SmartMarket Report

DODGE DATA & ANALYTICS

Safety Management in the Construction Industry 2017

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Safety Management in the Construction Industry 2017 SmartMarket Report

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About Dodge Data & Analytics

Dodge Data & Analytics is North America's leading provider of analytics and software-based workflow integration solutions for the construction industry. Building product manufacturers, architects, engineers, contractors, and service providers leverage Dodge to identify and pursue unseen growth opportunities and execute on those opportunities for enhanced business performance. Whether it's on a local, regional or national level, Dodge makes the hidden obvious, empowering its clients to better understand their markets, uncover key relationships, size growth opportunities and pursue those opportunities with success. The company's construction project information is the most comprehensive and verified in the industry. Dodge is leveraging its 100-year-old legacy of continuous innovation to help the industry meet the building challenges of the future.

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Introduction

This study is the third in an ongoing series that began in 2012, examining the positive impacts of a wide variety of safety-related practices, and changes in means and methods of safety training and communication. Key findings include:

- A continuing shift of industry focus toward engaging jobsite workers in safety programs.
- Increasing evidence of the relationship between safety-related investments and improved project and business outcomes. The consistency of those findings, especially considering the evolution of the construction market itself between 2012 and 2017, lends weight to the compelling advantages of investing in safety.
- Large contractors continue to engage in more safety practices, conduct more safety training and to reap more benefits than smaller ones.
- Toolbox talks continue to be the most effective means of communicating with jobsite workers about safety.

In addition, this study explores two emerging trends that promise to impact safety in the future: Prevention Through Design (PtD) and the use of technologies to improve safety.

PtD recognizes that projects can be designed in ways that make them safer to construct. To capture a broad view of this emerging trend, both architects and contractors were surveyed. The following conclusions emerge from the findings:

- Although awareness of the specific phrase "Prevention Through Design" is relatively low, many respondents report they are currently conducting a number of the beneficial activities that comprise this practice, suggesting that more promotion of the term will help the industry to rally around it.
- Architects currently are more focused on the impact of their designs on safety during the operational phase than during construction. Some are concerned about liability if they practice PtD, but owner requests and insurance company incentives could encourage them to engage more fully with this approach.
- Contractors are generally less concerned about obstacles than architects, and most are interested in more information about PtD practices.

The study also explores the sharp increase in technologies available to address construction safety in the past few years. It not only offers insights into well-known technologies, but also provides a baseline for emerging ones like drones, laser scanning, wearable devices, photogrammetry and robotics.

- **BIM:** The study clearly shows that BIM use improves safety. Not only is there a dramatic increase of 27 percentage points from 2012 (42%) to 2017 (69%) of contractors reporting a positive impact from BIM, but respondents who use BIM consistently use more safety practices and experience more benefits from their safety investments than those who don't.
- **Mobile Technologies and Tools:** The high rate of adoption of smartphones and tablets facilitates the use of a multitude of mobile tools for safety purposes. Cameras are used by 85% of respondents, with document sharing and project management apps/software used by 57% and 49%, respectively. Use of safety inspection (42%) and GPS/mapping apps (41%) is slightly less prevalent, but still quite notable.

We thank CPWR and United Rentals for their ongoing partnership and support for these studies, and we look forward to continuing to provide this vital information on safety management to the industry in the future.

Stephen A. Jones
Senior Director
Industry Insights Research
Dodge Data & Analytics

Stephen A. Jones leads DD&A's Industry Insights Research division. He is active in numerous industry organizations and frequently speaks at industry events around the world. Before DD&A, Jones was vice president with Primavera Systems (now part of Oracle), a global leader in project management software. Prior to that, he was principal and a Board of Directors member with Burt Hill, a major A/E firm (now merged with Stantec).

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Donna Laquidara-Carr currently provides editorial direction, analysis and content to DD&A's *SmartMarket Reports*. Prior to this position, she worked for nearly 20 years with DD&A's Dodge division, where she gained detailed insight into the construction industry.

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Cover illustration: Raymond Biesinger; Opposite page: Left: Image care of Mortenson Construction, Right: Image courtesy Clark Construction Group, LLC

Left: Mortenson Cosntruction practiced Prevention Through Design (PTD) in their use of prefabrication on Saint Joseph Hospital in Denver, including the exterior wall panels.

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Executive Summary

Construction safety continues to benefit from new approaches and tools, along with ongoing attention to better safety management.
The latest research affirms the business benefits of safety established in the two previous studies in 2012 and 2015, and it also explores emerging trends for safety, from attention to Prevention Through Design (PtD) to the ways in which technologies are helping to improve safety onsite.

Benefits of Investing in Safety

Since the 2012 study, results have shown that contractors experience critical benefits from their safety investments. These not only include the core project benefits on budget, schedule and quality shown in the chart at right, but also business benefits like improved standing in the industry and the ability to contract new work, which are reported by the majority of contractors participating in the study.

Practices Used to Promote Safety

The chart at lower right shows the policies and organizational practices most commonly used to promote safety by all contractors. These findings underscore the high deployment of practices pertaining directly to jobsite workers.

When it comes to less commonly used practices and policies to promote safety, including conducting job hazard analysis/job safety analysis before construction start, carrying out prompt and thorough near-miss and incident investigations, having measurable safety goals and objectives, and prequalifying subcontractors based on safety performance, there is a broad gap between large contractors, especially those with 500 or more employees and small ones, especially those with fewer than 20 employees. In general, that gap exists to a lesser degree in all the practices and policies measured in the study. Since many of these have been demonstrated to be highly effective practices, this highlights a need in the industry to encourage or incentivize smaller contractors to engage in them.

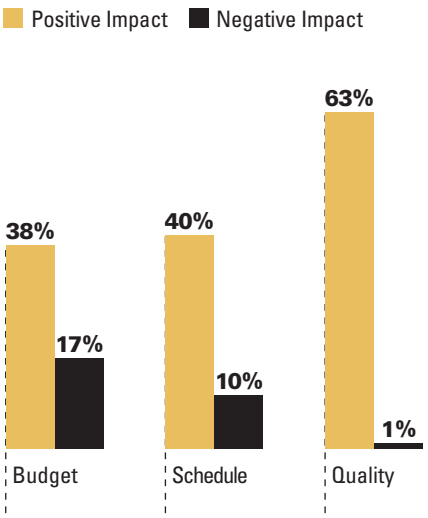
Influential Factors on Contractors

Findings have remained generally consistent since 2012 on the factors influencing contractors to implement their current safety practices, with the highest percentage (82%) reporting that they do so out of concern about worker health and safety, and over two thirds also citing insurance costs and liability concerns (68% for both).

Impact of Safety Practices on Projects

(According to Contractors Who Rate Them as Positive or Negative)

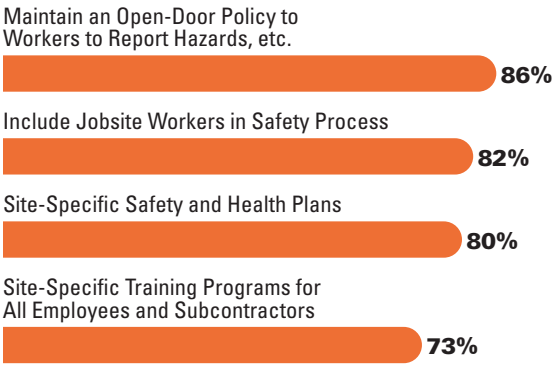
Dodge Data & Analytics, 2017



Policies and Organizational Practices Commonly Used to Promote Safety

(Percentage of Contractors Reporting Use of Each)

Dodge Data & Analytics, 2017



Given this finding, it is not surprising that three quarters say that reduced insurance rates would encourage them to increase their investment in safety, demonstrating the importance of the insurance industry in promoting safety in construction. Other influential factors include increased owner/client requirements and more data on the positive financial impacts of improving safety.

Emerging Trends for Improving Safety

PREVENTION THROUGH DESIGN

Thoughtful, informed design can improve downstream construction safety, a practice formalized as Prevention Through Design (PtD). As the chart at the upper right reveals, most of the design and construction industry are not familiar with this specific term. However, when it is explained to them (see page 18 for the exact definition used in the survey), over half of all architects and about two thirds of contractors believe that they are practicing this at least to some degree. This suggests that more information to raise awareness in the industry will be useful since it is not likely to require a major transformation in terms of how work is currently done.

- **Architects:** During design, architects tend to consider prefabrication and operational safety more commonly than they are performing reviews for construction safety. Concerns about increased liability are the biggest obstacle raised by them to more actively engage in this activity, and they would be mostly likely to be influenced by owners/clients requesting it and by insurance incentives.
- **Contractors:** Most contractors report using permanent safety features, such as those preventing falls, but less than half use prefabrication/modularization, parapet walls at a proper height above the roof surface or grates at skylights specifically as safety enhancements, suggesting significant opportunities for further engagement. They are generally more open to engaging in these practices than architects are, with no obstacle considered serious by more than half of them.

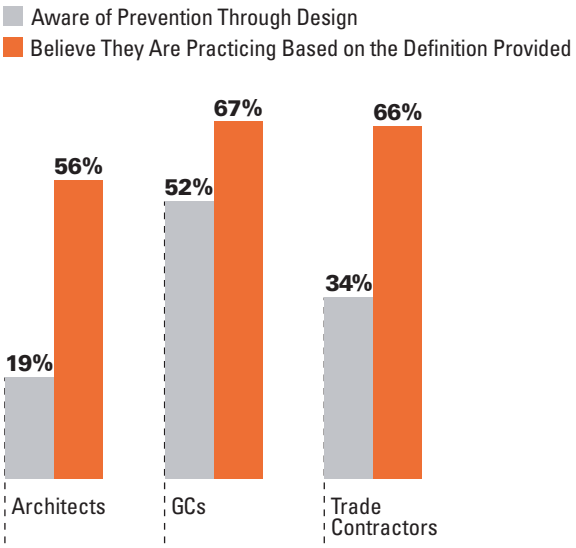
TECHNOLOGY TRENDS: USE OF BIM

Roughly half of the contractors surveyed use BIM, and most of them report that its use has a positive impact on the safety of their projects, a significant increase from the 2012 findings, as the chart at lower right reveals.

Over half of those who find this improvement say BIM improves safety through the following capabilities: the ability to identify potential site hazards before

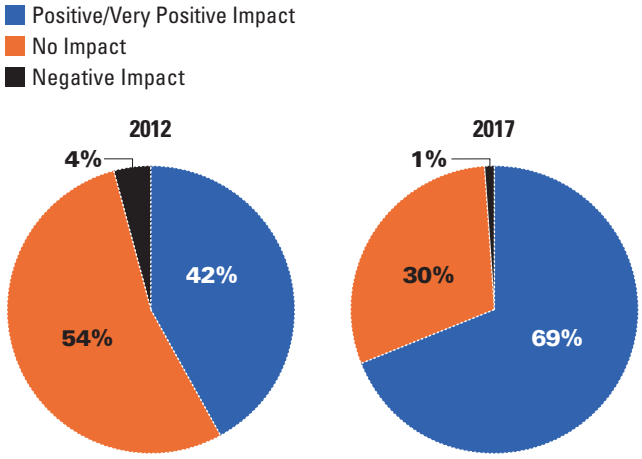
Awareness and Reported Practice of Prevention Through Design (According to Architects, GCs and Trade Contractors)

Dodge Data & Analytics, 2017



Impact of BIM on Safety (According to Respondents Using BIM in 2012 and 2017 Studies)

Dodge Data & Analytics, 2017



construction begins; clash detection; the ability to support prefabrication; and the creation of 3D images.

In addition to the questions asked directly of those using BIM, there is further evidence in the study that use of BIM improves safety through the disparity of responses throughout the survey between those using BIM and those who are not. In addition to wider use of practices and training approaches, BIM users also report increased levels of nearly all benefits reported from safety investments, including reduced reportable injury rates, improved project quality, improved schedule, increased ability to contract new work, and increased ability to attract and retain staff.

TECHNOLOGY TRENDS: USE OF MOBILE TOOLS

Use of smartphones onsite is not only nearly ubiquitous (reported by 88%), but is expected to stay at that level in two years, suggesting market saturation of this technology. Tablet use, on the other hand, while common now (reported by 73%), is still expected to grow by another 12 percentage points to 85% in two years. The top tools being used onsite for these devices are reported at right, but only cameras are widely used, suggesting that the benefits of these tools are just beginning to emerge.

Training and Communication

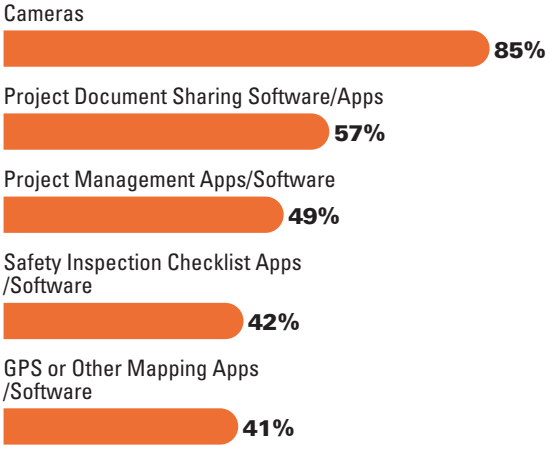
The findings on training remain for the most part consistent with previous studies. Employers who require safety training are still less common than those who merely offer it, pointing to an opportunity in future studies to correlate better outcomes with training requirements.

It is notable that online safety training is currently more widely used by GCs than trade contractors, and that gap is expected to grow in the next two years.

Toolbox talks continue to be the most effective means of communicating with workers about safety, whether as a means to communicate safety messages or to provide information on safer tools, equipment, materials and processes. Training programs are also widely used and considered effective, but other means, including seminars and meetings, emails or videos are infrequently ranked first for effectiveness in these communications.

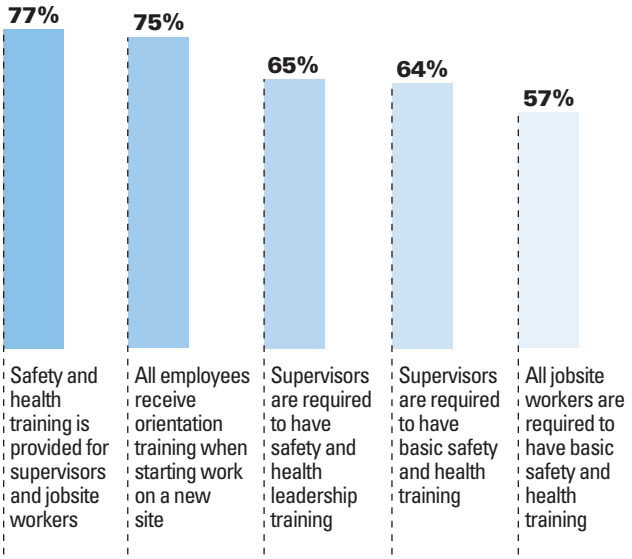
Top Mobile Tools Used Onsite
(According to All Contractors)

Dodge Data & Analytics, 2017



Safety and Health Training Made Available or Required on More Than 75% of Projects
(Percentage of Contractors Requiring or Offering Training)

Dodge Data & Analytics, 2017



Data: Introduction

Since 2012, Dodge Data & Analytics has conducted studies on safety management. The study featured in this report, the third in the series, demonstrates the ongoing importance of safety to the construction industry and emerging trends to achieve safer jobsites.

The report continues to track the evolution of the use of safety practices, the benefits derived from investing in safety management, the top factors influencing safety investments, training practices and trends, and the most effective means of communicating about safety through comparisons with the previous studies conducted in 2012 and 2015.

In addition, the current study revisits the issue of the impact of technology on safety explored in 2012, and demonstrates the increase in the use of BIM and mobile technologies to enhance safety on the jobsite. It also establishes a baseline for the use of emerging technologies like drones, photogrammetry, laser scanning and wearable devices, which can be explored further in later studies. In addition to direct questions on BIM and its impact on safety, the report examines the different responses from contractors using BIM and those who do not about their use of safety practices, the benefits they derive from their safety management approaches and other findings. This analysis again supports the findings from 2012 that contractors who use BIM are also using more safety practices and seeing more benefits from their use.

This study also looks at another emerging trend in safety: the use of Prevention Through Design (PtD). This approach recognizes that safety begins in the early design phases and can be increased by engaging the designer and contractor in consideration of safety factors early in a project. Therefore, in addition to the survey of contractors that has formed the basis of all the previous studies, an additional survey was conducted among architects to measure their awareness of PtD and their use of various practices, along with the influence of a LEED pilot credit to encourage wider use of this practice. Contractors were also asked a few questions about their awareness and use of PtD and its specific practices relevant to them.

Because the concept of PtD is still not widely known, a fuller explanation of this approach is also provided on pages 16–17, along with a case study article examining its use on projects. Various sources for additional information are also available in the Resources section.

Notes About the Data

The data and analysis in this report are based on the responses of 334 contractors conducted from June to August 2017. In addition, the Prevention Through Design (PtD) section of the report includes analyses based on data from a separate survey of architects conducted in June 2017 with 108 respondents.

The architects are analyzed as a single group in that section, but throughout the report, analysis of contractors' responses includes comparisons with studies on safety management in construction conducted by Dodge Data & Analytics in 2012 and 2015.

Throughout the report, several analytic variables are also included in the examination of the contractor responses, including the type of company, size of company, use of BIM and the role of the respondent at the company.

- Type of Company: All responses have been grouped into two categories: GCs (which includes general contractors, construction managers and design-build contractors) and trade contractors (which includes trade and engineering contractors).
- Size of Company: Company size is measured by number of employees.
- Use of BIM: Those identified as using BIM include both contractors who author models and those who work with models created by other companies. Respondents who engage in neither of the activities are considered non-BIM users.
- Role of respondent: From a range of roles identified in the demographic questions in the study, respondents have been grouped together into seven categories: C-level, safety leadership, vice president (other than safety), director (other than safety), project manager, other type of manager and estimator.

A more complete description of each analytic variable and more information on the survey in general can be found in the Methodology section on page 68.

Data: Safety Culture and Practices

Use of Policies to Promote Safety

Contractors were asked about their use of five specific safety policies, and, because their responses varied by size of company, the chart below shows those differences, along with the percentage of all respondents who report using each.

The two most frequently used policies demonstrate the contractors' commitment to site-specific safety practices. Site-specific safety and health plans are used by 80% of all respondents, and by more than 90% of respondents working for large companies (100 or more employees). Site-specific training is used by 73% of all respondents, with high levels of use reported by all except for small companies with fewer than 20 employees.

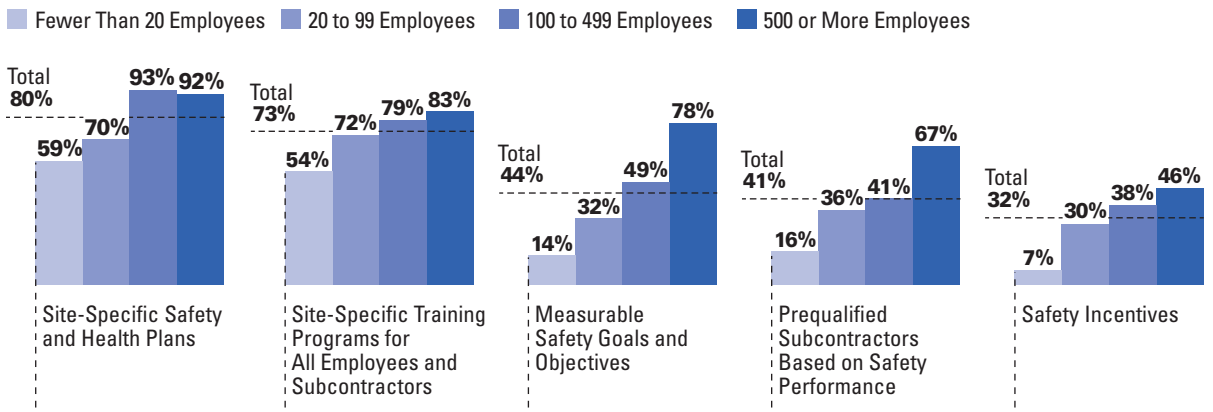
Use of measurable goals and safety objectives is less common overall than the site-specific policies and is only used widely by those working at companies with 500 or more employees. Measuring performance consistently across projects can be resource intensive, but the data gathered can help companies create and achieve better safety goals.

