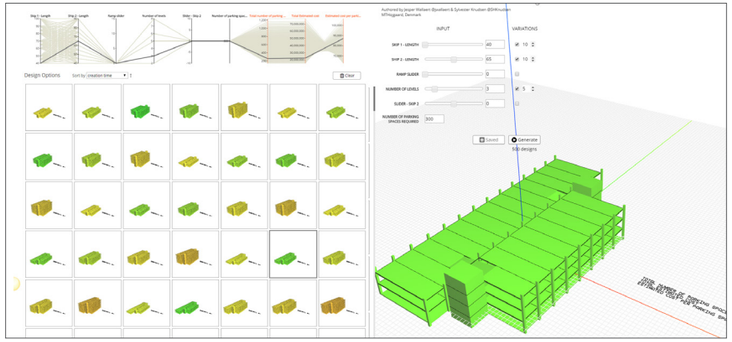
To convert the concept phase geometry into a fully parametric BIM that can be used for estimation, fabrication, etc., the team used Dynamo graph, which has the same foundation as the script for generating the concept model. Built-in rules for things like number of columns and beams, and placement of structural reinforcement generated the entire structural model of the parking garage with the appropriate amount of levels, significantly automating almost all of the modeling process.

Also, by making sure the naming conventions are always done in the same way, they were able to link to the software they use for automated quantity takeoff and 4D simulations.

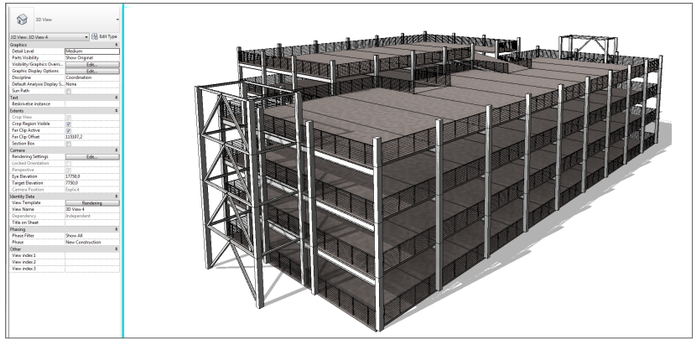
While this does not necessarily design the entire parking garage automatically, it is an effective method to create thousands of garage scenarios, optimized on relevant parameters, to validate design decisions early in design and continue integrated development to final modeling.

*Source: MTH GROUP*

## Dynamic Design Generation for Parking Structures *(cont'd)*



Apply filters on all inputs and outputs to optimize for client



Transfer the approved concept model to BIM for final

## INSIGHT CAPABILITY EXAMPLES

### ANALYZE BUILDING PEFORMANCE AGAINST BENCHMARKS

Analysis conducted in the cloud for a typical office building allows comparisons of various performance design options. When a change is made (e.g., lighting, HVAC system, glass type, building orientation, envelope construction, etc.), the analysis is updated and compared against ASHRAE 90.1 energy baseline and Architecture 2030 goals.

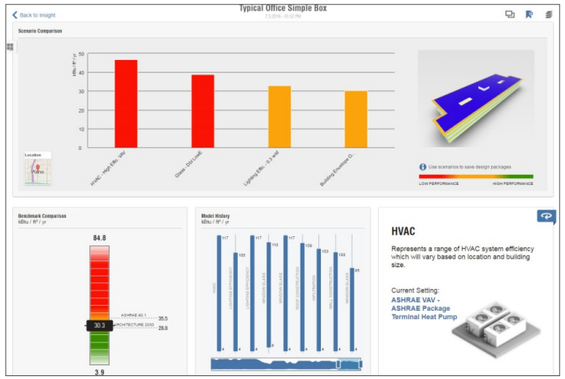
*Source: Corgan Associates*

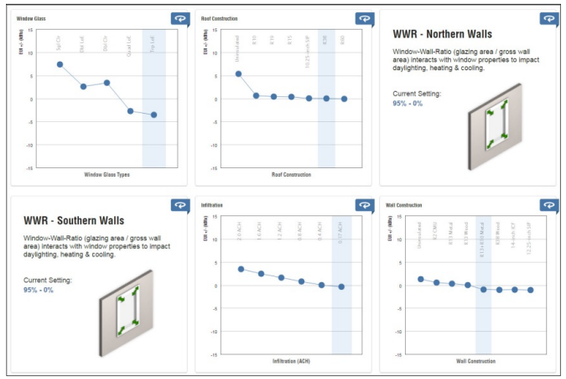
### CREATE VISUAL LOGIC TO EXPLORE PARAMETRIC CONCEPTUAL DESIGNS AND AUTOMATE TASKS

Corgan Associates' BIM plug-in uses defined sun time/date settings to generate model lines representing the direction, angle and refractive bounces of solar rays intersecting any selected model surface, analyzing for both interior glare and exterior reflection, as well as sunshade and light shelf devices.

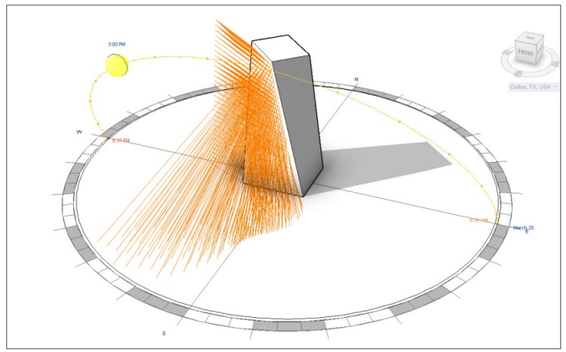
*Source: Corgan Associates*

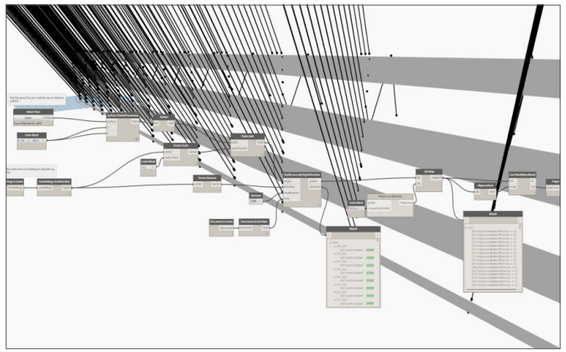
## Benchmark Analysis




## Applying Parametric Logic





## INSIGHT CAPABILITY EXAMPLES

### RUN PERFORMANCE ANALYSES FOR WIND

A BIM plug-in simulates a wind tunnel, based on building orientation, size of the analysis volume, flow line velocity/size and other customizable parameters. Designers can prevent unpleasant wind vortex conditions or high/low pressures on the building envelope from directly impacting pedestrian experience.

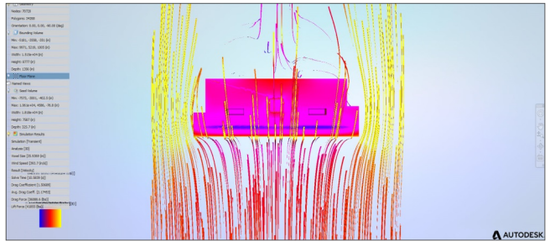
*Source: Corgan Associates*

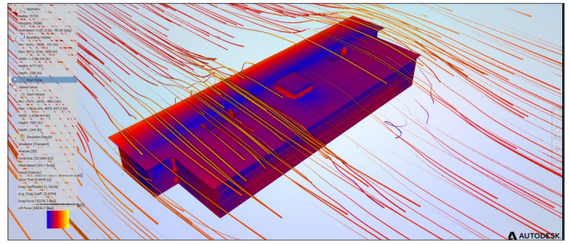
### SOLVE GLARE CHALLENGES COMPUTATIONALLY

Potential glare locations at various orientations and times of year are determined by calculating lighting level readings per glazing type, orientation, time of day, solstice and a statistical sun model. This is simulated in renderings to identify areas that may need mitigation.