Very large companies are also prequalifying subcontractors based on safety performance more frequently than other companies. Prequalification involves a fundamental change to the way many companies do business, and this may be why this practice is more frequently adopted by larger companies, which are often the trendsetters of industry change.

Use of safety incentives is a relatively uncommon practice across this industry. Many are concerned about inadvertently encouraging less productive behaviors through the use of incentives, such as under reporting of near-misses.

Policies Used to Promote Safety (Percentage Using Each Policy by Size of Company)

Dodge Data & Analytics, 2017



Organizational Practices Used to Promote Safety

Contractors were asked about their use of five organizational practices to promote safety. The use of these practices varied directly with the size of the company, so the chart below shows those differences, along with the percentage of all respondents who report using each.

Maintaining an open-door policy for workers to report hazards, etc., is the most common of the practices studied. Even respondents from the smallest companies (fewer than 20 employees) report wide use of this approach, and all (100%) of those in safety leadership report that this policy is in place at their companies.

Including jobsite workers in the safety process is also common, reported by 82% of all respondents. However, in this case, there is a notable drop in those from small companies who report this. This drop-off suggests that greater inclusion of workers in the safety process from small companies would be beneficial to improving safety in the industry.

More respondents from large contractors report that their company designates competent project safety personnel than smaller companies. For companies with fewer than 20 employees, it is not surprising that many do not have employees specifically designated in safety roles, but the percentage for which this is true in companies with 20 to 99 employees is also notably lower than at larger ones.

Companies with more than 50 employees also more frequently conduct job hazard/job safety analyses before construction begins. Among companies with 100 or more employees, it is a common practice, with 91% reporting that this occurs at their company. In the 2015 study, published in the *Building a Safety Culture SmartMarket Report*, this was considered one of the most effective safety practices by those who conduct these analyses, and helping small companies do so more frequently could also help improve safety in the industry.

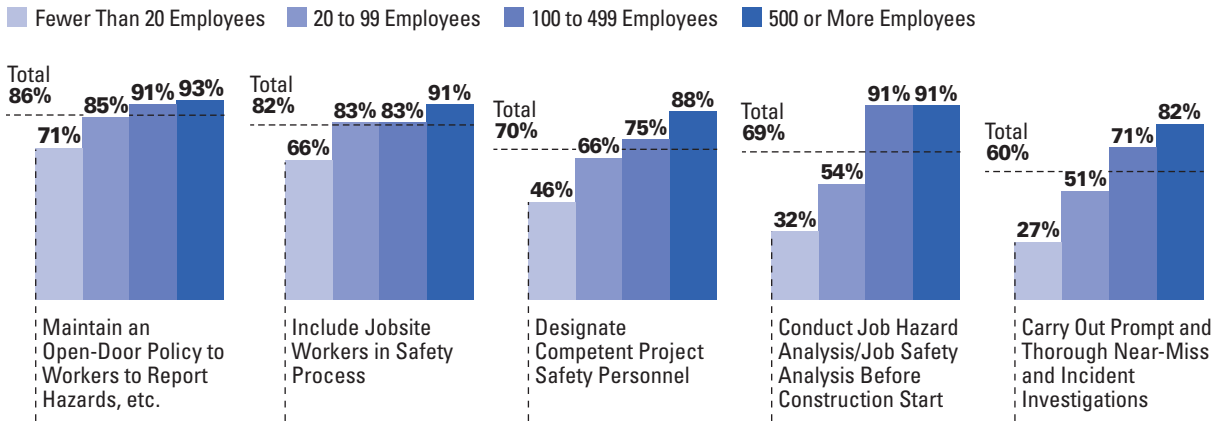
While doing prompt and thorough near-miss and incident investigations is relatively common at very large companies (500 or more employees), it is significantly less common at all others, with very few doing it among the smaller companies. In fact, the difference between each category by size is notable, with likelihood of use increasing as size of company goes up. This may demonstrate the need for rigorous safety protocols for this to occur.

Variation by Type of Company

GCs consistently use these organizational practices more frequently than trade contractors do, with the differences ranging from a 9 percentage point gap in those who maintain an open-door policy to a 20-point gap in those who carry out prompt and thorough near-miss investigations. These findings suggest that outreach to trades on all of these practices would be quite valuable.

Organizational Practices Used to Promote Safety (Percentage Using Each by Size of Company)

Dodge Data & Analytics, 2017



Aspects of a World-Class Safety Program

Contractors were asked to select all the options they believe to be the most essential aspects of a world-class safety program from a list of 12 that was presented to them. The six practices shown at right were selected by more than half of the contractors in the current study, and they are shown in contrast to previous findings from 2012 and 2015.

- **Jobsite workers' involvement continues to be the top practice,** after first moving to that position in 2015. The recognition of the importance of jobsite workers to improve safety that was first revealed in the 2015 study in multiple findings has not abated in the current study.
- **Strong safety leadership abilities in supervisors is also widely recognized as an essential aspect of a world-class safety program.** With jobsite workers involvement and supervisory leadership the factors selected by over three quarters of respondents, it is clear that most contractors believe that a world-class safety program focuses on the jobsite.

Most of the other top options in the current study were also the top options in 2012 and 2015, and in the same order indicated in the chart. However, there is a notable decline in the percentage selecting each between 2015 and 2017, ranging from 9 to 15 points. There are no clear indicators about why this decline has occurred: There are no demographic differences by size or type of company that would align with this finding, nor is there a shift to wider selection of less popular aspects. It will be interesting to track this trend on future surveys to see if there is a continued decline in the number of practices contractors consider essential.

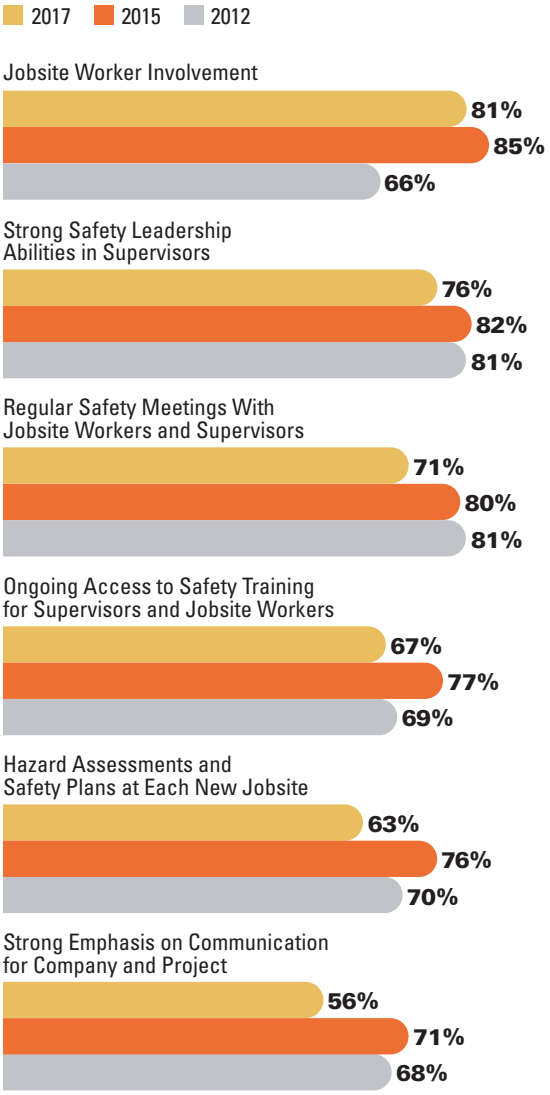
Variation by Size

The size of a company appears to be closely correlated with the degree to which the contractor selects multiple options to this question. The chart at the bottom of page 11 lists the factors with a significant difference in the percentage of respondents by size of company who select each factor as essential to a world-class safety program. Consistently, a higher percentage of respondents from very large companies (500 or more employees) select these aspects than do respondents from companies with fewer employees.

However, beyond that overall trend, some interesting variations by size emerge from the data:

Top Aspects of a World-Class Safety Program (By Year)

Dodge Data & Analytics, 2017



- Small contractors with fewer than 20 employees consistently have the lowest percentage selecting all aspects.
- However, there are a couple of items in which the percentages from small companies and midsize ones are relatively close, including strong safety leadership abilities in supervisors and ongoing access to safety training for supervisors and jobsite workers. The higher percentage of small companies selecting these options demonstrates that for them in particular, jobsite safety practices are the most critical.
- For the most part, large companies (100 to 499 employees) widely recognize the importance of many different aspects of a safety program, nearly as frequently as very large companies.
- However, there are a few notable exceptions where only very large companies have a high frequency of considering these aspects essential, including prompt and thorough near-miss investigations, and regular safety audits.

Variation by Use of BIM

BIM users identify more formalized practices as essential to a world-class safety program than non-BIM users. These practices include hazard assessments and safety plans at each new jobsite, regular safety audits, prompt and thorough near-miss investigations, staff positions dedicated to safety and specific safety goals with associated metrics to measure performance. This may indicate a correlation between companies that invest in BIM and those that invest in more formal processes in general.

BIM users are also notably more enthusiastic about strong safety leadership abilities in supervisors as a part of a world-class safety program.

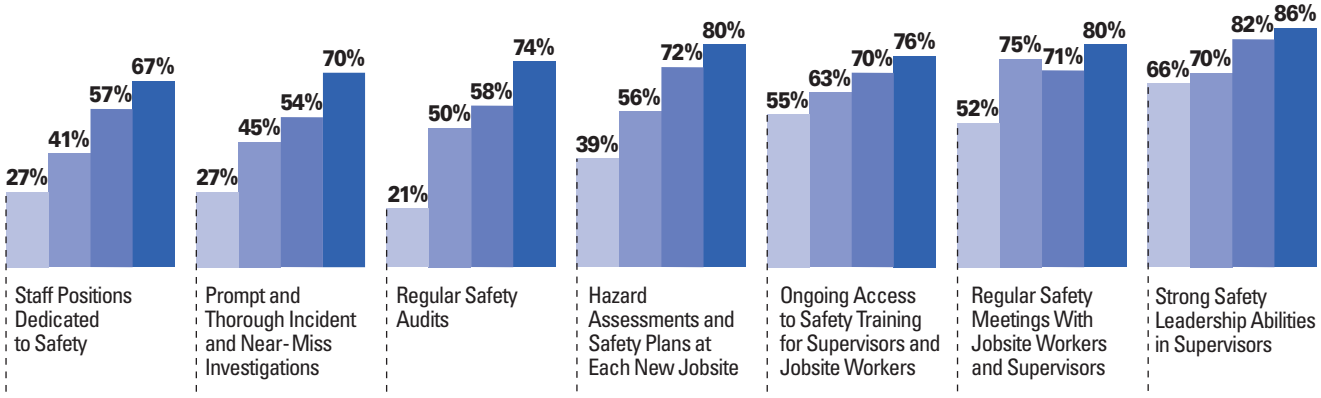
Variation by Role

Not surprisingly, a higher percentage of those in safety leadership roles select many of these practices as essential than those at the C-level, vice president level or director level, or than project managers or estimators. In addition to strong safety leadership abilities in supervisors, safety leadership more highly value aspects that deal with communication and data gathering.

- **Communication:** Strong emphasis on communication for the company and project, and regular meetings on safety among staff at the corporate level are two ways in which communication is highly valued.
- **Gathering data:** Doing regular safety audits, prompt and thorough near-miss investigations, and having specific safety goals with associated metrics to measure performance are aspects that safety leaders value more than those in other roles.

Top Aspects of a World-Class Safety Program With Significant Differences by Size of Company

Dodge Data & Analytics, 2017



Safety Culture Indicators

With the Greatest Impact on Improving Project Safety Outcomes

The 2016 *Building a Safety Culture SmartMarket Report* provided an in-depth view of the level of contractors' engagement with 33 indicators of a safety culture. The current study uses an abridged list of eight indicators and asks contractors to select the ones that they consider to have the highest impact on improving jobsite safety climate and the safety outcomes on projects. Those who selected more than one indicator were then asked to identify the most impactful from among those they selected. All eight indicators and the contractor responses are shown in the chart at right.

- **Training at all levels is considered the indicator with the greatest impact on project safety, selected as impactful by over three quarters (77%) of contractors, and ranked as most impactful by nearly half of them (41%).** For more information about the types of safety training contractors offer and the frequency with which they offer that training, see pages 51 to 56.
- **Empowering and engaging employees is also a top indicator.** It is considered impactful by over two thirds (67%), and over one quarter (26%) of them rank it first as the factor with the greatest impact. This finding continues to reflect the increased recognition first reported in the 2016 *Building a Safety Culture SmartMarket Report* of the importance of engaging jobsite workers in safety.
- **About half of the contractors surveyed select management-level indicators—ensuring accountability at all levels, demonstrating management commitment, improving communication and aligning around safety as a value—as having a high impact on project safety.** Three of these—ensuring accountability, demonstrating management commitment, and aligning and integrating safety as a value—are also ranked first in impact by about one quarter of those who selected them. This demonstrates that management of workers and providing leadership from the top on values are considered important factors for improving project safety, even if they lag slightly behind training at all levels and worker empowerment.

Safety Culture Indicators Considered Most Impactful (According to All Respondents)

Dodge Data & Analytics, 2017

Safety Culture Indicators With Greatest Impact on Improving Project Safety Outcomes

CONTINUED

Variation by Size of Company

The chart at right shows the factors that are considered important by significantly more respondents from large firms (100 or more employees) than small ones (fewer than 20 employees). Notably, most of these are "softer" measures involving attitudes and values rather than direct actions, including empowering and involving employees, demonstrating management commitment, and aligning and integrating safety as a value. It is likely that such measures may need to be codified for larger companies, where they can be seen to have more impact, but that they may be more informally handled at small companies.

Variation by Level of BIM Use

Six of the eight indicators measured are considered to have a high impact by a significantly higher percentage of BIM users than by those not using BIM. While it is likely that this is in part due to higher use of BIM by larger companies, it is also true for indicators with no significant difference by company size, including training at all levels, ensuring accountability at all levels and improving communication. Therefore, the degree to which BIM users place greater value on these indicators is driven by more than the size of the company.

Variation by Role of Respondent

More than half of respondents in safety leadership roles (56%) believe that encouraging owner/client involvement in safety to be important, far more than those at the C-level (30%), vice president level (28%), director level (21%), project management level (32%) or estimators (22%). This may in part reflect the difference by company size since over 50% of the safety leadership respondents work for companies with 100 employees or more. It also may suggest that owner/client involvement in safety is an emerging issue, one that is widely recognized as important by professionals in this area but one that still needs greater attention across the rest of the company.

Most Impactful Safety Culture Indicators With a Significant Difference in Ranking by Large and Small Companies

Dodge Data & Analytics, 2017

case study

Equipment is Replaceable

How Technology is Helping Electrical Line Workers Keep Their Distance

COUTTS BROS., MAINE

The first step in working with electricity is to make sure everything is turned off. But for workers at Coutts Bros., a Maine-based electrical line construction and maintenance contractor, that's not an option: energized, high voltage work is Coutts's market niche, accounting for 90% of what they do.To minimize the inherent risks of this niche, the company is investing in technologies that improve safety on workers' behalf, from robotics to sensory devices. "Any time you can put equipment in instead of a lineman, you always want to do that," says Jared Rossignol, safety director at Coutts. "You can replace equipment."

Each year, Coutts's team inspects between 6,000 and 10,000 transmission structures. This typically entails a lineworker climbing the structures to examine components for signs of deterioration. For some structures, however, this is impossible. Corner poles, for example, are built and strung in such a way that they can be safely climbed only when the lines they support are de-energized. And since clients are reluctant to cut off power to what could be as many as a million people, inspection of these structures has to wait until a power outage occurs for another reason (which may or may not happen), with the only safe option in the meantime being a visual inspection from the ground.

Extrasensory Perceptions

Recently, however, Coutts has begun investing in Unmanned Aerial Vehicles (UAVs), to safely extend inspections of inaccessible poles and other structures beyond what lineworkers can see from the ground. Flown by a licensed military pilot, with photography directed by an experienced lineworker, the UAV collects hundreds of high-resolution images, which can then

Using drones to help with safety inspections makes the process safer.

Shutterstock

CONTINUED

How Technology is Helping Electrical Line Workers Keep Their Distance

COUTTS BROS., MAINE

be downloaded for review. "We can take a picture from 30 feet away, and tell you how many legs are on an ant on the cross-arm," says Rossignol. These images allow lineworkers to identify issues such as cracked insulators, missing cotter pins and wire fray from the safety of a computer terminal.

Introducing something as novel as a UAV into an industry sector where change happens slowly hasn't always been smooth flying. It doesn't help that anyone at all can buy and use a drone, says Rossignol, with examples of irresponsible flying and inappropriate picture-taking making headlines. To resolve client concerns, Coutts provides evidence of professionalism, "showing them that we've hired the right people and have the right policies and procedures in place," says Rossignol. In addition to having a licenced helicopter pilot fly its UAVs, Coutts uses the National Guard's policies and procedures as a template for its own.

Storm Recovery

One of the most hazardous aspects of electrical line work is storm duty. Workers may have to walk or snowmobile along a transmission line for hours in conditions of poor visibility, day or night, looking for the cause of a power outage. "You might not see what's in front of you until you're right on top of it," says Rossignol, noting that there have been numerous cases throughout the U.S. where workers have found an energized line by taking a step onto it or brushing up against it.

It's safer—and faster—to fly a UAV along the line. During a major storm that swept through Maine last winter, for example, in which power to more than 100,000 people was knocked out, a UAV took less than half an hour of flight time to find a tree on the line.

Once the problem is found, though, it is workers who get out and fix it. "It's our job," says Rossignol, "so how do we keep our workers as safe as possible while they do it?" That's where personal voltage detectors, worn like a necklace or clipped to a safety harness, can help. When the detector picks up the electromagnetic field of an energized power line, it begins to beep and flash, alerting its wearer to the need to maintain a safe distance. Having tried out the voltage detectors on storm duty several times, Coutts is now in the process of upgrading to a brighter, louder and more compact version.

At least with live wires, workers know to watch out. But if their own equipment—their truck for example—becomes electrified, an essential tool of the job is now an invisible killer. Every job has a spotter on the ground to make sure bucket or digger trucks don't come into contact with live wires, but Rossignol is watching with interest the emergence of a new product that would supplement the spotter's watchfulness with technology. Expanding the personal voltage detector into a web of linked sensors acting in concert, beacons about the size of a hockey puck can be placed on and around a bucket truck, for example. When one of the beacons gets close to a voltage source, they all sound an alarm, with green, yellow and red lights helping workers to identify which beacon is becoming electrified. "This tool would help us to eliminate a human factor," says Rossignol, "to make sure that even if someone had their back turned as the boom swung around, everyone would still be alerted that the truck had become energized."

Technology in Context

Effective though these technologies may be in reducing the hazards of the job, it is important to note that they are not a stand-alone strategy. They form part of a comprehensive, award-winning safety program Coutts initiated about four years ago, hiring Rossignol, developing a behavior-based process for safety training, undergoing the Associated Builders and Contractors' safety training and evaluation process, and working to change the companywide culture around safety.

All Coutts employees now participate in a program that comprises classroom-based training, standardized testing, and on-the-job training, including simulations in the company's training center of every type of work employees will encounter. Training is reinforced with a quarterly companywide Safety Training Day as well as weekly reviews and Monday morning meetings. The company also encourages employee feedback on its program: "If they hear or see something being done differently by another company that they feel will help them work safer, we explore that method," says Rossignol.

It's in the context of this safety culture that Coutts is continuing to vet and apply relevant technologies. "This is one of the most dangerous industries there is," says Rossignol, "and technology is something we can utilize to make it safer. We'd be silly not to." ■

Prevention Through Design:

Stopping Accidents Before They Start

The best way to keep workers safe from a jobsite hazard is to prevent the hazard from arising in the first place. That's the idea behind Prevention Through Design (PtD), a process in which design professionals explicitly consider the safety of construction and maintenance workers during the design phase of a project, and "design out" risks and hazards across all stages of a project's lifecycle.

"Design is a risk factor," says Jonathan Bach, coordinator of the National Institute of Occupational Health and Safety (NIOSH)'s Prevention Through Design Initiative. Multiple studies based on data from the U.S., Europe and Australia link between 22% and 63% of workplace fatalities to design-related factors. And increasing numbers of these jurisdictions are making PtD mandatory. The U.K., where PtD has been mandatory since 1994, reports a construction fatality rate one fifth that of the U.S.