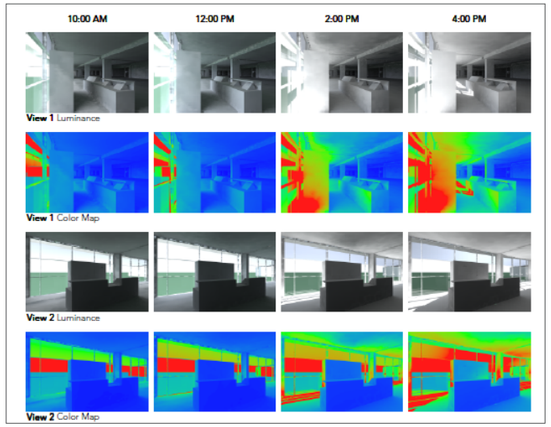
*Source: Corgan Associates*

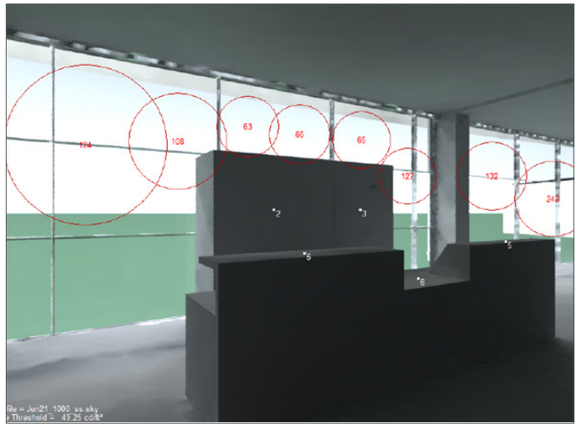
## Wind Analysis




## Glare Analysis



## INSIGHT CAPABILITY EXAMPLES

### REALITY CAPTURE TO ENSURE SUCCESS OF DESIGN FOR PREFABRICATION

Laser scanning, modeling and site simulation helped a design-build team to manage critical design tolerances and ensure that anchor bolts would align properly with anchor plates on a large structural project where most of the work was prefabricated offsite.

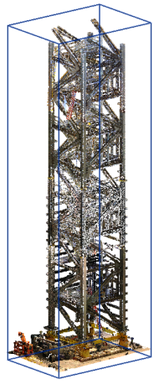
*Source: Hensel Phelps*

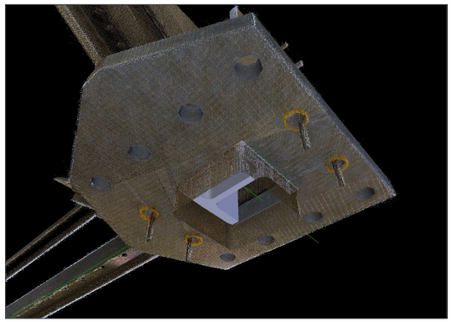
### REALITY CAPTURE OF EXISTING CONDITIONS FOR EXTENSIVE RENOVATION/ALTERATION

A plan to lower the lobby of a historic hotel into an existing interstitial space to create a new ballroom required extensive understanding of the complex existing conditions and systems that would have been impossible without laser scanning prior to beginning design.

*Source: Hensel Phelps*

## Reality Capture for Constructability





## Reality Capture for Renovations

# Key Takeaways



## CONNECTED INSIGHT

### BIM IS IMPROVING DESIGN INSIGHT AND OUTCOMES

Most respondents (88%) agree that BIM is enabling better design insight, and 74% say the insight improves performance predictability of their completed buildings.

Data on building performance and other key design parameters contributes directly to their insight workflows. 91% believe more valuable industry information is available and want it to be accessible digitally to improve design insight.

### GENERATIVE DESIGN USE POISED TO EXPAND

About half (46%) are aware of generative design tools and practices, and over one third (37%) of those are currently using them. Several strong value propositions position generative design to grow significantly:

- Generating and exploring more design alternatives that produce better, more functional final solutions
- Improved quality, budget control, documentation and constructability
- Valuable ability to automate routine tasks

### SPECIFIC BIM INSIGHT ACTIVITIES BECOMING STANDARD PRACTICES

Among the specific activities studied, two that occur during early design show a high degree of both awareness and use, suggesting that they are well on their way to becoming standard practices by BIM users:

- Conducting early-stage sketching that connects conceptual design to BIM
- Analyzing building performance during conceptual design stage

### CONTEXTUAL DESIGN GAINING TRACTION

Reality capture capabilities and integration of BIM with GIS data both have over 70% usage rates among BIM users who are aware of them, also indicating a positive acceptance that should lead to more implementation.

### COMPUTATIONAL DESIGN IS EFFECTIVELY AUTOMATING TASKS AND IMPROVING INTEROPERABILITY

The vast majority of those using computational design capabilities report success in automating routine tasks (88%), and improved interoperability (85%).

### EMERGING PRACTICES HAVE DEVOTED USERS

While fewer than half of BIM users register awareness of the insight capabilities shown below, over three quarters of those who are aware report using them, suggesting that they are providing valuable benefits and therefore are positioned well to grow in both awareness and use as BIM maturity expands.

- Creating visual logic to explore parametric conceptual designs and automate tasks
- Assessing design against industry building-performance benchmarks

# Research Demographics



## SURVEY

Findings for this report came from two surveys fielded in 2016.

### RESPONDENTS

Respondents include 257 architects and 201 engineers.

Engineers include the following disciplines:

- Structural
- Mechanical
- Plumbing
- Electrical
- Civil

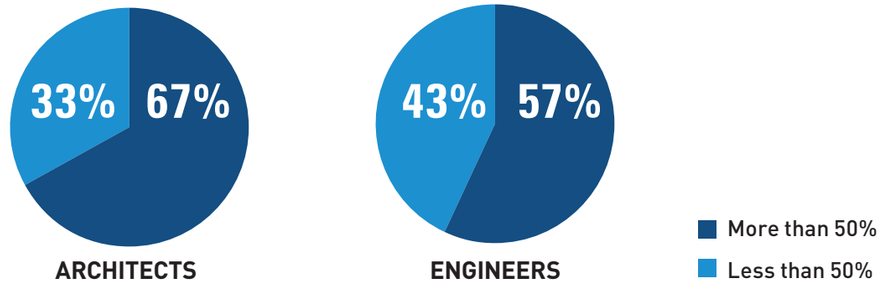
All the respondents:

- Work primarily on building projects (versus infrastructure, industrial or other non-building projects)
- Currently use BIM on at least some percentage of their building projects

More information about the sample is shown at right.

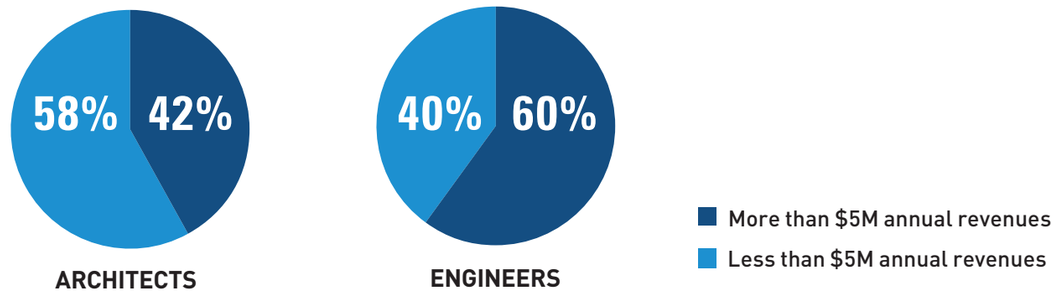
## BIM Engagement

*Percentage of respondents' projects that involve BIM*




## Annual Revenue

*Percentage of respondents in each tier of annual revenue*



# Contacts+Resources

## DD&A EDITORIAL TEAM

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Senior Director
**Industry Insights Research**