Emerging in the U.S.

In the U.S., PtD is an emerging best practice. It requires bringing a safety perspective to bear early and iteratively throughout the design process. ANSI/ASSE Standard Z590.3-2011, Prevention Through Design Guidelines for Addressing Occupational Hazards and Risks in Design and Redesign Processes provides guidance for adopting PtD, and the U.S. Green Building Council (USGBC), in collaboration with NIOSH, has tailored a process specifically for the green building industry. Launched in 2015, a PtD pilot credit under the Leadership in Energy and Environmental Design (LEED) certification program addresses both construction and operations and maintenance, requiring the design team to perform a safety review prior to completion of the schematic design phase, and to document protective measures incorporated as a result. Since the launch of the credit, 109 projects (about half of which are located in the U.S.) have registered for it, with seven projects complete so far (one of which, a government project, is located in the U.S.). LEED Technical Director Batya Metalitz describes this uptake as about average for a pilot credit at this stage of development.

While uptake rates for LEED's PtD pilot credit may be average, industry experts report that, 10 years after the launch of NIOSH's PtD Initiative, nationwide uptake is still low: Estimates put adoption at near 0% in the commercial, residential and infrastructure sectors, and between 10% and 30% in the process sector.[1] "In my view we're at a roadblock," says Michael Behm, a Professor in the Occupational Safety Program at East Carolina University.

Obstacles to the widespread adoption of PtD in the U.S. include a lack of safety expertise among designers, a concern that PtD may entail additional cost, and a fear of liability if designers engage with the safety of their design. In addition, for creative professions in which risk is essential to innovation, a cultural shift may be necessary to decouple a perceived link between safety and banality. Behm sees a need for a program to engage architects and enable them to develop a sense of ownership of the PtD process, and for more and better examples to demonstrate that "PtD is not about staying out of trouble, but about opening new doors for creativity and innovation in design."

Overcoming Obstacles

Project delivery method can help compensate for a lack of safety expertise among designers. Integrated Project Delivery (IPD) and Design-Build methods bring a contractor's perspective to the early design phases in which decisions critical to PtD success are made. (Some of the most significant PtD opportunities occur in the first 30% of the design process.) But even a Design-Bid-Build process can achieve effective PtD by bringing on a safety consultant or contractor to advise on the implications of early decisions. Design checklists are publicly available to support the team's work. In addition, USGBC provides two PtD training webinars through its website in support of the LEED PtD pilot credit.

Building safety expertise among designers in the longer term, NIOSH is publishing a series of discipline-specific training manuals. (To date, modules are available for architectural design and construction, reinforced concrete design, structural steel design and

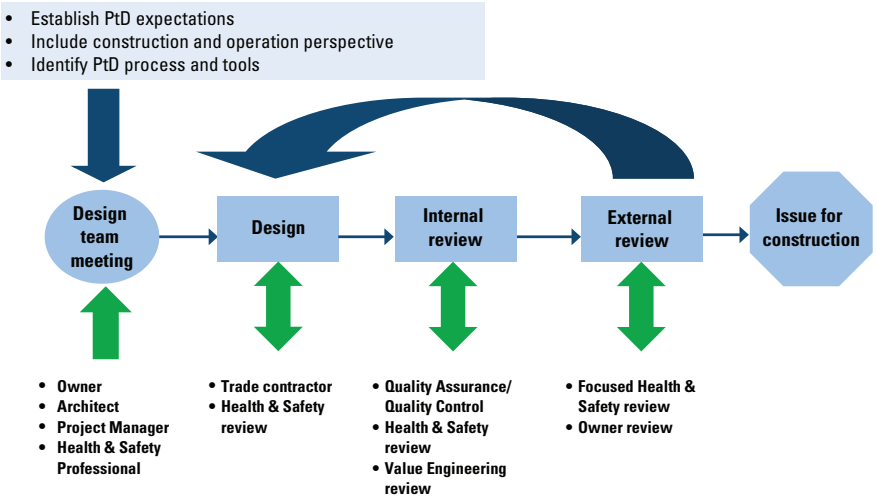
[1] Toole, T.M. and Gambatese, J. (2017). "Levels of Implementation of Prevention through Design in the United States." In Proceedings of the Joint CIB W099 and TG59 International Safety, Health, and People in Construction Conference, sponsored by Nelson Mandela Metropolitan University (NMMU) and Central University of Technology, Free State (CUT), Cape Town, South Africa, June 11-13, 2017.

mechanical-electrical systems, with additional modules forthcoming.) These are intended for incorporation into professional education programs so that emerging designers will understand their impact on construction safety.

To help project teams evaluate the business advantages of transitioning to a PtD design process, NIOSH has created a free Business Case Developer software tool. By making work safer, PtD tends to make it easier and faster, thereby saving direct costs in addition to the indirect costs of accidents. Prefabrication of building envelope modules and utility racks, for example, can achieve both significant cost savings and safer working conditions. For example, Mortenson Construction's analysis of the extensive use of prefabrication on SCL Health's St. Joseph Hospital, Denver, estimated that every dollar spent on prefabrication returned about 13% to the project in quantifiable benefits, with exterior wall panels' benefit-to-cost ratio of 1.74 making it the most valuable of the project's prefabrication strategies.

To mitigate a potential increase in liability from engaging in a PtD process, Clark Hill construction lawyer Douglas Folk advises that most design professionals will need to prepare, especially those who are accustomed to design-only roles on their projects, and sets out eight recommendations. These include acquiring expertise, clarifying responsibilities, documenting hazard analysis and decision-making, and including additional terms in the design professional's contract. Folk also recommends starting small, with a familiar project-type, and allocating sufficient time and fees to implement the PtD process carefully and well.

Prevention Through Design Process
(Hecker et al. 2005)



Incremental Adoption

For project teams interested in an incremental approach to PtD, a recent paper by T. Michael Toole and John Gambatese offers a three-tiered strategy. At the first level, Invisible Safety Constructability, the owner and contractor provide explicit safety input to the designer as part of routine constructability reviews starting early in the design process. At the second level, Enabled Voluntary PtD, the owner seeks a designer willing and able to make a substantive contribution to safety reviews. At the third level, Contractual AE-Led PtD, the owner selects a design firm having demonstrable PtD capability to provide leadership to the PtD process. For each level of implementation, the authors recommend organizational characteristics and project processes that will allow adopters to reduce risks, reduce resources and increase the chances of successful implementation.

In a context of voluntary adoption, "we want to encourage a widespread effort of practical implementation, so that PtD becomes an expected norm," says Jonathan Bach. He expects that design and construction firms working internationally will incorporate other jurisdictions' mandatory PtD into their own best practices and bring it home, compounding education and policy efforts in the U.S., and helping to make sure that more of America's construction workers themselves get safely home. ■

Data: Prevention Through Design

Awareness and Prevalence of Prevention Through Design

Contractors and architects were presented with the following definition from NIOSH about PreventionThrough Design (PtD): "PreventionThrough Design (PtD) involves all of the efforts to anticipate and design out hazards to workers in facilities, work methods and operations, processes, equipment, tools, products, materials, new technologies and the organization of work."

After viewing that definition, they were asked two questions: Were they familiar with the concept of PtD before reading the definition, and based on the definition, do they believe they are practicing PtD? Even those who stated that they were not familiar with PtD were still asked if they practice it since they may be engaging in these behaviors even if they are not familiar with the formal definition of the practice.

Their responses appear in the chart at right, and a few interesting results are apparent.

- **Less than half of all respondents were familiar with PtD before reading the definition.** GCs were most aware of this practice, with 52% of them citing familiarity with it before reading the definition. However, fewer trade contractors (34%) and just a small percentage of architects (19%) were aware of PtD before reading the definition in the survey.
- **Despite low familiarity with the concept, many believe that they are practicing PtD based on the definition.** Around two thirds of GCs (67%) and trade contractors (66%) believe that they are practicing PtD, and over half (56%) of architects believe that they are. However, as later findings make clear, some aspects of PtD are more widely adopted than others.

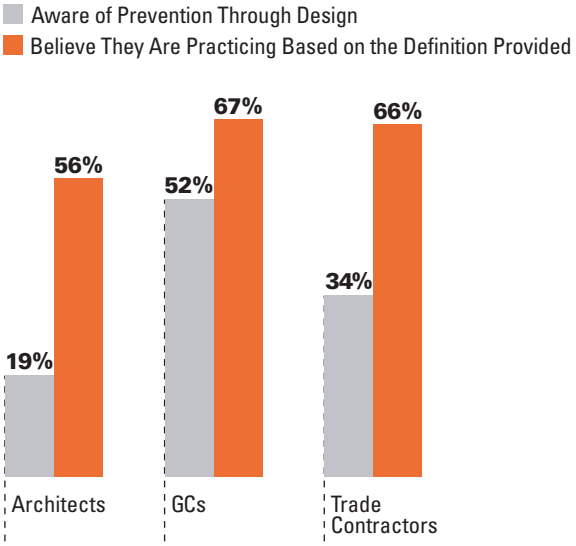
Variation Among Contractors

The following variations apply to those who believe they are practicing PtD.

- **Size of Company:** Over three quarters of contractors working at companies with 100 or more employees (78%) believe they practice PtD, compared with 50% of those at companies with fewer than 50 employees.
- **Use of BIM:** 78% of those who use BIM believe they use PtD, compared with 54% of those who don't.
- **Role:** 79% of safety leadership report the use of PtD, far more than any other role.

Awareness and Reported Practice of Prevention Through Design (According to Architects, GCs and Trade Contractors)

Dodge Data & Analytics, 2017



Architects' Use of Specific PtD Practices

Use of Specific Practices

Architects were asked how frequently they implement four PtD practices, which are listed in the chart at right, by selecting one of the following: never, occasionally, frequently or always. The chart shows those who occasionally, frequently or always use these practices.

Working with the GC and key trades before completion of schematic design to identify opportunities for prefabrication is the top practice that architects at least occasionally engage in, reported by 83%.

Approximately two thirds of architects also report that they consider the operational safety of a building before the completion of schematic design, either through safety design reviews or by using a lifecycle safety approach. **This is notably higher than those who conduct design reviews at this early stage in the project for safety during construction, which is only done by about one half (51%).** This finding may reflect the influence of the building owners, who are the direct clients of the architects, and therefore whose needs may be more top-of-mind than other downstream players in the construction process.

This clearly demonstrates opportunities for improving construction safety through design reviews conducted early in the design process. Increasing the involvement by contractors in the early stages of design may be one way to encourage wider use of this approach.

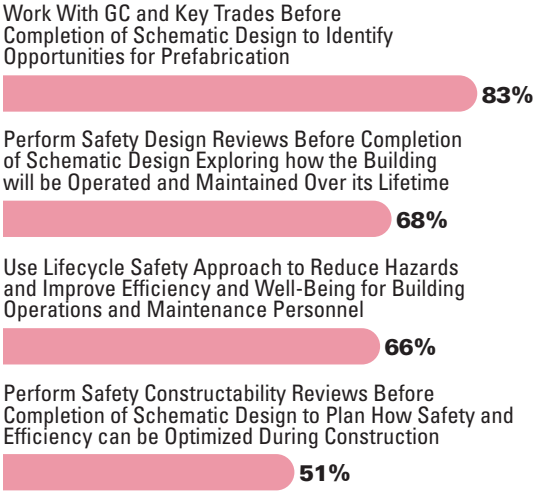
Analysis of Safety Impacts on Building Systems During Construction and Operations

All architects who indicated that they perform safety reviews for construction or for how the completed building will be operated and maintained over lifetime were asked about the specific systems they review.The chart at right reveals the percentage who consider these systems during their constructability and operational reviews.

- **All but recyclables are reviewed by a relatively high percentage for both construction and operational safety impacts.**
- **Safety impacts of exterior systems, including envelope and roofing, are more frequently considered during construction reviews.**
- **Safety impacts of equipment rooms and systems are most frequently considered during operational reviews.**

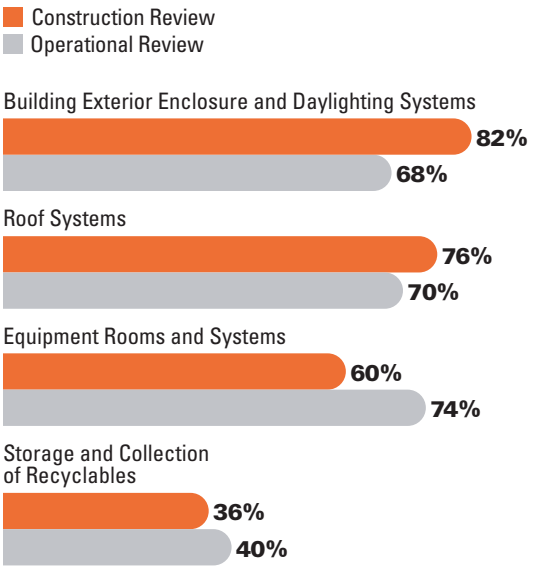
Use of Specific PtD Practices (According to Architects)

Dodge Data & Analytics, 2017



Building Systems Analyzed for Safety Impacts (According to Architects)

Dodge Data & Analytics, 2017



Contractors' Use of Specific PtD Practices

Use of Specific Practices

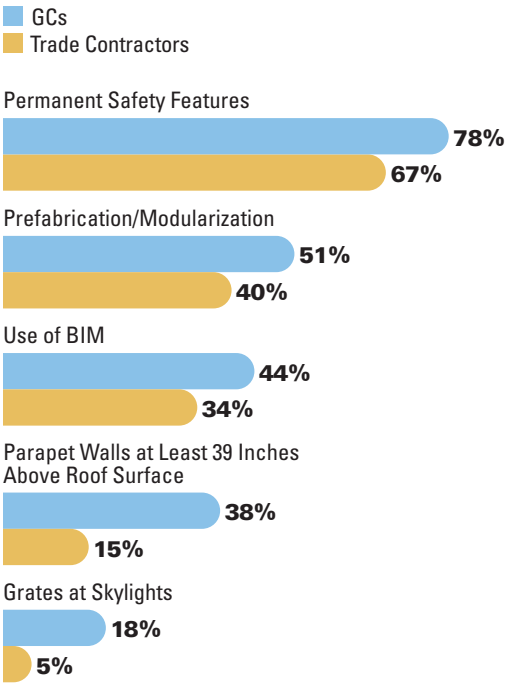
Contractors were also asked about specific PtD practices, but the approach taken with them was different from that with the architects.

- Only contractors who stated that they were practicing PtD in the previous question (see page 18) were asked about their specific practices.
- Contractors were asked about a different set of practices, which are all included in the chart at right.
- Instead of rating the frequency with which they engaged in these practices, contractors were simply asked to check the ones they use.
- No follow-up questions were asked of contractors.

The responses of GC and trade contractors are indicated in the chart at right. Points of interest in the findings include the following.

- **The practices used most frequently by GCs are also used most frequently by trade contractors.**
- **The top practice for both is permanent safety features,** which is more than 25 percentage points higher for both than any other practice, and is clearly a common practice across the industry.
- **A relatively high percentage of both also use prefabrication and BIM,** industry practices that are widely adopted for the many benefits they offer, of which safety is just one.
- **Since GCs bear responsibility for the whole building project, it is not surprising that they report higher levels of use of parapet walls and grates on skylights,** since some trade contractors may not have the opportunity to use either of these.

Use of Specific PtD Practices
(According to Contractors)
Dodge Data & Analytics, 2017



Drivers Encouraging the Practice of

Prevention Through Design

Architects who do not currently practice PtD were asked to rate the influence of a list of eight potential drivers for PtD adoption on a five-point scale, from "no influence" to "very high influence." Contractors were asked to rate the influence of five of the eight drivers. The chart at right shows the percentage of architects and contractors who rated each practice highly influential.

- **The top driver for both architects and contractors is client request.** In particular, most architects (81%) consider client request highly influential, demonstrating the importance of owner advocacy for this practice to encourage wider adoption. Further supporting this inference are the other client-related factors that are also highly influential for more than half of architects, including improved client relationships (61%) and the ability to attract new business (53%).
- **More information about how to practice PtD is an important driver for over half of architects (54%).** It is highly influential for fewer contractors, only 38%. Nearly the same percentage of contractors (40%) also consider lack of knowledge about how to implement PtD a barrier to adoption (see page 23), suggesting that education of both architects and contractors in this area could help to encourage wider PtD practice.
- **While increasing liability is the top barrier for architects not practicing PtD (see page 22), more guidance on controlling liabilities is only a top driver for 40% of them.** This suggests their reluctance to take the chance on increasing liability is greater than their confidence in their ability to control it.
- **Relatively few architects or contractors regard establishing the benefits of PtD as highly influential in their decision to practice it.** This corresponds to the low percentage who believe that PtD has a low impact on safety (see pages 22 and 23), and it indicates relatively wide industry acceptance of the impact of these practices on safety. It suggests that efforts to promote it need to focus on owners, reducing architect liability and information about how to practice it.
- **Most architects and contractors do not believe that greater involvement on integrated teams would influence their willingness to practice PtD.** This finding is surprising among architects because integrated teams could help address both the issues of liability and knowledge for architects. This may reflect larger issues with integrated team contracts than its ability to positively impact PtD.

Drivers Encouraging the Practice of PtD
(Percentage of Architects and Contractors Who Consider Them Highly/Very Highly Influential)

Dodge Data & Analytics, 2017

Barriers to the Practice of Prevention Through Design

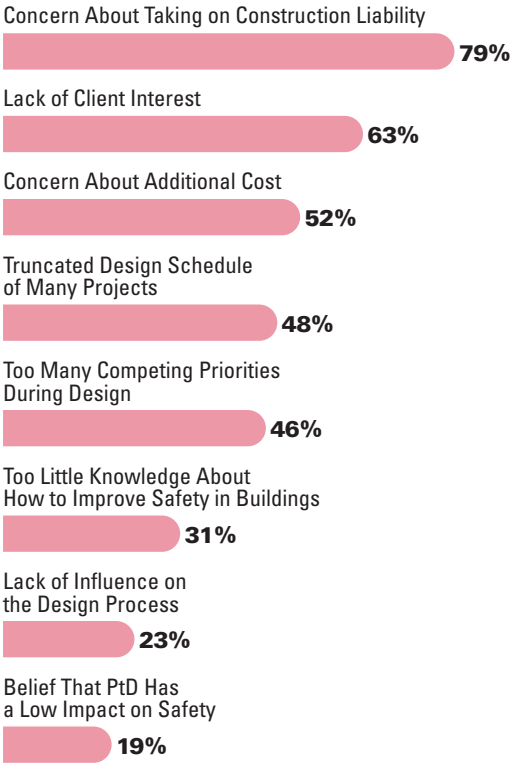
Architects

Architects who are not currently practicing PtD were asked to rate a list of eight potential barriers to their adoption of this approach on a five-point scale, from "no impact" (1) to "would prevent practice" (5). The chart at right shows the percentage of architects who rated each practice with a four or five, indicating that they considered them major barriers.

- **By far, the top barrier is the concern about taking on construction liability.** Over three quarters (79%) consider this to be a major barrier, which suggests that advocates of PtD must address this issue head on to increase its practice.
- **Almost two thirds (63%) believe that lack of client interest is a major barrier.** This finding corresponds with the importance of clients as a major driver that would encourage architects to practice PtD, and it again reinforces the importance of owners to encourage this practice in the industry.
- **About half of architects are concerned about barriers from individual project logistics and priorities,** including concerns about adding costs (52%), lack of time due to truncated design schedules (48%) and competing priorities during design (46%).
- **Almost one third (31%) consider lack of knowledge about how to influence safety to be a major barrier.** While this percentage is lower than many of the other issues, it is high enough for industry education efforts to influence the possibility of wider practice of PtD.
- **It is notable that less than 20% believe that PtD would have no impact on project safety.** This is important because it suggests that if some of these other concerns could be overcome, architects might recognize the importance of impacting safety on the projects they work on, and ultimately regard PtD as an effective means to do so.

Barriers to Practicing PtD (Percentage of Architects Who Consider Them Major Barriers)

Dodge Data & Analytics, 2017



Contractors

Contractors who do not currently practice PtD were also asked to rate a list of potential barriers using the same scale as the architects, but they were only asked about the four barriers indicated in the chart at right.

Less than half of contractors consider any of these to be top barriers to their adoption of PtD. While architects are generally very cautious about their willingness to fully adopt PtD, contractors are clearly far more open to the prospect, probably because they already bear full liability for project safety.

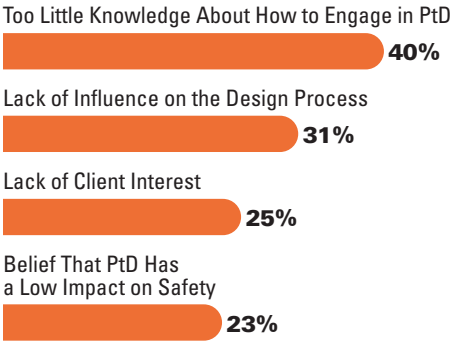
Surprisingly, more contractors are concerned that they lack the knowledge to implement PtD than are architects, with 40% who consider this a major barrier. Since safety has long been the purview of contractors, with great attention paid to it, it is the specifics of what PtD calls for that must be a stumbling block here. This certainly suggests that an education campaign among contractors by proponents of PtD could influence wider adoption.

About one third (31%) also consider lack of influence on the design process to be a major barrier to their willingness to practice PtD. Again, while this is a low percentage when compared with the architects who report some major barriers, it is enough to make a difference if addressed in the industry.

The concern that PtD would not impact project safety has the lowest percentage of contractors who consider it a major barrier, similar to the architect findings. This suggests that industry recognition of the value of this approach is relatively widespread, which may mean that addressing the other issues will help promote wider adoption of PtD as a practice.

Barriers to Practicing PtD (Percentage of Contractors Who Consider Them Major Barriers)

Dodge Data & Analytics, 2017



Interest in Use of LEED Pilot Credit for

Prevention Through Design

In 2015, the US Green Building Council released a new pilot credit in the LEED project certification system for Prevention Through Design (PtD). The credit requires design reviews before the completion of schematic design to consider work safety and health in the construction and operation phases. Projects must document how these reviews led to protective measures being incorporated into applicable building features in both construction and operations/maintenance. There is one point possible.

Over two thirds of architects in this study (69%) work for an organization that has completed a LEED project, and roughly the same percentage (70%) have worked on a LEED project either with this company or with another one. **However, despite wide familiarity with LEED, the majority of respondents (83%) are not familiar with the PtD pilot credit.**

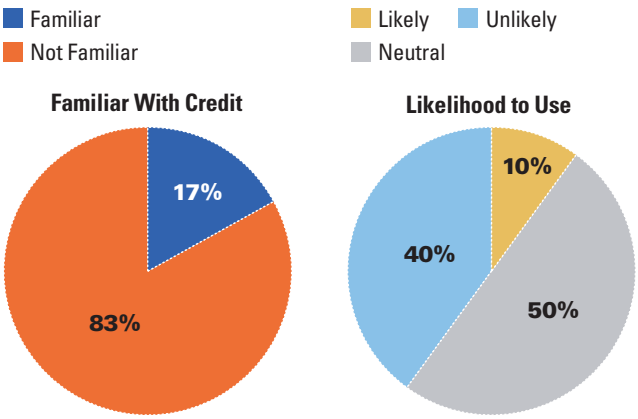
In addition, very few express direct interest in using it, although more are neutral than are negative about its use. To understand their response, all architects were asked to rate several barriers to using the credit, indicated in the chart at right, on a scale of one to five, with one being no concern and five being that it would prevent use of the credit. The chart shows the percentage who rated each barrier a four or five.

- **Concerns about increased liability is the top barrier.** This corresponds to the finding that concerns about increased liability are the top barrier to PtD use in general. (See page 22.)
- **Lack of knowledge about PtD is also an important barrier.** It is a more important barrier to the use of the credit than the use of PtD by architects in general (see page 22).
- **Concerns about the amount of effort required for a one-point credit are also expressed by 42% of architects.** This factor also ranks third in a more general evaluation of the obstacles to using LEED credits, which is consistent with the typical issues raised about LEED credits in general also asked of these respondents.

The findings suggest that addressing the general concerns that architects have about PtD, including increased liability and lack of knowledge, would influence the interest in using the credit. However, they also reveal that the credit itself will not encourage many more designers to consider incorporating PtD in their practice.

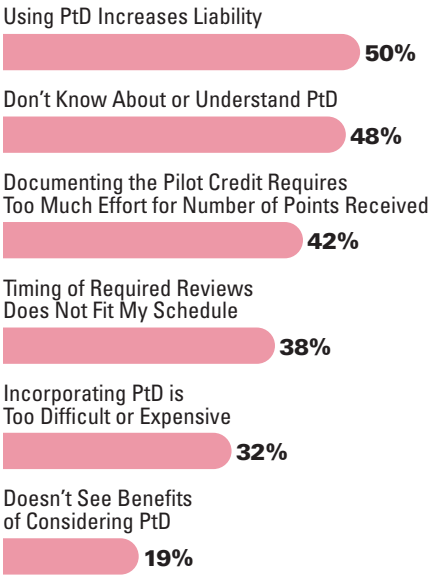
Awareness of and Interest in Using a LEED Pilot Credit on PtD by Architects

Dodge Data & Analytics, 2017



Barriers to Using the LEED Pilot Credit for PtD (Percentage of Architects Who Consider Each Factor to be a Significant Barrier)

Dodge Data & Analytics, 2017



Chronic Exposure

Reducing the Health Impacts of Construction Materials

More than 80,000 chemicals are currently in use in the United States, yet few have been adequately tested for their effects on human health. Multiple toxins, including heavy metals, bioaccumulative compounds and endocrine disruptors, are now found in everyone. Among the most common sources of exposure are building materials.

Efforts to improve indoor air quality typically focus on reducing chronic exposure to toxins for the building's end users, but construction workers' use of the same products across multiple jobsites means their exposures are also chronic. "Construction workers are the forgotten users of these materials," says Jay Bolus, President of Certification Services at McDonough Braungart Design Chemistry (MBDC), originators of the Cradle to Cradle design framework. "It's time the industry looked at that."

Exposure Routes

Construction workers are most commonly exposed to toxins by inhalation, either of volatile organic compounds (VOCs) or of particles from materials that are sanded or cut, and, until recently, product manufacturers had no requirement and little incentive to disclose what these toxins might be. In the last five years, however, growing awareness of the health impacts of building materials has led to increased product transparency. In response to market demand, numerous product declaration platforms, rating systems and certification programs now support project teams in choosing from a widening range of more benign alternatives.

Even with increased product transparency, however, the sheer number of products, chemicals and competing priorities that a project team has to consider makes optimizing material selections for health a major effort. Ironically, when a project team does succeed in getting more benign materials specified, industry sources report that it's often contractors who reintroduce the nasty stuff.

A contractor may fail to read project specifications closely enough to include the more benign products or to allow for budget or schedule implications. Or, seeing an unfamiliar product in the spec, they may simply price it unattractively, rather than make the effort to change. And even when a contractor's leadership does buy into the materials health priority, the message may not reach every worker onsite. These patterns suggest opportunities for information and engagement to better safeguard workers' health.

Dropping the Toxic Load

On the Chesapeake Bay Foundation's Brock Environmental Center, by contrast, it was the contractor, Hourigan Construction, that took charge of sourcing and vetting materials to comply with the stringent requirements of the project's certification goals. Not only did the project achieve LEED Platinum and Living Building Challenge certifications, it palpably reduced the toxic load on the people who built it. "Nearly everybody commented on it," says Tyler Park, the assistant project manager at Hourigan who took on the project's materials brief. "Brock has its own smell—or lack thereof. It doesn't smell like you expect a commercial building to smell."

The research conducted for Brock has made a difference in how Hourigan now selects or recommends products on other projects, insofar as the contractor has a say. The product categories most affected are coatings and adhesives. "The industry has come a long way in a short amount of time to offer products that aren't as offensive to apply or be near," says Park. "In the past, a lot of these items were so strong smelling they would clear out a work area. So not only are the alternatives better for you, but they make fiscal sense from a production standpoint."

Construction firms wanting to understand the health implications of the materials they work with can take advantage of product transparency initiatives and industry publications to conduct their own research, or they can retain a materials consultant to advise them. MBDC, for example, uses an Inventory-Assess-Optimize paradigm to identify a company's high volume, high impact materials, analyze their potential hazards and select more benign alternatives. "You'd be surprised," says Bolus, "at how many construction companies—and even manufacturers and suppliers—don't know what it is they're using." ■

case study

Building Faster and Safer: Prefabrication Contributes to Safety by Design

Saint Joseph Hospital

DENVER, COLORADO

Installation of a prefabricated exterior wall panel.

Image care of Mortenson Construction

Rules, procedures and personal protective equipment are safety's quick fixes, relying on individual workers to apply them once work is under way. More enduring and reliable solutions minimize the role of the worker in implementing safety measures, or eliminate the hazard outright. This latter type of solution needs to be considered long before construction begins. Ideally, Prevention Through Design (PtD) is a deliberate, safety-driven effort, but it can also occur as a productive byproduct of achieving other priorities, as happened at SCL Health's Saint Joseph Hospital, in Denver.

The project schedule for Saint Joseph, an 831,237-square-foot, 360-bed facility completed in 2014, allowed only 30 months for constructing a building for which linear, onsite construction would have required 36 months. "This is beyond fast track," Rob Davidson, then principal at H+L Architecture, says in a short film about the project. "In fact, I've heard it called psycho track." To meet the required 18% schedule compression, the project's construction manager, Mortenson Construction, proposed building major components concurrently, using prefabrication. This strategy not only brought the ambitious schedule within reach, it did so in a way that mitigated the need-for-speed's potential impact on safety.

Safety Advantage of Prefabrication

Prefabrication, often chosen for its advantages for schedule, quality control or logistics, is also one of the most effective strategies for PtD. Compared to onsite construction, prefabricating building components in a warehouse provides safer conditions through reduced congestion, better ergonomic positions, environmentally controlled spaces and reduced schedule demands.

In a study Mortenson conducted to quantify the costs and benefits of prefabrication on Saint Joseph, the company concluded that the strategy had averted seven safety incidents. "Prefabrication is proven to positively impact safety," says William Gregor, vice president of operations at Mortenson. "Hallways were less crowded, there were fewer lifts on the exterior and interior of the building, and significantly less material, noise and dust." The estimate of seven safety incidents averted is based on the ratio of total onsite labor hours to total OSHA-defined, onsite safety incidents, says Gregor. This ratio was then applied to the 150,500 labor hours that prefabrication diverted offsite—where zero safety incidents occurred.

The decision to prefabricate occurs early in the design process, usually before design is 30% complete. This is because prefabrication is most effective when a project comprises multiple repeatable items. Prefabrication also depends on early integration of the construction perspective into the design process. Saint Joseph's project delivery method, Construction Manager at Risk, helped with this, enabling early construction advice, accelerating decision-making and facilitating owner-architect-trade coordination.

The building components the project team identified as most conducive to prefabrication included 440 bathroom pods, 250 exterior wall panels, nearly a mile of multi-trade

CONTINUED

Saint Joseph Hospital

DENVER, COLORADO

utility racks, and 376 patient-room headwalls. Each prefabrication effort required the design team to integrate constructability considerations, and achieved its safety outcomes in tandem with cost- and schedule-related benefits.

Win by Win

Prefabricating the bathroom pods diverted 78,000 hours to safer, offsite conditions, accounting for more than half of the project's total labor hours diverted. Achieving this component of the prefabrication effort necessitated significant coordination among the owner, design team, supplier and construction manager to finalize bathroom sizes, locations and finishes much earlier in the project than usual, and entailed a direct cost increase of 4.6% compared with site-built bathrooms. However, this extra effort and outlay returned almost 130% of direct costs in indirect savings, knocked 52 days off the schedule and averted an estimated four safety incidents.

For exterior wall panels, prefabrication efforts focused on the hospital's upper four floors (the ones with the most repeatable elements), with panel size and details coordinated between the framing subcontractor, structural engineer, architect and construction manager. Much of this coordination occurred through building information modeling (BIM), which also enabled the project team to see, while still in design, that integrating a lifting apparatus into the panels would help ensure safer and more seamless installation. Offsite, the production line for the panels included numerous jigs and templates to facilitate the work, and it allowed craft workers to fabricate the walls at a comfortable height on elevated tables. The panels were sent to site complete with framing, brick ledge, sheathing, air barrier, insulation and brick ties: Only the detailing of the connections between panels remained to be done onsite. This enabled the building to be closed in much faster than usual, eliminating fall hazards sooner and enabling interior work to begin in a protected environment. Prefabricating this element shortened the schedule by 41 days, returned 174% in indirect benefits for each dollar of cost, diverted 33,000 labor hours offsite and averted an estimated two safety incidents.

The multi-trade rack (MTR) portion of the prefabrication effort supplied nearly a mile of prefabricated MTRs to the project. The production line produced and stored up to two floors of MTRs ahead of onsite construction, essentially removing these trades from the critical path; the mechanical subcontractor transported, hoisted and installed the MTRs; and onsite crews completed the system by tying together five-foot gaps between the racks. Hazards mitigated through this approach include overhead work and site congestion in main corridors.

As with the bathrooms and wall panels, the effort entailed intensive coordination among project team members to group and design the utilities for effective and efficient prefabrication. In the end, the MTRs achieved a 122% benefit-to-cost ratio, saved 20 workdays, diverted 24,000 hours offsite and averted one safety incident.

The fourth component in the prefabrication effort, patient-room headwalls, provided improved certainty and quality control for a 93% benefit-to-cost ratio, diverted 16,000 labor hours offsite and averted one safety incident.

"Recordable injury rates plummet in a warehouse compared with the construction site, and every labor hour diverted to the warehouse reduces the probability of a safety-related incident," Mortenson's study concludes. "The use of prefabrication was, without a doubt, a major contributor to the success of the Saint Joseph project, and significantly reduced the typical risk of a highly technical, aggressively scheduled hospital project." ■

stats

Project Facts and Figures

Completion Date
2014

Size
831,327 square feet

Construction Cost
$405M

Owner
SCL Health

Architects
Davis Partnership Architects, H+L Architecture, ZGF Architecture

Construction Manager/ General Contractor
Mortenson Construction

Bathroom Pod Manufacturer
Eggrock Modular Solutions, a division of Oldcastle

Framing Subcontractor
South Valley Drywall

Mechanical Subcontractor
U.S. Engineering

Casework Subcontractor
ISEC

Interview: Thought Leader

Anthony (Tony) Colonna, Senior Vice President, Innovative Construction Solutions, Skanska USA

Tony leads an organization responsible for strategically integrating new technology, automation and advanced construction techniques into everyday planning and operations activities, including virtual design and construction; prefabrication and modular building; and Skanska's national Innovation Grant Program.

How has safety technology for construction evolved in recent years?

COLONNA: There are technologies that are evolving in other industries first but getting applied to the construction industry. I think there is a recognition out there that construction is fertile ground for new technology, and there seems to be more openness to looking at new technologies and new ideas than there was five to 10 years ago.

For example, we are working with a company called Triax on a new product. The origin of their research was with the NFL. They were helping the NFL study concussions. They did this by instrumenting the helmets; collecting data that resulted from impacts; taking the profiles; and then matching different profiles to when a concussion occurred. They use a lot of accelerometers. In looking at construction, they said "if we can profile a concussion hit, we can profile a trip or a fall." That was the origin of this device that we're starting to look at. We've done some local pilots and are doing an expanded pilot. It's expanded to being able to profile safety incidents.

I've seen them evolve the product in just the last 12 months. As they learn more about the industry, they look at: If someone will wear that device, what other safety aspects can we look at? What if we put in an alarm, so that if you had to evacuate the site, everyone would hear it. You could use it from a security standpoint because you can monitor everyone who is on the site. So, if you evacuate and you had one person missing, you could use a proximity technology to find that missing person.

So, what started as, "We know how to profile data that comes from an accelerometer," becomes an application for the construction industry. And as they've learned more, they've built in more features that address a number of other safety issues.

What role do companies like Skanska play in development of safety technology for construction?

COLONNA: What companies like Skanska can bring to the table is the domain knowledge of what a construction site is; what the issues and problems are that we're looking to solve; and to give these start-up companies the opportunity to pilot. We've seen technology work in a controlled environment, but [what happens for example] when you get into the field and you didn't account for the fact that there would be [so much] dust? Giving them the opportunity to pilot the technology in a real-life environment is really important.

What is the biggest obstacle to adoption of these technologies?

COLONNA: A lot of the recent safety technology involves personal wearables. There is a degree of skepticism in the workforce [about this] ... A lot of people will look at that and say, "You just want to know where I am." We can show them that the safety device is about monitoring any dangerous or negative impacts you might have.

That kind of skepticism is universal. It's not union versus non-union. We've seen similar behaviors on both sides of the fence. It's really something that needs to be explored. When we do these pilots, as much as we're studying the technology, we're also studying the human behaviors. Trying to understand where people's heads are at. What are their fears? How can we get them to adopt the technology?

Do safety technology companies understand the needs of the construction market?

COLONNA: A lot of the companies we get involved with seem to have a piece of the puzzle. They understand a little bit. But [frequently], for their product to create value, they need to expand.

One company we worked with—which was another human trackable device for safety and security—one of the issues they learned about from talking with us was tracking safety certifications, especially in a metro area like New York, where a worker might have to prove that they have scaffold training on six different jobsites in a week. When they learned about this, they said it would be simple to attach a database to the electronic badge. Now, if they

take that badge from Skanska site to Skanska site, all of their training and certifications would go with them. I think that's an example of a tech start-up learning more about the problems that we have.

How field-ready are these technologies when you first use them?

COLONNA: It's very much an evolving technology area. What we've tried to do is create a living lab in our Boston office. Before we try the technology on a jobsite, we use it in our office. We have tracking systems there, environmental monitoring systems, and we test them out there first.

I will tell you that things then get into the field and do not work as prescribed. An example: I was very excited about some exoskeletons that we piloted on the West Coast. We used them with a carpentry crew that was going to do a lot of overhead drywall and construction. We went to the lab first and tested the suit in the lab. It was phenomenal. One of the women, who works for me, said she could lift 40 to 50 pounds like it was nothing. When we got into the field, we had to convince these construction workers that no one will make fun of them for wearing this suit. We got some volunteers to try it out. We found that it didn't last as long as we hoped. There were some mechanical design flaws and it really didn't hold up. But if they go back and correct what we saw, I'm willing to try it again.

That's a pretty typical example. Nothing I've seen has gone into the field and worked as described. And it's not just the start-ups. Even some Fortune 500 companies have technologies that have not worked as advertised.

How do economics factor into the equation?

COLONNA: A lot of these systems require infrastructure. For example, you can't just wear a badge; you have to have a mesh network on the construction site. So, with a lot of the technology, it's not as simple as just putting the wearable on, it's the infrastructure that goes with it. That infrastructure can be pricey. The economics of all of these solutions is something that's always reviewed.

We look at the technology aspects, but we also look at the use cases, the economics and the business models. One badging system company said, "We will give you the badges. You hand them out in the morning and collect them in the afternoon." I said, "You think we have the resources for handing out 300 to 400 badges and tracking them down at the end of the day? Then making sure the battery works?" There was a lot of discussion. They had to rethink their business model. Our resources are limited on a construction site. They need to provide a turnkey solution in terms of the logistics and how to manage their product in the field.

That's another thing that I run into. They haven't thought through the business model and the logistics of how they manage their product.

Where is safety technology headed in the coming years?

COLONNA: What I see is that adoption is driven by personal safety—and that's why you see more and more wearables. What will help technology move forward is if they can provide value in multiple areas.

For example, a company starts with a device that is focused on safety, and they learn that the safety is very good, but what's also important is real-time visibility into who is on the jobsite. Certain clients require me to monitor who is on the jobsite, so companies put in very expensive turnstiles. If I can use a system, and it allows me to replace all of these turnstiles, that would provide value. I want the safety benefit, but economically, if you could also be my security system, that makes the sale a lot easier. The message is that if you can solve multiple business problems, with one of them being safety, I think that's a quicker path to adoption. ■

Data: Technology and Safety

Impact of BIM on Safety

Respondents who use BIM were asked about the impact that they believe their use of BIM has on safety. Those using BIM were asked the same question in the 2012 study. The results of both studies appear on the right.