**Donna Laquidara-Carr PhD, LEED AP**
Research Director
**Industry Insights Research**

## ADDITIONAL RESOURCES

AUTODESK. autodesk.com

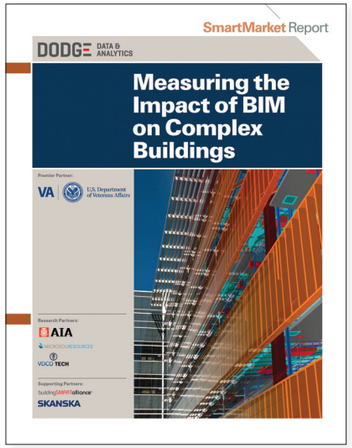
Technology is radically disrupting the way buildings and infrastructure are designed, built and used. Disruptive innovation is transforming markets, and traditional methods of working are being displaced. Tools and processes are evolving rapidly, blurring the lines between physical and digital, and creating a new landscape for innovation and competition.

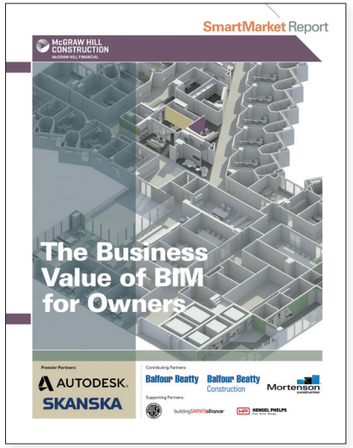
Autodesk understands the challenges our customers face today and in the future because we have a history of leading through change. Beginning 30 years ago, Autodesk led the shift from the drafting table to the computer (CAD) through the era of documentation. When 2D moved to 3D, Autodesk invested strongly, with BIM technologies that helped visualize, simulate and analyze the physical and functional performance of buildings and infrastructure before breaking ground; and now we are leading the industry's transformation to BIM during the era of optimization. Today, as new technology is disrupting the way things are designed and made, Autodesk will lead again, building upon our BIM portfolio with technology and platforms that connect designers and builders not just through the model, but through connected projects, teams, insight and outcomes that will enable a new means of creating, using, and measuring building and infrastructure systems in the era of connection.

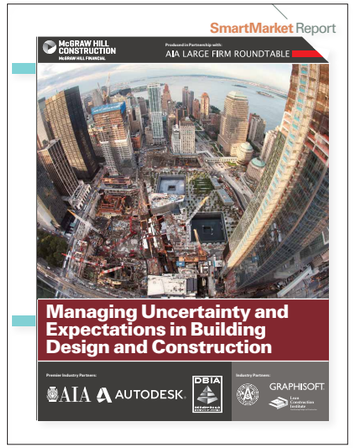
DODGE DATA & ANALYTICS

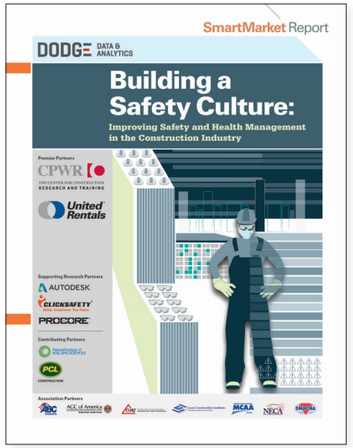
**Dodge Data & Analytics: Main Website: construction.com Dodge: construction.com/dodge**
**Research & Analytics: www.construction.com/products/dodge-research-analytics Sweets: sweets.com**
**SmartMarket Reports: analyticsstore.construction.com**

# DODGE DATA & ANALYTICS Industry Insights





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