In the last five years, a much higher percentage of contractors using BIM (69%) report that it has a positive impact on safety than did five years ago (42%). Several factors likely contribute to this finding, including greater experience with BIM and the development of better tools like photogrammetry that can be employed within the model to impact safety.

Certainly, the positive impact of BIM on safety is likely part of the reason why BIM users report seeing stronger benefits from their safety practices, as is reported on pages 40 and 44.

Variation by Size

As the chart at lower right demonstrates, over three quarters of contractors working at companies with more than 100 employees report a positive impact on safety from their use of BIM. This corresponds to the higher levels of BIM implementation consistently seen among larger companies in other Dodge Data & Analytics' studies, and it supports the inference that greater BIM experience leads to wider recognition of how to use BIM to improve safety.

Variance by Role

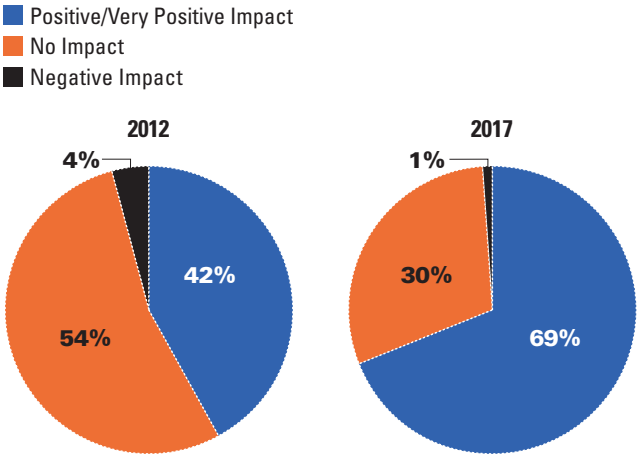
Since only about half of the respondents report using BIM, the number of respondents in each role responding to this question is relatively small. However, there is a trend for a relatively high percentage of those in leadership roles (other than those at the C-level) to report a positive impact from BIM:

- **95% of director-level respondents (other than safety professionals)**
- **80% of safety leadership**
- **74% of vice presidents/senior vice presidents**

These findings are in contrast to project managers, only 57% of whom believe BIM has a positive impact on safety.

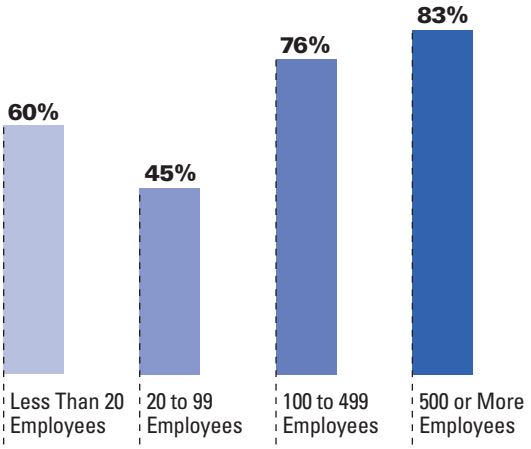
Impact of BIM on Safety
(According to All Respondents Who Use BIM in 2017 and in the 2012 Study)

Dodge Data & Analytics, 2017



Contractors Reporting BIM Has a Positive Impact on Safety (By Size of Company)

Dodge Data & Analytics, 2017



How BIM Improves Site Safety

Respondents who use BIM and who also believe its use positively impacts site safety were asked to select the aspects of BIM that improve safety onsite.

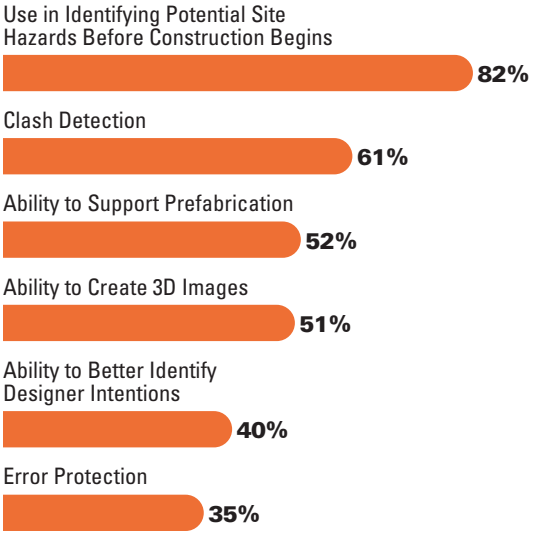
As the findings in the chart at right demonstrate, most contractors (82%) believe their ability to use BIM to detect site hazards before construction begins improves safety. Being able to create an effective plan for dealing with hazards in advance can help with training and employee awareness and play a critical role in a safety program.

Being able to visualize in 3D is another way in which BIM helps with planning and training for safety onsite, and that is selected as contributing to its positive impact by about half (51%) of contractors. However, this is far more commonly selected by BIM users at companies with more than 50 employees, than at ones with fewer than 20 employees, which suggests that more experience or more sophisticated BIM use may be required to fully take advantage of this benefit.

Clash detection is another aspect of BIM that many contractors (61%) find improves project safety. The ability to avoid clashes can lead to better workforce planning onsite and fewer hazardous situations. While the number eligible to respond is relatively low, project managers are particularly enthusiastic about this aspect of BIM, with 88% selecting it as a way in which BIM improves site safety.

The use of prefabrication to improve safety is a well-accepted practice in the industry. BIM's ability to support prefabrication is seen by about half of contractors (52%) as contributing to its positive impact on safety.

Aspects of BIM That Improve Site Safety
(According to Respondents Who Find That BIM Improves Site Safety)
Dodge Data & Analytics, 2017



Stages at Which Safety Professionals Are Involved

In the BIM Process

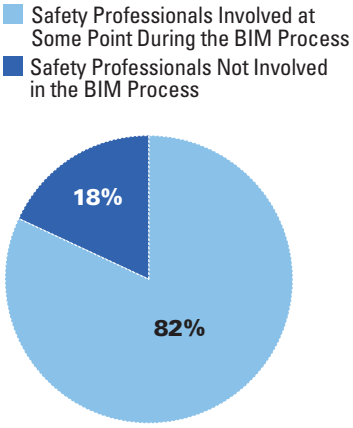
Contractors who use BIM were asked to select the stages at which construction safety professionals are involved in the BIM process on their projects. They were allowed to select all applicable stages, or they could indicate that safety professionals are not involved in BIM at their company. The charts at right show the overall involvement of safety professionals in BIM and the stages at which they get involved.

- **Getting safety professionals involved in BIM is a common practice.** 82% of contractors report that they have safety professionals involved at some point during the BIM process, further supporting relatively wide recognition of the impact BIM use can have on safety.
- **Involvement in the earlier stages of design is less common than just prior to construction start or during construction.** Less than one fifth of BIM users report that their safety professionals are involved at design inception (18%), after structural members are designed (15%) and after mechanical systems are designed (14%). However, nearly half report that safety professionals are involved just prior to construction start (41%) and throughout the construction process (49%).

Earlier involvement by safety professionals in the BIM process could help increase consideration of safety throughout the design process, leading to safer projects.

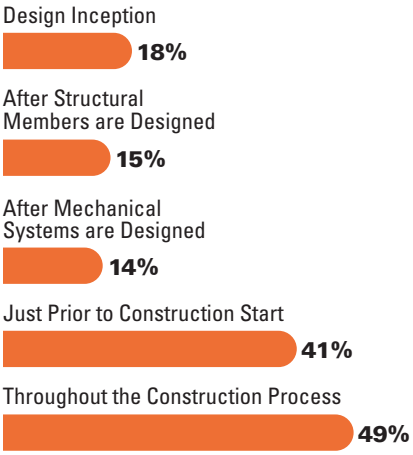
Involvement of Safety Professionals in the BIM Process (According to Contractors Using BIM)

Dodge Data & Analytics, 2017



Project Stages at Which Safety Professionals are Involved in the BIM Process (According to Contractors Using BIM)

Dodge Data & Analytics, 2017



Use of Mobile Devices Onsite

Contractors were asked to select the mobile devices they use onsite now and those they expect to use onsite in two years as part of their construction process. The findings demonstrate that mobile tools are entrenched on the jobsite.

- **Smartphones are widely used, and the findings suggest that their use may have saturated the market.** 88% of contractors use smartphones onsite now, and the same percentage intend to do so in two years, suggesting that all those interested in deploying this device have done so.
- **Tablets expect to see a sharp increase in use in the next two years.** While they lag behind smartphones now, they are still used by nearly three quarters of the respondents (73%), and 85% expect to use them in the next two years. More construction-related apps, more affordable tablets and greater familiarity with the use of tablets outside work may all be contributing factors to this expected increase.
- **Laptop use sees a slight drop from the percentage using them now to the percentage expecting to use them in the future.** The drop is very small, only 5 percentage points, but laptops are the only technology with fewer expecting to use them in two years than use them now.
- **Use of GPS devices and handheld devices is limited, but still trending upward for 2019.** These devices are used by less than one quarter of respondents, but minor growth in use is forecasted by the survey respondents in the next few years. A small but notable percentage of contractors still see a future for these devices.

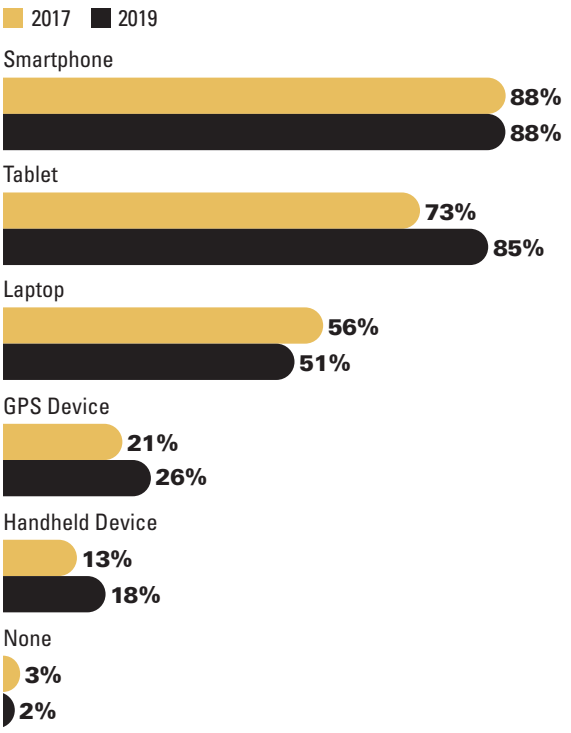
Variation by Type of Company

More GCs use smartphones, tablets and laptops onsite as part of their construction process than do trade contractors, as can be seen in the chart at right.

By 2019, the gap closes notably, especially in the use of tablets, with a 16 percentage point leap between trade contractors using tablets now (65%) and those who expect to do so in two years (81%).

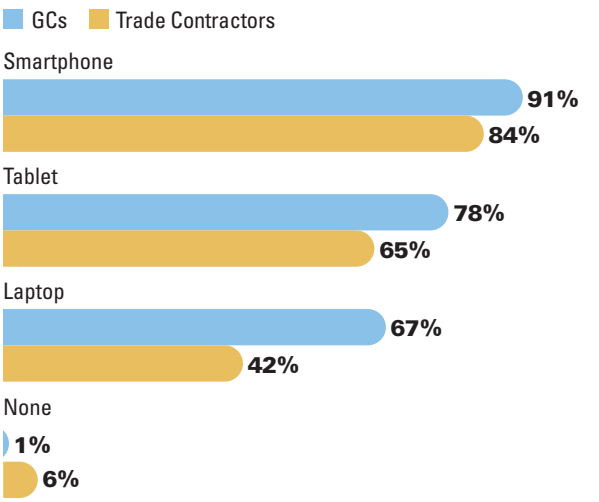
Use of Mobile Devices by Contractors as Part of the Construction Process

Dodge Data & Analytics, 2017



Use of Mobile Devices as Part of the Construction Process (By Type of Company)

Dodge Data & Analytics, 2017



Use of Mobile Tools Onsite

Contractors were asked which tools they are currently using on their mobile devices. Some are directly related to safety, but all can impact safety management. They were allowed to select all that they use from a list of 15 tools. The chart at right shows the tools used by more than 20% of contractors, and the chart on the following page shows all the significant differences in use between GCs and trade contractors.

Most Widely Used Tool

85% of contractors use cameras. Not only is this use nearly ubiquitous, but it is 28 percentage points higher than the next most popular tools. This finding is consistent with the findings from a similar question asked in 2012, and it clearly reflects the power of being able to easily and effectively document and share site conditions and work progress to improve safety.

Frequently Used Tools

About half of contractors use a variety of tools that help them manage projects and people, and communicate more effectively. GCs also tend to use all these tools more frequently than trade contractors, often due to the responsibility they hold for document distribution, project management and safety on projects.

- **Project Document Sharing:** Software and apps that support the sharing of project documents are used by 57% of contractors overall. Making sure all those working on the project have the most up-to-date documents can have safety implications onsite. More GCs (61%) use this software than trade contractors (51%), most likely because they need to keep all project team members up to date.
- **Project Management:** Project managers can better plan for and address safety concerns when they have greater transparency about onsite issues. Software and apps that support project management are used by 49% of contractors, a notable increase from the 38% who reported using these tools in 2012.
  - **Type of Company:** They are also used by twice as many GCs (62%) than trade contractors (31%).
  - **Size of Company:** They are more frequently used by companies with more than 500 employees than they are by companies with fewer than 50 employees.
  - **Use by Role:** Around 40% of contractors report that site superintendents and senior management use these tools onsite, compared with approximately one quarter reporting their use by safety directors or foremen, and only 6% believe they are used by jobsite workers.

Top Mobile Tools Used Onsite
(According to All Contractors)

Dodge Data & Analytics, 2017

- **Safety Inspection Checklist:** These apps/software are the most commonly used safety tools measured in the study. They are also much more widely used than they were in 2012, with a jump of 12 percentage points from 30% to 42%.
  - **Type of Company:** These tools are also used by nearly twice as many GCs as trade contractors.
  - **Size of Company:** They are used more frequently by contractors from companies with fewer than 20 employees than contractors from larger companies.
  - **Use by Role:** Over half (56%) of contractors believe safety directors at their company use these tools onsite, and about one third believe that site superintendents and foremen are using these tools.

- **GPS or Other Mapping Tools:** The ability to track equipment and see the location of specific employees through GPS technologies can have strong safety implications. While still in frequent use with 41% reporting that they employ these tools, they are less commonly reported than they were in 2012, when 51% of contractors were using them.

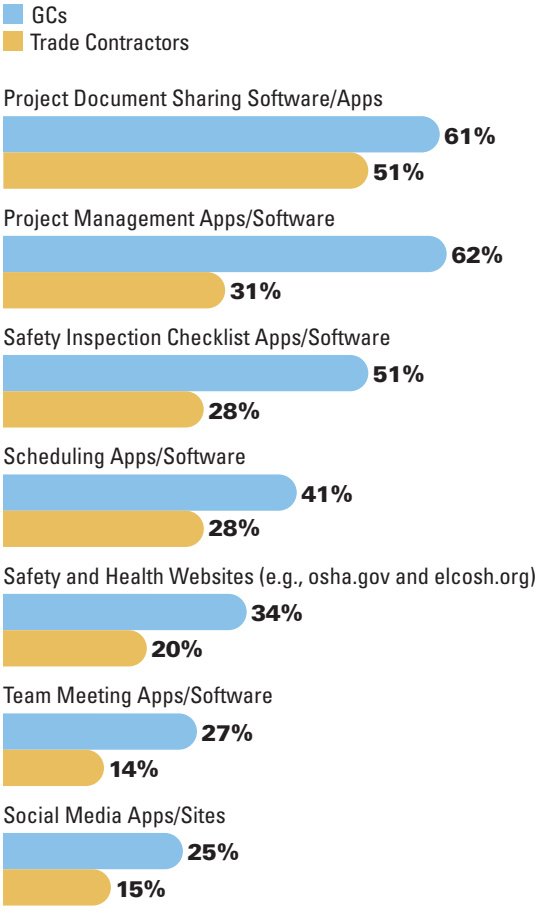
Moderately Used Tools

Around one quarter to one third of contractors report that they use tools for scheduling, to improve safety and communication, and BIM also lands in this category.

- **Scheduling:** Again, a shared understanding of employee engagement onsite can have safety implications. Scheduling software/apps are used by more than one third (36%) of all contractors, and they are used more frequently by GCs (41%) than by trade contractors (28%). 30% of contractors believe that they are used by site superintendents and 27% believe that they are used onsite by senior management.
- **Safety Training and Information:** About one third (35%) do safety training with their devices, and slightly fewer (28%) are using their devices to access websites with information about safety.
  - **Type of Company:** GCs are more frequently visiting these websites than trade contractors, but they both report relatively the same level of use of tools for safety training.
  - **Size of Company:** Both are used more frequently by contractors who work at companies with 500 or more employees than by those at companies with fewer than 100 employees.
  - **Use by Role:** Both are also believed to be used most frequently by safety directors, far more than by site foremen, supervisors, senior management or jobsite workers.
- **Communication:** Roughly the same percentage are using two types of communication tools: meeting apps and social media. These findings are consistent with those from 2012. GCs use both of these tools more frequently than trade contractors do, but there are no significant differences by size of company.
- **BIM:** While 50% of survey respondents overall report using BIM, only 21% say that it is used onsite. Software providers may need to consider how to make these tools better suited to use onsite.

Mobile Tools Used Onsite (Tools With a Significant Difference in Use by GCs and Trade Contractors)

Dodge Data & Analytics, 2017



Emerging Technologies

This study provide a baseline for the level of use of several emerging technologies that are all used by less than 10% of contractors currently, including risk management software/apps, reality capture and the NIOSH ladder safety app.

Differences in Use of Mobile Devices by Role

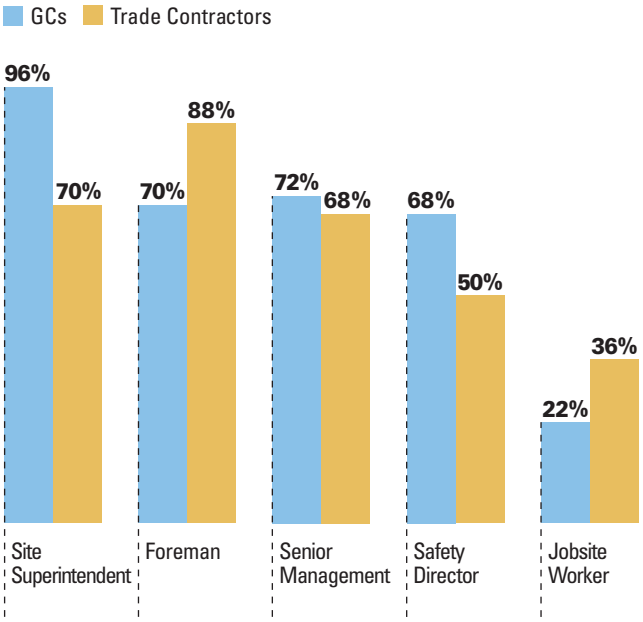
Contractors were asked if they believe that five types of employees—senior management, safety director, site superintendent, foreman and jobsite worker—use mobile devices onsite. They were also asked which workers are encouraged to use these devices.

The chart at right indicates the percentage of general and trade contractors who believe that the staff in these roles are using mobile devices onsite. Since the findings about those who are encouraged to use mobile devices onsite matches closely with those they believe are actually using them, with only a few percentage points of difference, only the percentage of use is shown.

- **The highest percentage of GCs report that site superintendents use mobile devices onsite.**
  - Nearly all (96%) GCs report this, far more than trade contractors (70%).
  - A higher percentage of contractors from companies with 100 or more employees (93%) report that site supervisors use mobile devices onsite than those from companies with fewer than 50 employees (72%).
- **The highest percentage of trade contractors (88%) report that foremen use mobile tools onsite.** However, there is no difference based on the size of company.
- **Over two thirds (68%) of GCs report that safety directors use mobile tools onsite, compared with just half (50%) of trade contractors.** Again this is associated with larger companies as well, with three quarters (75%) of companies with 50 employees or more reporting this, compared with 30% of smaller companies. Therefore, this could simply be due to the greater prevalence of safety directors working for larger companies.
- **More trade contractors (36%) than GCs (22%) believe their jobsite workers use these devices, but few respondents overall believe that jobsite workers use mobile devices for construction processes onsite.** Jobsite workers are also only encouraged to use mobile devices by 25% overall, with a similar split between GC and trade contractors as that seen in use. This suggests that mobile tools are seen to aid management functions more than the construction work performed on a project.

Use of Mobile Devices as Part of the Construction Process (According to GCs and Trade Contractors)

Dodge Data & Analytics, 2017



Emerging Technologies That Enhance Jobsite Safety

In recent years, there has been an explosion of technologies that can enhance safety on jobsites in addition to mobile devices. For this study, contractors were asked about their use of a few of these devices, with the goal of benchmarking their use now, specifically for promoting safety, in order to see if usage increases in the future.

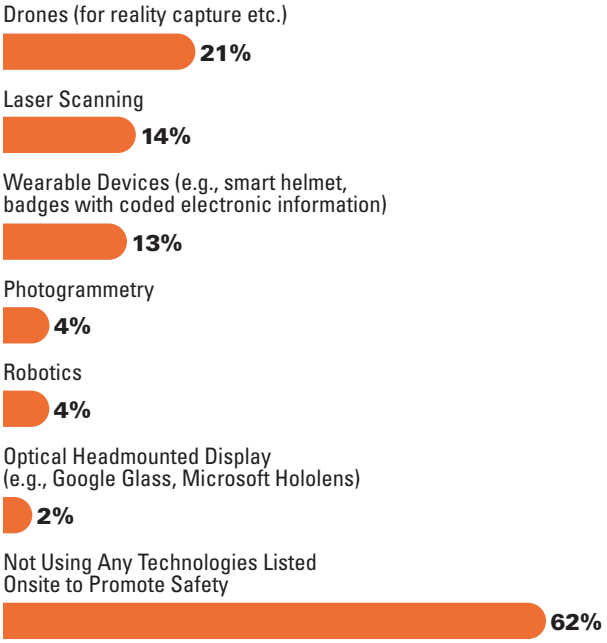
The chart at right shows all the technologies included in the survey and the percentage of contractors that report using them.

- **Since these are emerging technologies, it is no surprise that the highest percentage (62%) do not use any of these technologies.** This is likely to change in the future as some of the benefits of using these technologies are proven out, wider awareness of them grows and prices for some of them come down.
- **Drones are the most widely used of these emerging technologies.** Drones are used for a variety of purposes onsite, but the most common at this point is to do reality capture with cameras mounted on them. They have gained some acceptance among GCs, with nearly one third (32%) reporting that they use them, but they are not commonly used by trade contractors (6%). Over one third (36%) of very large companies (500 or more employees) employ drones onsite.
- **Laser scanning (14%) is currently used by more contractors than photogrammetry (4%).** Both are means of capturing existing conditions electronically. Laser scanning is highly accurate, but it is also far more expensive than photogrammetry can be. Given the prevalence of using cameras onsite (see page 34), it will be interesting to see if photogrammetry use grows in the next few years.
- **Wearable devices are used by 13% currently.** As with most of the other technologies listed here, very large contractors are leading the way in adopting these technologies, with 21% reporting using them.

Not surprisingly, contractors who use BIM are also more frequently adopting all of these technologies. Not only does BIM use suggest that they are technology-friendly companies, but reality capture, laser scans and photogrammetry can be incorporated into models to help improve onsite safety.

Application of Emerging Technologies to Promoting Safety (According to All Contractors)

Dodge Data & Analytics, 2017



Impact of Emerging Devices on Safety

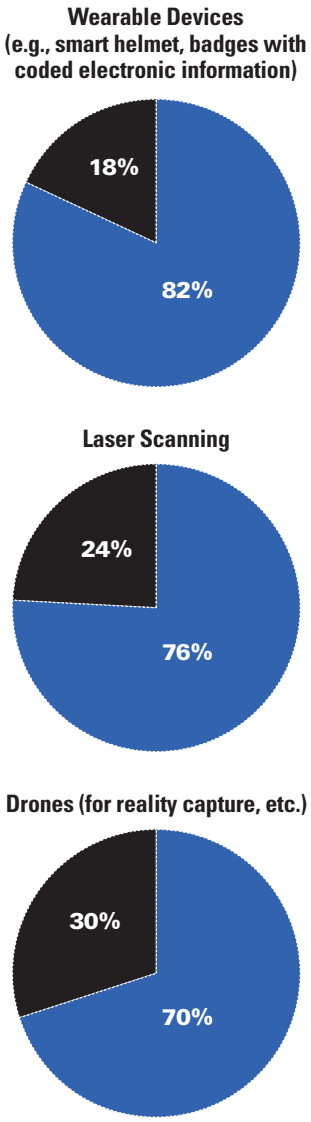
All contractors who reported that they use these devices were asked about their impact on safety. Since the percentages using most of the emerging technologies are very low, only three—drones, laser scanning and wearable devices—had sufficient responses to evaluate. However, the response to each of these is very positive.

- **The highest percentage (82%) report that wearable devices have a positive impact on safety.**
- **Over three quarters (76%) who have made the investment in laser scanning find that it improves safety.**
- **70% of those using drones say they improve safety.**

All of these findings bode well for wider adoption of these technologies since the majority of those who are using them are seeing a positive impact on jobsite safety.

Impact of Devices on Safety
(According to Contractors Using Each Device)

Dodge Data & Analytics, 2017



Data: Impact of Safety Practices

Impact of Safety Practices on Project Success Factors

Contractors were asked to rate the impact of various factors that influence the success of their projects and their businesses on a five-point scale from very negative impact to very positive. The same question was presented to contractors on previous studies in 2012 and 2015. The chart at right shows the percentages reporting a positive or negative impact on their projects in the current study compared with those in the previous ones.

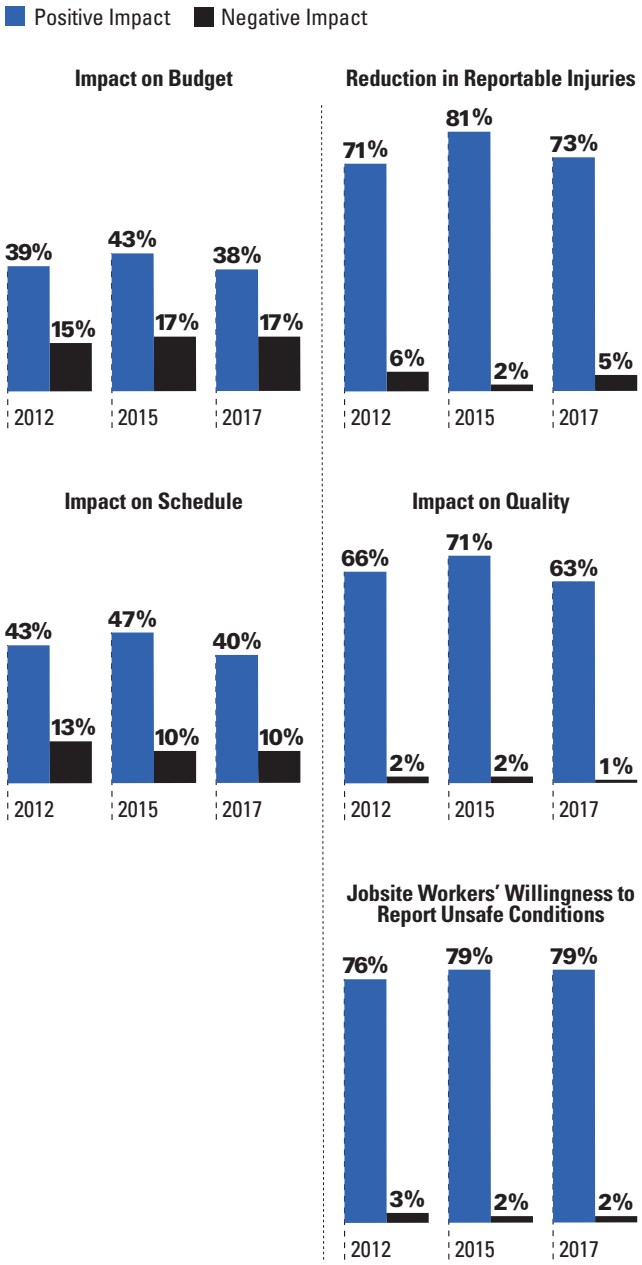
The chart shows that reporting of project benefits has remained fairly consistent over the three studies, with a slight uptick in 2015 and a modulation back in 2017. It specifically demonstrates that a high percentage of contractors consistently experience a reduction in reported injuries, improved project quality and increased willingness by jobsite workers to report unsafe conditions due to their investments in safety practices. In general, it demonstrates that investing in safety helps to improve projects for most contractors.

Variations Based on Use of BIM, Size of Company and Type of Company

Frequent differences emerge in the percentage who report achieving positive project benefits due to their investments in safety based on three factors: their use of BIM, the size of the company for which they work and between GCs and trade contractors. Where such differences emerge, they consistently favor BIM users, large companies and GCs. While it is likely that the three are interrelated, since GCs tend to be larger than trade contractors and 69% of those using BIM work for companies of 100 employees or more, there are also differences that suggest other influences besides size.

- **Workers' Willingness to Report Unsafe Conditions:** A higher percentage of contractors who use BIM and those who work for large companies (those with 100 or more employees) report that their safety investments have a positive impact on worker willingness to report unsafe conditions. For large companies, this may be in part due to the creation of formal processes and rules for jobsite workers to report unsafe conditions.
- **Project Quality:** More contractors who use BIM and those who work for large companies experience higher project quality due to their safety investments. This finding may be influenced by the likelihood that both of these groups may track measures of project quality more frequently than those who are not as technologically advanced or smaller firms with fewer resources.

Impact of Safety Practices on Projects
(According to Contractors Who Rate the Impacts as Positive or Negative)
Dodge Data & Analytics, 2017



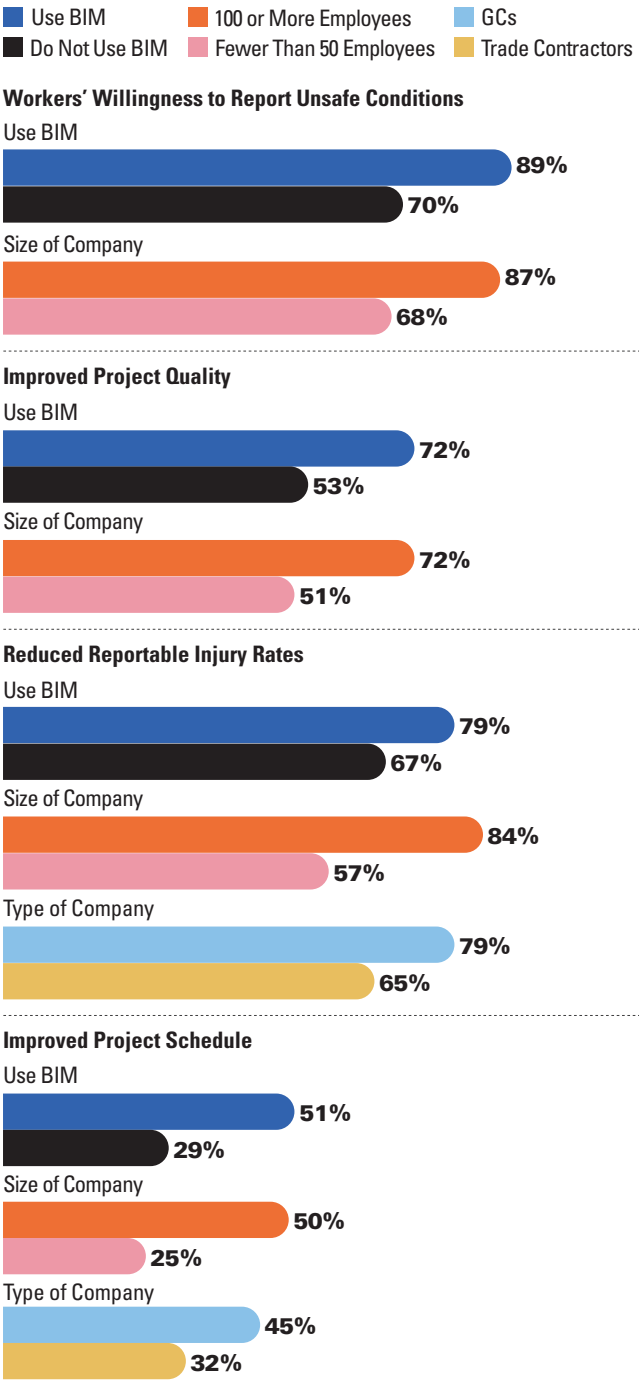
Impact of Safety Practices on Project Success Factors

CONTINUED

- **Reduced Reportable Injury Rates:** All three groups report reduced reportable injury rates. Here, it is likely that size is the most influential factor, since there is a much larger gap between large and small companies than between users and non-users of BIM or between GCs and trade contractors. Certainly, it makes sense that those with more employees would be able to more precisely track the impact on injury rates than those with few employees.
- **Improved Project Schedule:** Again, all three groups report this improvement due to their safety investments. There is a particularly notable gap between those using BIM and those who do not on this issue, suggesting that use of BIM may be correlated with how safety improvements can help improve schedule performance.

Factors Impacting Positive Project Benefits of Safety Practices

Dodge Data & Analytics, 2017



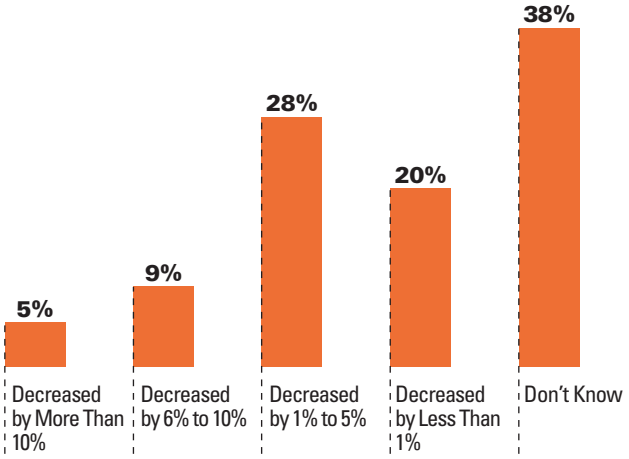
Impact of Safety on Project Budget

Contractors who experienced a positive impact from their safety practices on project budget (see page 39) were asked to indicate the degree of impact. The chart at right shows their responses.

The highest percentage could not quantify the percentage of impact of safety practices on project budget. However, among those who do provide information, a decrease of 1% to 5% is most commonly reported. If this reduction translates to more profitability for contractors, then even a 1% to 5% decrease can make a big difference. These findings are generally consistent with the results of the 2015 study.

Overall, these findings do not significantly vary by type of company or by size of company. Interestingly, a higher percentage of contractors who use BIM (71%) are able to provide an estimate for the impact of safety on project budget than those who do not use BIM (48%).

Impact of Safety on Project Budget
(According to Contractors Who Report a Positive Impact)
Dodge Data & Analytics, 2017



Impact of Safety on Project Schedule

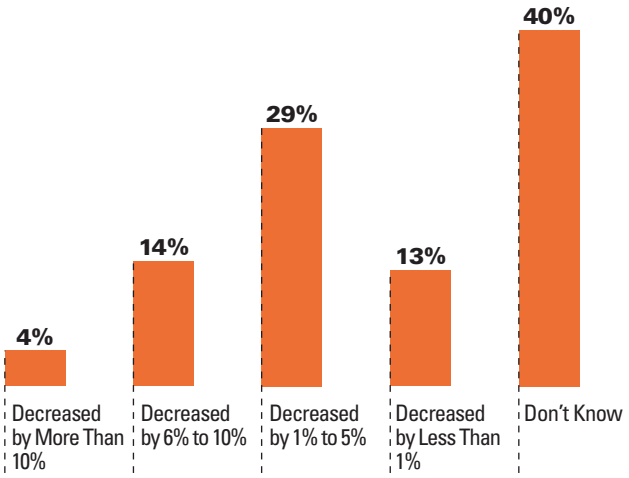
Contractors who experienced a positive impact from their safety practices on project schedule (see page 39) were asked to indicate the degree of impact. The chart at right shows their responses.

Overall, the findings follow the same pattern as the impact on budget.

- **The highest percentage could not quantify the impact (40%).**
- **Among those who do indicate a percentage, a decrease of 1% to 5% is most commonly reported.**
- **The findings are relatively consistent with the 2015 study.**

There are no significant differences in the findings by type or size of company or by whether they use BIM. As in previous studies, this clearly demonstrates that attention to safety can have a notable positive impact on project schedule.

Impact of Safety on Project Schedule
(According to Contractors Who Report a Positive Impact)
Dodge Data & Analytics, 2017



Impact of Safety

On Reducing the Number of Reportable Injuries

Contractors who experienced a positive impact from their safety practices on reducing reportable injuries (see page 39) were asked to indicate the degree of impact. The chart at bottom shows their responses.

There are notable differences in the responses in the current study compared with the findings in 2015.

- **There is greater certainty about safety impact on injuries,** with the percentage who report that they cannot quantify those impacts reduced from 21% in 2015 to 16% in 2017.
- **A much lower level of overall impact is reported this year compared with 2015.** In 2015, a similar percentage of respondents suggested that they saw decreases ranging from more than 20% to just between 1% and 5%. Only four percentage points or less separated any of the four categories this range encompasses. In 2017, over 50% of respondents are concentrated in the two categories that span the range from 1% to 10%, concentrating the responses on the lower end of the impact scale.

There is no direct data to explain this decrease in safety practices reducing injury rates. Certainly, it is possible that the emphasis on safety over the past few years has raised the bar overall, so that improvements may be more incremental.

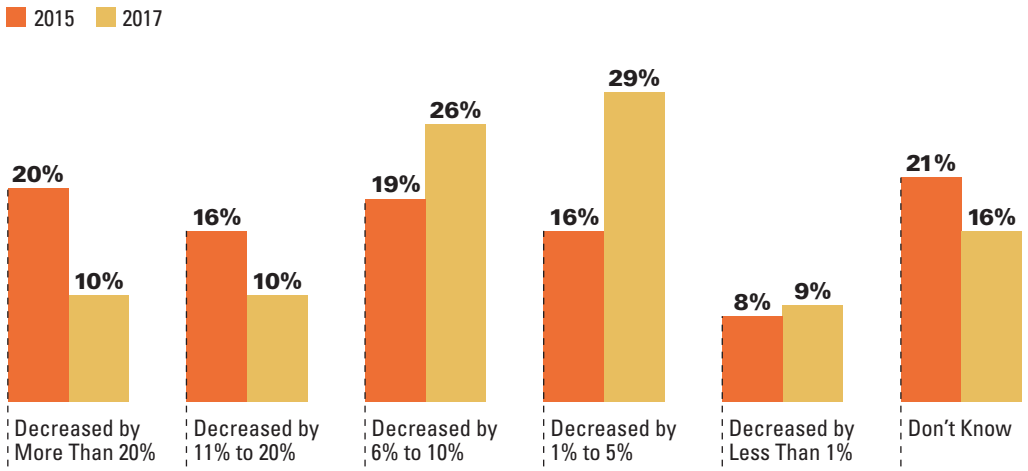
Another factor could be the growing concern over the availability of skilled labor. In research conducted quarterly by Dodge to support the production of the *Commercial Construction Index* (CCI), 60% or more of contractors report that it is difficult to find skilled workers to meet project demands, and most also report that they ask current workers to do more to help make up for this gap. While there is no direct evidence that this is influencing the decrease in the rate at which reportable injuries are being reduced, this approach to dealing with worker shortages certainly could have implications on worker safety in the long run.

It is interesting that a relatively high percentage of safety leadership (28%) reports that they see decreases of more than 20% in reportable injuries, a much higher percentage than company leadership (C-level respondents, vice presidents and directors), project managers or estimators. Since safety leadership are the most likely to be directly tracking the data on injuries, this may suggest a slight underreporting in the overall findings.

Impact of Safety on Reducing the Number of Reportable Injuries

(According to Contractors Who Report a Positive Impact)

Dodge Data & Analytics, 2017



Impact of Safety Practices on Business Benefits

In addition to being asked about the factors that impact project success reported on page 39, contractors were also asked to rate the impact of safety practices on several factors that impact the success of their business on a scale of 1 to 5, from a very negative impact to a highly positive impact. This question was also asked in the 2012 and 2015 studies. The chart at right shows the percentage of contractors who indicated that their safety practices had a positive impact (4 or 5 rating) on each of these factors in the current study and the two previous ones.

The highest percentage of contractors (72%) report that safety practices have a positive impact on their standing in the construction industry. While there is a directional shift downward in this finding from 2012, it remains consistent with the 2015 finding, and it demonstrates the importance of keeping a focus on safety in the industry to encourage wider adoption of safety practices.

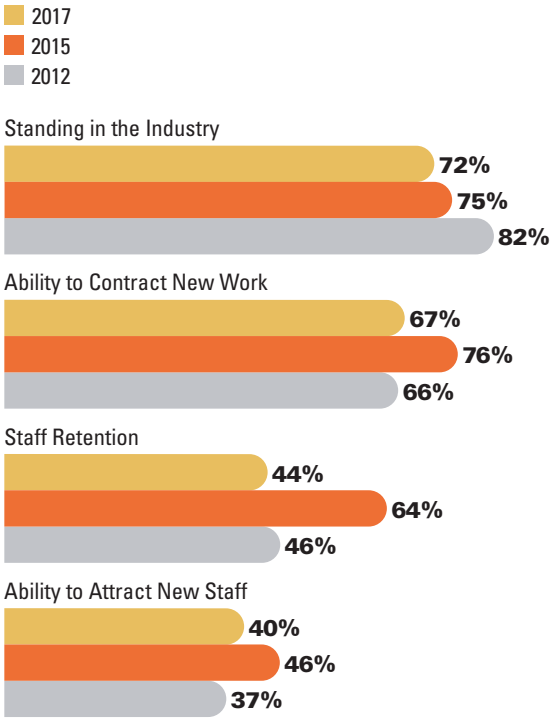
Over two thirds of contractors report that they believe the implementation of their safety practices has a positive impact on their ability to find new work. As the industry continues to shift slowly to more best value contracts instead of lowest cost, business factors like their safety record become more relevant to their ability to contract work. This finding did drop from the 2015 results, but it is consistent with the percentage reported in 2012.

The percentage who believe that their safety practices had a positive impact on staff retention dropped notably from 2015, from nearly two thirds (64%) to well less than half (44%). The increasing level of concern about skilled worker shortages has created a worker-friendly market, and it is possible that staff retention is a bigger problem in general than it was in 2015, which could be contributing to this drop. However, that same issue also reinforces the importance of having an appealing workplace, including a company's safety record.

The ability to attract new staff has consistently remained below 50% in the last three studies. While employees may be familiar with safety records of companies that employ them, knowledge about the safety culture at other companies may be more difficult to obtain. This is an area where improving standing in the industry may indirectly help, by building a reputation beyond the company and its clients for its safety achievements.

Impact of Safety Practices on Businesses
(Contractors Reporting a Positive Impact on Various Business Benefits in 2017, 2015 and 2012)

Dodge Data & Analytics, 2017



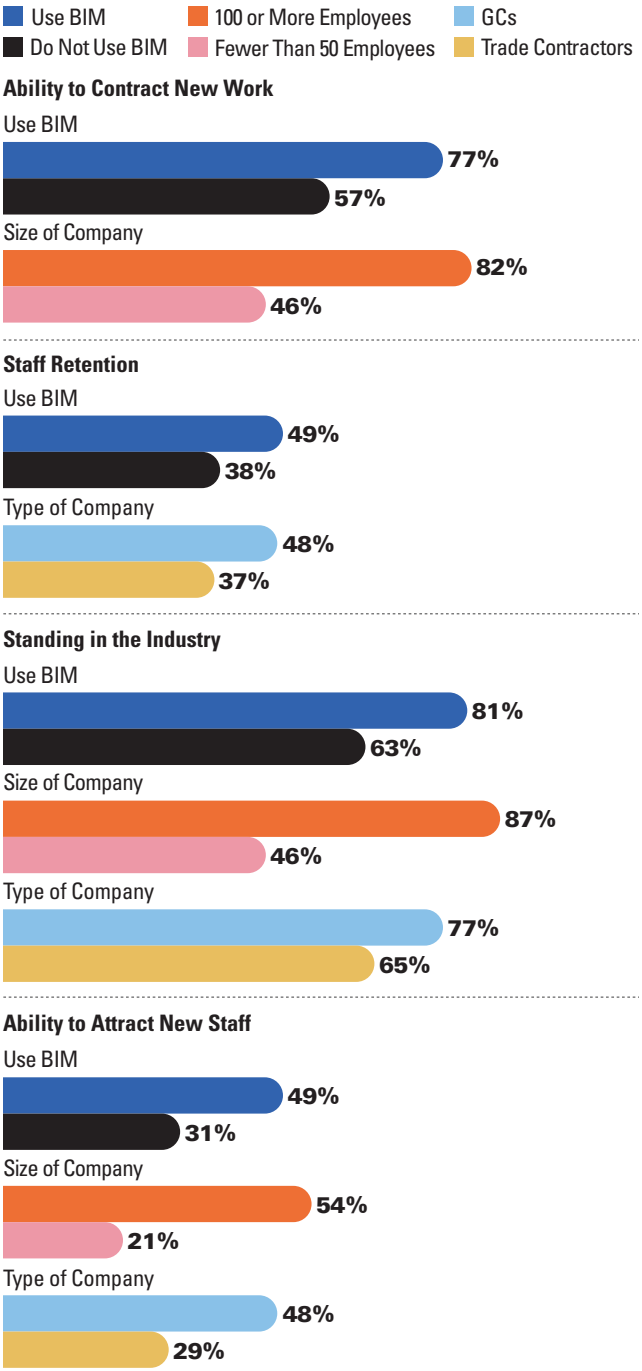
Variations Based on Use of BIM, Size of Company and Type of Company

As with the project-related impacts (see page 40), a higher percentage of respondents who use BIM, who work for companies with more than 100 employees and who work for GCs rather than trade contractors tend to report positive business impacts from their safety practices.

- **Ability to Contract New Work: Size of company appears to be the most critical difference among those who see a positive impact,** with most (82%) of contractors working at large companies reporting that they get a positive impact from their safety practices on this factor, compared with less than half (46%) of those who work at companies with fewer than 50 employees. It would be interesting to know the degree to which smaller companies tend to still procure projects through traditional design-bid-build compared with larger companies, since other procurement methods could be more influenced by a contractor's safety record.
- **Staff Retention:** Contractors who use BIM and GCs are more likely to find that their safety practices improve their ability to retain staff.
- **Standing in the Industry:** While significant differences are reported for all three categories, the findings suggest size of company is the key differentiating factor in this case. This is not surprising since concern about standing in the industry is more common among large national firms than small regional or local ones.
- **Ability to Attract New Staff:** Sharp differences between respondents in each category suggest that the type of company, the use of BIM and the size of company are all factors in the ability to capitalize on safety practices to improve their ability to attract new staff.

Factors Impacting Positive Business Benefits of Safety Practices

Dodge Data & Analytics, 2017



Data: Influence Factors

Factors That Influenced Contractors to

Adopt Safety Management Practices

Understanding what has influenced contractors to adopt their current safety management practices can help those seeking to encourage wider adoption of these practices, both internally in their own organization and across the construction industry. Therefore, contractors were asked to rate how influential 10 factors were in their decision to adopt their current safety management practices. The chart at right shows the percentage who consider each factor influential or highly influential.

As in both the 2012 and 2015 studies, where this question was also asked, **concern about worker health and safety is rated as a highly influential factor by most contractors (82%).** This suggests that demonstrating the efficacy of various measures to improve safety can be very persuasive with contractors.

Around two thirds select insurance costs and liability concerns as highly influential in their decision. This reveals the importance of insurance and litigation for driving improved safety in construction. However, it also suggests that contractors may be conservative about adopting cutting-edge practices without knowing what their impact will be on these factors.

All other factors are considered highly influential by about half of contractors, suggesting that there are many influences driving contractors to adopt safety practices.

- **Some reflect what contractors are compelled to do,** such as regulatory requirements and owner/client demand, which suggests that keeping up this external pressure is important to sustain gains in the adoption of safety practices in the industry.
- **Others reflect the importance of contractors' standing in the industry,** such as industry leadership in overall safety culture, and keeping a competitive advantage. These indicate how important the focus on safety has become in the construction industry.
- **Direct business factors have also been influential,** including avoiding potential business disruptions and the desire to improve productivity, which suggests more data on these factors could still be influential.

Variation by Type of Company

There are no statistically significant differences in the responses of GCs compared with those of trade contractors. This is particularly notable given the wide variation by size of company (see below), and suggests that GCs and trade contractors largely face the same challenges and seek the same benefits when considering adoption of safety management practices.

Influential Factors for the Adoption of Safety Management Practices (Rated as Having a High/Very High Influence by Contractors)

Dodge Data & Analytics, 2017

Variation by Size of Company

In general, most factors are more influential for large companies than small ones. However, there are some subtle differences between factors.

- **More Influential on Moderate to Large Companies:** For several factors, there is a clear divide in the percentage who find them influential between those with 50 or more employees versus those with fewer than 50 employees. These include:
  - Industry Leadership in Overall Safety Culture
  - Owner/Client Demand
  - Competitive Advantage
- **Less Influential on the Smallest Companies:** For other factors, very small companies (fewer than 20 employees) lag notably behind large companies, with moderate-sized businesses falling in between.

Factors That Influenced Contractors to Adopt Safety Management Practices

CONTINUED

- Concern About Worker Health and Safety
- Avoiding Potential Business Disruptions
- Past Incidents Involving Worker Health and Safety

Variation by Use of BIM

Many of the variations based on whether or not the respondent's company uses BIM align closely with differences by size of firm, including concerns about worker health and safety, industry leadership in overall safety culture, avoiding potential business disruptions, owner/client demand and having a competitive advantage. Since 69% of companies that reported using BIM also have 100 or more employees, it is possible that size of company plays a role in these responses.

However, there are two factors that influence those using BIM where a similar difference is not seen across large and small companies:

- Liability Concerns: 73% of those using BIM find this influential, compared with 62% of non-users.
- Past Incidents Involving Worker Health and Safety: 55% of those using BIM find these influential, compared with 42% of non-users.

Variation by Role

Over two thirds (68%) of those in safety leadership positions consider the following two factors highly influential, compared with around half or fewer of those in other roles:

- Past Incidents Involving Worker Health and Safety
- Competitive Advantage

Safety leaders may be more aware of how past incidents have influenced the adoption of safety management practices. They also may be more likely to be concerned about demonstrating the impact of safety on the bottom line through the competitive advantage it provides.

Interestingly, though, they are no more likely to report being highly influenced by their company's leadership in overall safety culture in the industry. This may suggest that safety leaders are more focused on the immediate impacts on their business than on larger concerns about reputation or standing.

Factors That Would Encourage Contractors to

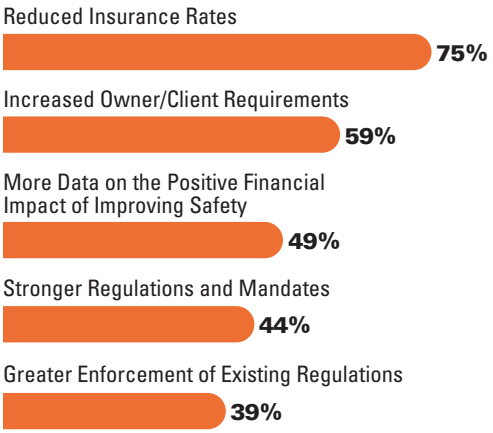
Invest in Safety Management Practices

Contractors were also asked to rate the influence of six factors on the likelihood that they will increase their investment in safety management practices, and the chart at right shows the contractors who rated each factor as highly influential. **The findings are consistent with those in 2015,** suggesting the importance of the top factors. They are also largely consistent between GC and trade contractors, with the only exception noted below.

- **Reduced insurance rates are the most influential factor.** This corresponds to the findings about the importance of insurance costs in driving them to make their existing investments (see page 45). This finding has also stayed remarkably consistent since the 2012 study, and it demonstrates the important role insurance companies can play in driving investment in safety.
- **The only other factor considered highly influential by over half of respondents are increased owner/client requirements (59%).** It is a testament to the importance of reduced insurance rates that it finished far above

Highly Influential Factors That Would Encourage Contractors to Invest in Safety Management Practices (Rated as Having a High/Very High Influence by Contractors)

Dodge Data & Analytics, 2017



Factors That Would Encourage Contractors to Invest in Safety Management Practices CONTINUED

client requirements, which are frequently a significant motivation for the adoption or increase in the use of approaches by contractors.

- **Nearly half (49%) believe having more data on the positive financial impacts of improving safety would encourage greater investment.** In particular, GCs believe this would be influential, with 54% who rate this as highly influential compared with 42% of trade contractors.

Variation by Size

A few interesting differences are evident in the findings based on company size.

- **Data is particularly important to larger contractors,** with 67% of those at companies with 500 or more employees rating this as an influential driver.
- **Increased owner requirements have the least influence on the smallest companies.** Only 38% of those who work at companies with fewer than 20 employees consider this a highly influential factor. Unlike the rest of the respondents, they see nearly equal influence from stronger regulations and mandates (34%) and greater enforcement of existing regulations (34%), as they do from client requirements. This may also be related to smaller contractors' tendency to work with smaller clients, who would be less likely to increase safety requirements.
- **Reduced insurance rates is still the top trigger for the smallest companies, but only 59% consider it influential,** a much smaller percentage than those from companies larger in size.

Variation by Role

Understanding what has the greatest influence on different players within a company can help safety advocates convince the right parties about the needs to invest resources to improve safety.

- **All roles find that reduced insurance rates would be influential.**
- **There is also wide agreement among company leadership that owner/client demand and data about the positive impacts of safety are important,** although fewer C-level respondents rate these highly than other members of company leadership.
- **Safety leadership are the only roles for which reduced insurance rates are not ranked first. More of them rate data on positive impacts and owner/client requirements highly,** suggesting that their focus is on demonstrating the value to senior leadership.
- **Project managers are more focused on regulatory requirements than the other roles.**

Highly Influential Factors That Would Encourage Companies to Invest in Safety Management Practices (By Role)

C-Level		Company Leadership Other Than Safety (Vice Presidents/Directors)		Safety Leadership		Project Managers	
1. Reduced Insurance Rates	**72%**	1. Reduced Insurance Rates	**77%**	1. More Data on the Positive Financial Impact of Safety	**65%**	1. Reduced Insurance Rates	**85%**
2. Increased Owner/Client Requirements	**58%**	2. Increased Owner/ Client Requirements	**72%**	2. Increased Owner/Client Requirements	**62% (tie)**	2. Increased Owner/Client Demand	**56% (tie)**
3. More Data on the Positive Financial Impact of Safety	**42%**	3. More Data on the Positive Financial Impact of Safety	**51%**	2. Reduced Insurance Rates	**62% (tie)**	2. Stronger Regulations and Mandates	**56% (tie)**

Contractor Response to OSHA Safety and

Health Management Program Guidelines

In November 2016, the Occupational Safety and Health Administration (OSHA) published Safety and Health Management Program guidelines for the construction industry. OSHA's recommended guidelines were designed to apply to all sizes of construction industry contractors, providing best practices to achieve key program elements. See page 50 for more information about them.

Contractors were asked two question to gauge the reach of these guidelines. First, they were asked if they were aware of the guidelines, and second, those who were familiar with them were asked if they made any changes to their safety and health management program based on the guidelines. The responses to both questions have been combined together in the pie chart at right.

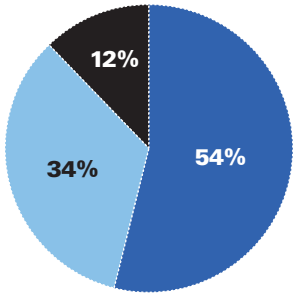
Most contractors (88%) are at least aware of the guidelines, and over half (54%) have made changes to their programs based on them. This represents a broad response by the industry.

93% of larger companies (those with 100 or more employees) are aware of the guidelines compared with 79% of smaller companies (those with fewer than 50 employees), and the smallest companies (fewer than 20 employees) are the only ones where less than half of those who are aware of these guidelines have made changes based on them.

This suggests that more outreach is needed to smaller companies about these tools, especially since the guidance they provide would be particularly useful for smaller contractors.

Contractor Response to OSHA Safety and Health Management Program Guidelines

Dodge Data & Analytics, 2017



Most Influential Roles for Improving Safety

Contractors were asked to rank the roles that people have at their company based on the ones that they consider most influential for improving safety. The chart at right shows the percentage who rank each role first in order to reveal the positions considered most critical for improved safety by contractors.

There is general agreement that the greatest influence comes from the top down, with 27% of contractors ranking company ownership and 25% ranking company leadership first. These findings are consistent with the findings from the previous study in 2015.

However, the types of leadership positions considered most important differ between GCs and trade contractors. A much higher percentage of GCs (31%) consider company leadership influential, while more trade contractors select their company owners as the most influential (39%). These findings echo the distribution of those ranking these positions by company size, with 38% of those working for companies with less than 50 employees who rank owners first, compared with 37% of those at firms with 500 or more employees who rank company leadership first.

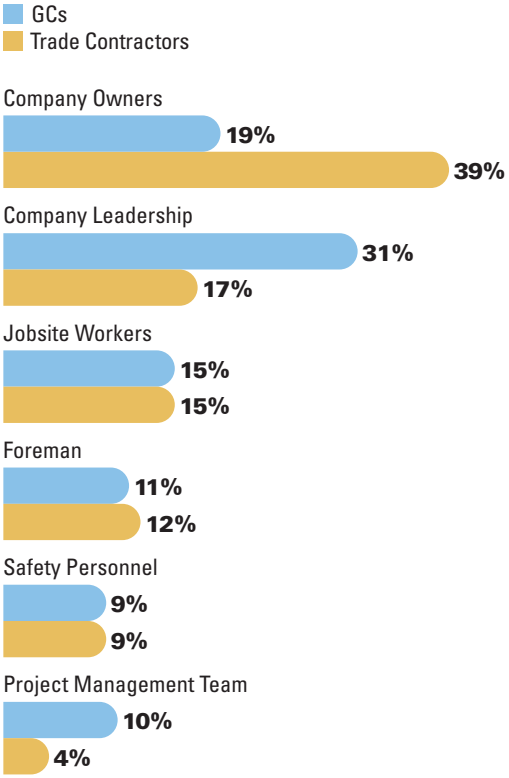
The variations by size of company appear to drive similar findings from those who use BIM versus those who do not, with 34% of those who use BIM who rank company leadership first and 35% of those who do not use BIM who rank company owners first.

There are also interesting variations by role in the positions they rank first.

- **More project managers consider themselves critical to improving safety than respondents from other roles.** 21% of project managers rank their role first for improving safety, compared with less than 5% of C-Level, safety leadership, directors or estimators.
- **Few of the safety leadership respondents (3%) consider jobsite workers the most important role for improving safety.** Jobsite workers are considered most important by a higher percentage of most other roles, including C-level respondents (26%), director-level respondents (24%), project managers (15%) and estimators (14%).
- **Instead, those in safety leadership favor roles who have the most direct influence over their decisions and budgets,** with 35% ranking company owners and 32% ranking company leadership as most influential.

Most Influential Roles for Improving Safety
(Ranked First in Influence by GCs and Trade Contractors)

Dodge Data & Analytics, 2017



OSHA Recommends:

Updated Best Practices for Safety and Health Programs

In December, 2016, the Occupational Safety and Health Administration (OSHA) issued Recommended Practices for Safety and Health Programs in Construction, updating its 1989 guidelines specifically for the construction industry. These advisory recommendations do not create new legal obligations or alter existing obligations under OSHA; they are intended to help industry employers develop safety programs proactively.

Industry-Specific Safety

The recommended practices take into account current conditions in the construction industry: new techniques, materials and equipment that have come into common use, a more culturally diverse workforce (which means that workers on a jobsite may not all share a common language), an aging workforce, and increasing rates of temporary and contract employment.

Guidance in the recommendations addresses general contractor employment, staffing agency employment, multi-employer work situations, and short-term and multi-year projects.

The document organizes the recommended practices into seven categories:

- Management Leadership
- Worker Participation
- Hazard Identification and Assessment
- Hazard Prevention and Control
- Education and Training
- Program Evaluation and Improvement
- Communication and Coordination on Multi-Employer Worksites

These updated practices offer a refresher for companies already engaged with safety management, but OSHA anticipates that the recommendations will be particularly helpful to small and medium-sized contractors without safety and health specialists on staff.

The document's reception in the industry has been generally positive: "Whenever we can aggregate information and best practices from industry leaders, and develop compliance tools for implementation, it's extremely helpful," says Brad Sant, Senior Vice President, Safety and Education, at the American Road and Transportation Builders Association (ARTBA). Expressing a view common among industry sources, Sant commends OSHA's decision to issue these practices as a guide, rather than as regulations. "There needs to be flexibility as to how companies, from the smallest to the biggest, implement their safety programs," he says. "These guidelines help people to understand principles of safety management and how to adapt them."

Boosting Adoption

Because these are recommendations and not mandates, strategies to encourage adoption emphasize benefits. In announcing the release of the recommendations, for example, David Michaels, then Assistant Secretary of Labor for Occupational Safety and Health, linked them to injury prevention and profitability. OSHA links them to safety improvements and reduced costs of poor safety practices. And in emphasizing the necessity for worker participation, OSHA highlights program effectiveness and ancillary benefits, such as improved productivity, quality of work, morale, recruitment and retention, as well as an enhanced reputation among customers, suppliers and the community.

Real though these benefits are, under a voluntary system the recommendations may need further inducements to promote uptake. In June 2017, OSHA held its first annual Safe+Sound Week to raise awareness of the value of safety and health programs.

Trade unions and associations also have a role to play in fostering uptake by raising awareness among their members and providing additional, craft-specific resources for implementation, says Wayne Creasap, Senior Director of Health and Safety with The Association of Union Contractors (TAUC).

Creasap notes that OSHA incentives and privileges, such as partnership programs and focused inspections,* have proven effective in boosting participation in past initiatives, but now seem to have been moved to a back burner. Along similar lines, Sant suggests that an event with a goal and a deadline around which the industry could coalesce might provide a much-needed focus for action. ■

*Focused inspections were an incentive by which companies with superior safety programs qualified for inspections focused on major hazards only.

Data: Jobsite Safety Training

Availability and Requirements

For Safety and Health Training

Contractors were asked about the percentage of projects on which different types of safety training were offered or required. The chart below shows the percentage of GCs and trade contractors who offer or require these types of training on 75% or more of their projects.

- **Providing safety and health training is a common practice among GCs and trade contractors alike,** with about three quarters saying they offer it on 75% or more of their projects.
- **The highest percentage of GCs (80%) report that all employees receive orientation training on a new site on 75% or more of their projects.** This is a less common offering by trade contractors, with only 67% reporting that they offer this training at that frequency.
- **A higher percentage of GCs commonly require supervisor training on safety than do trade contractors.** About 70% of GCs require supervisors to have safety and health leadership training and to undergo basic safety and health training themselves (minimum of OSHA 30-hour training in the U.S.) on the majority of their projects, while only around 50% of trade contractors have the same requirements.
- **A lower percentage of GCs (57%) require basic safety and health training for jobsite workers on the majority of their projects than do those that require supervisory training.** In fact, the percentage of GCs requiring this training is nearly equal to trade contractors (56%). Basic safety and health training for jobsite workers in the U.S. is a minimum of OSHA 10-hour training.

Despite relatively robust requirements by GCs for supervisors, these findings demonstrate a tendency for contractors to focus training on the immediate needs of the site rather than a more comprehensive series of requirements. They suggest that more attention to safety training requirements is needed for jobsite workers in particular.

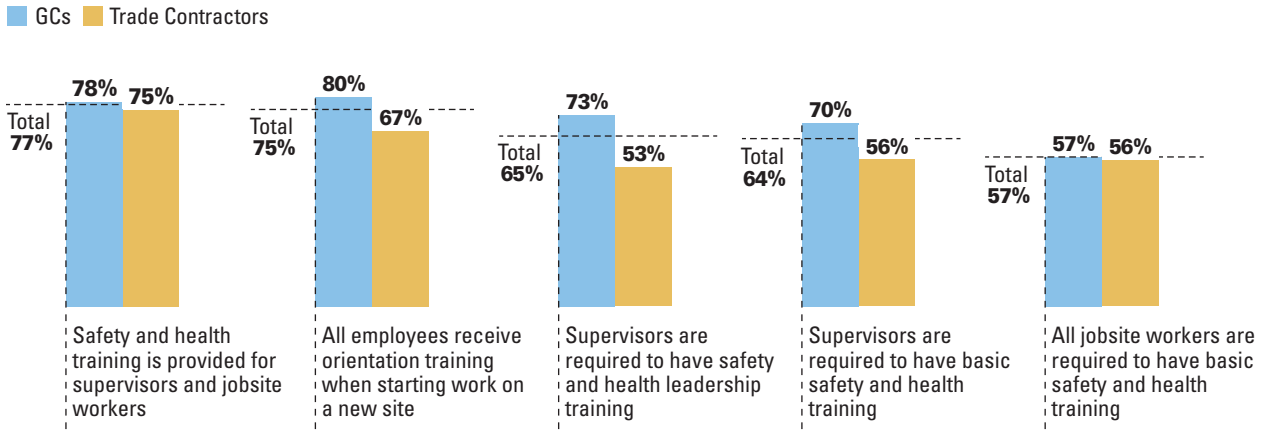
Variation by Size of Company

Companies with 50 or more employees more frequently adopt all five practices listed in the chart below than those with fewer than 20 employees. This may be because large companies are more likely to have formal training requirements in place and the resources to implement them.

Available and Required Safety and Health Training

(Percentage of Contractors Who Offer or Require Training on 75% or More of Their Projects)

Dodge Data & Analytics, 2017



Value of Different Modes of Safety Training by Role

Contractors were asked to rate the degree to which different modes of safety training provide value to supervisors and jobsite workers, ranging from no value to great value. The chart at right indicates the percentage of contractors who feel that each mode is of great value.

On the Jobsite

The highest percentage of contractors consider training delivered on the jobsite to be of great value. This was also the case in the studies conducted in 2015 and 2012. However, while the percentages across all three studies of those who believe onsite training is of great value to jobsite workers have remained very consistent, the percentage of those who perceive that it is of great value to supervisors has steadily declined, from 82% in 2012 to 77% in 2015 to 69% in the current study. There is no offsetting increase in the rated value of other modes for supervisors, which may suggest that contractors are finding it increasingly challenging to identify a mode of training that best serves supervisors.

Classroom

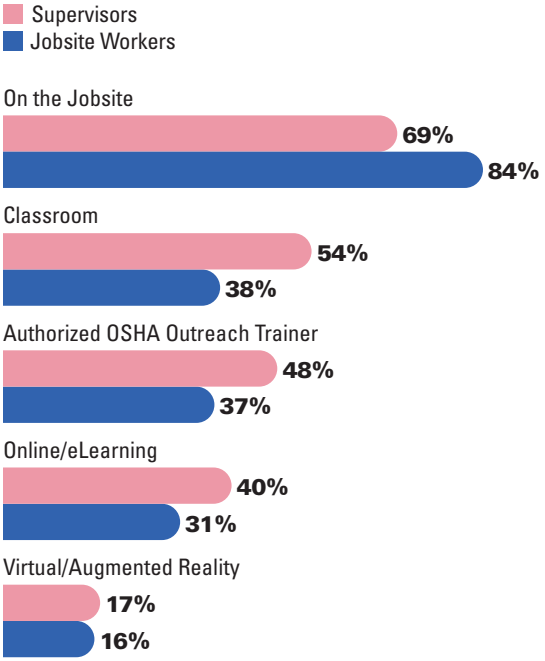
Classroom training is considered valuable for supervisors by a higher percentage of contractors (54%) than for jobsite workers (38%). The percentages who consider it valuable for both are relatively consistent with those in the previous study in 2015.

This finding aligns with the fact that for jobsite workers in particular, safety training associated with orientation to the jobsite is more common than other types of safety training, again emphasizing, especially for jobsite workers, the site-specific focus of training.

- **Size of Company:**
  - **Training for Supervisors:** A significantly lower percentage of those who work for companies with fewer than 20 employees (29%) find classroom learning to be valuable for supervisors than those at larger companies.
  - **Training for Jobsite Workers:** More than twice as many respondents from companies with 100 employees or more (45%) consider classroom training of great value to jobsite workers than those who work for companies with fewer than 20 employees (20%).
- **Role:** A much higher percentage of respondents in a safety leadership role find classroom training to be of great value for supervisors (71%) and jobsite workers (62%) than those in any other role.

Value of Different Modes of Safety Training on Supervisors and Jobsite Workers
(Percentage of Contractors Who Find Each Mode of Great Value)

Dodge Data & Analytics, 2017



Authorized OSHA Outreach Trainer

A higher percentage of contractors also consider having training provided by an authorized OSHA outreach trainer valuable for supervisors (48%) than for jobsite workers (37%). This finding aligns with the types of training required (see page 51), since basic safety and health training for supervisors (OSHA 30) is more frequently required by contractors, and especially by GCs, than basic safety and health training for jobsite workers (OSHA 10).

- **Type of Company:** More GCs (54%) find using an authorized OSHA outreach trainer for supervisors highly valuable than trade contractors (40%). This is also similar to the findings on page 51 about the types of training required by GCs compared with trade contractors.
- **Size of Company:** The percentage of respondents who work for companies with fewer than 20 employees who regard using an authorized OSHA outreach trainer for supervisors as valuable (20%) is less than half that of respondents from companies with 20 employees or more (54%).

Online/e-Learning

More contractors consider online/e-learning to be highly valuable for supervisors (40%) than for jobsite workers (31%), but the gap is notably smaller than for the three previously discussed modes of training.

While the percentage who consider this mode valuable for supervisors has remained relatively consistent since the last study in 2015 (42%), there has been an increase of 7 percentage points in those who consider it valuable for jobsite workers (24% in 2015). This may be a reflection of the broad use of mobile tools onsite (see page 34), and the increasing sophistication of those tools.

There are no significant differences for this mode by type of company, size of company, role or use of BIM.

Virtual/Augmented Reality

This is the first study in which data has been gathered on the value of using virtual/augmented reality as a training mode for supervisors or jobsite workers. This is an emerging technology in terms of use. While the percentage who report that this mode is of great value for supervisors or jobsite workers is relatively low (17% and 16%, respectively), it was included in this study in order to be able to track changes over time, as use of these technologies grows in the construction industry.

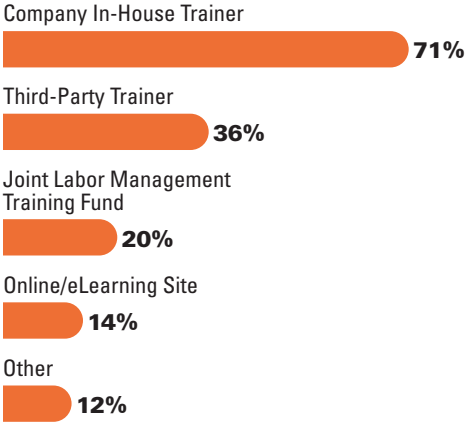
How Safety Training is Conducted for Jobsite Workers

Contractors were asked to identify all the entities that provide safety training for jobsite workers. The chart at right shows the most widely used ones.

- **Having a company in-house trainer is the most common industry practice,** reported by 71%. More GCs use this than trade contractors, and more companies with 100 or more employees use this than those with fewer than 50 employees.
- **About one third (36%) hire third-party trainers.** There are no notable differences by company type or size in the use of these trainers. The use of third-party trainers has increased since the last study in 2015, when only 28% reported using them.
- **Less than one quarter (20%) have training funded and conducted by a joint labor management training fund, but use of this approach has grown significantly since 2012,** when only 7% reported using it. There is also a directional increase over the 17% who reported using this in 2015, suggesting that this may still be an emerging approach.
- **Only 14% report using online/e-learning sites.** Surprisingly, this number has remained consistent since the 2012 study. However, they are used by nearly one quarter (24%) of very large companies (500 or more employees).

How Safety Training is Provided to Jobsite Workers (Percentage of Contractors Who Provide Safety Training Through These Means)

Dodge Data & Analytics, 2017



Frequency of Offering Formal Safety Training

To Jobsite Workers

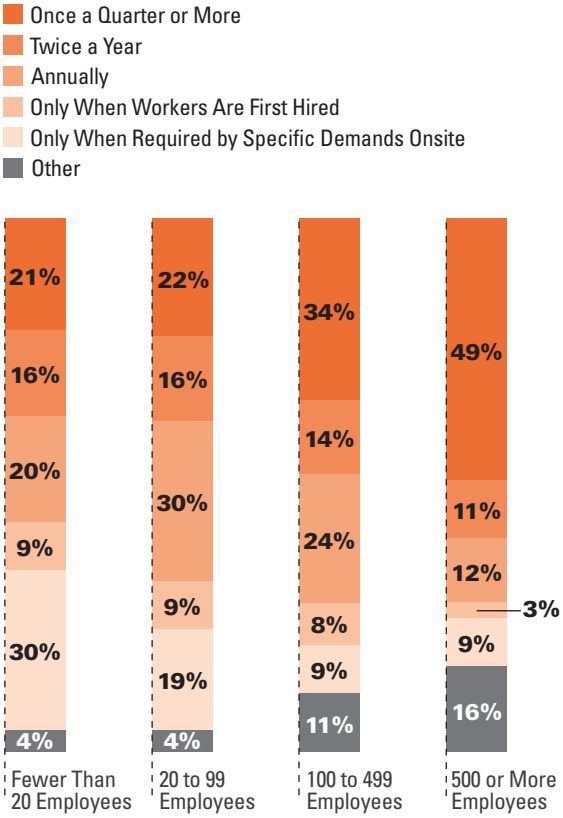
Contractors were asked how frequently they offer formal safety training to jobsite workers. The percentages of different intervals of training by size of company is listed in the chart at right. While there is significant variation by size, there is no variation by type of company, and the findings are consistent with those in the previous studies in 2012 and 2015.

Larger companies offer training more frequently than smaller companies. The trend is notable throughout, but it is most evident in the differences in the frequency of training offered by companies with fewer than 100 employees and companies with 100 employees or more.

The consistency of these findings over the years is no doubt a reflection of resources and formal training policies, with larger companies likely to have more of both than smaller ones.

Frequency of Formal Safety Training for Jobsite Workers (By Size of Company)

Dodge Data & Analytics, 2017



Use of Online Safety Training

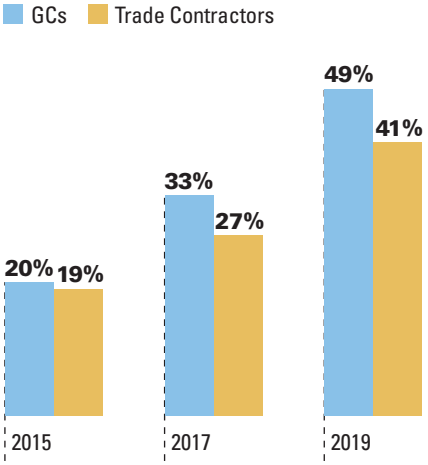
On page 54, contractors were asked about how safety training is provided to jobsite workers, and only 14% said that they use online/e-learning. However, safety training is not confined to jobsite workers, and the low use by them is not indicative of the wider use of online safety training for construction in general, as a question focused just on that means of providing training reveals.

On average, contractors report that safety training is conducted online for 31% of their projects. The chart at right shows that the use of safety training by contractors in the current study has been steadily increasing, up from an average of 20% two years ago. The rate of increase remains steady, with online training expected to be used on average for 45% of projects two years from now.

The chart also reveals that use of online safety training is accelerating at a more rapid pace for GCs than for trade contractors. This is not surprising given the fact that GCs in general are using more mobile devices onsite than are trade contractors (see page 33).

Use of Online Safety Training (Average Percentage of Projects on Which Online Safety Training is Used by GCs and Trade Contractors)

Dodge Data & Analytics, 2017



Awareness and Use of Foundations

For Safety Leadership Elective

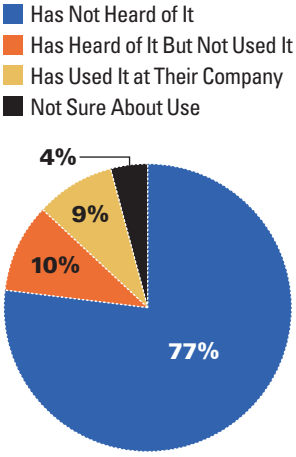
Beginning in January 2017, OSHA offers a Foundations for Safety Leadership training module as an elective in the OSHA 30-hour training course. Contractors were asked whether they have heard of or are using this elective. Since the survey was conducted a short time after the release of the training, this is intended as a baseline for further studies. For more information on this program, see page 60.

By the time the survey was conducted in the spring of 2017, most contractors (77%) still had not heard of the elective. About half of those who have heard of it reported using it at their company. Among those, more than half (55%) encouraged the foreman they sent to OSHA 30-hour training to ask the instructor to teach this elective.

These findings clearly demonstrate the relatively early stage of this initiative, but they also reveal that many of those with knowledge of the training take advantage of it. Awareness campaigns may be necessary to increase use of this elective.

Foundations for Safety Leadership Elective
(Percentage of Contractors Aware of, Using and Not Using It)

Dodge Data & Analytics, 2017



case study

Virtual Reality Enhances Safety Training

Austin-Bergstrom International Airport

AUSTIN, TEXAS

At Austin-Bergstrom International Airport, Hensel Phelps is piloting a new program to help improve worker engagement in safety policies and practices on its jobsites. Leveraging technology that it already uses on projects, the company is developing virtual reality training tools based on actual Hensel Phelps projects.

Developing Virtual Reality Environments

Hensel Phelps regularly uses a 360-degree camera on many of its projects to capture high-resolution images of existing conditions, primarily for quality control purposes.

Will Plato, VDC manager at Hensel Phelps, says he saw an opportunity to expand the camera's potential uses into safety. The 360-degree images can also be used to create virtual environments that users can "walk" through. "I have tools like these out there in the field that we use on a daily basis," he says. "The challenge was finding ways to use these tools for more than just VDC and adapt the technology to fit a gap in our safety training."

Plato saw an opportunity to create a virtual jobsite that workers can navigate through, similar to a video game, and be trained on safety skills, such as hazard recognition. Plato worked with Sam Merrell, director of safety and health at Hensel Phelps, to develop the concept. Since both of them are based in Austin, they selected the ABIA Terminal/Apron Expansion and Improvements project at Austin-Bergstrom International Airport. Plato says the project also presented many typical safety scenarios. "Being that it's hazard recognition, we wanted a project that could cover multiple topics, whether it's scaffolding or fall protection," Plato adds.

The $270-million multi-year, multi-phased expansion consists of a new stormwater and deicing collection facility; approximately 40 acres of new apron paving for approach and taxi lane improvements; a new terminal expansion offering 11 additional passenger boarding gates and other upgrades throughout the existing terminal. The project is scheduled to be completed in July 2019.

Reinforcing Use of Safety Manual by Workers

In developing the new safety training tool, Plato and Merrell took aim at one of the company's greatest challenges: getting younger workers to become familiar with Hensel Phelps's safety and health manual as well as OSHA regulations. "No one will ever memorize our safety and health manual or the OSHA standards word by word," Merrell says. "But they need to know how to navigate [the manual], so if there is a question, they can access that information quickly."

Within the virtual environment of the training tool, workers can navigate around the jobsite. Small buttons appear next to areas where workers need to answer questions. For example, a worker can walk up to a wall with a poster on it that reads "No job or service is so important that it cannot be performed in a safe manner." After pushing the button, the worker is asked where that statement can be found in the company's safety and health manual.

"They have to go in and tell us where these sections are," Merrell says. "You might know the answer to a question, but you still have to dive into our safety and health manual and find where that section is. That engages our younger individuals to read and dissect our manual. In doing so, they are learning other information because they have to read through [the manual] and figure out where [the answer] is located."

Using the Tutorial

In other cases, workers can glean safety tutorials. For example, by touching a button next to a ladder, a video pops up of a Hensel Phelps employee demonstrating proper ladder inspection.

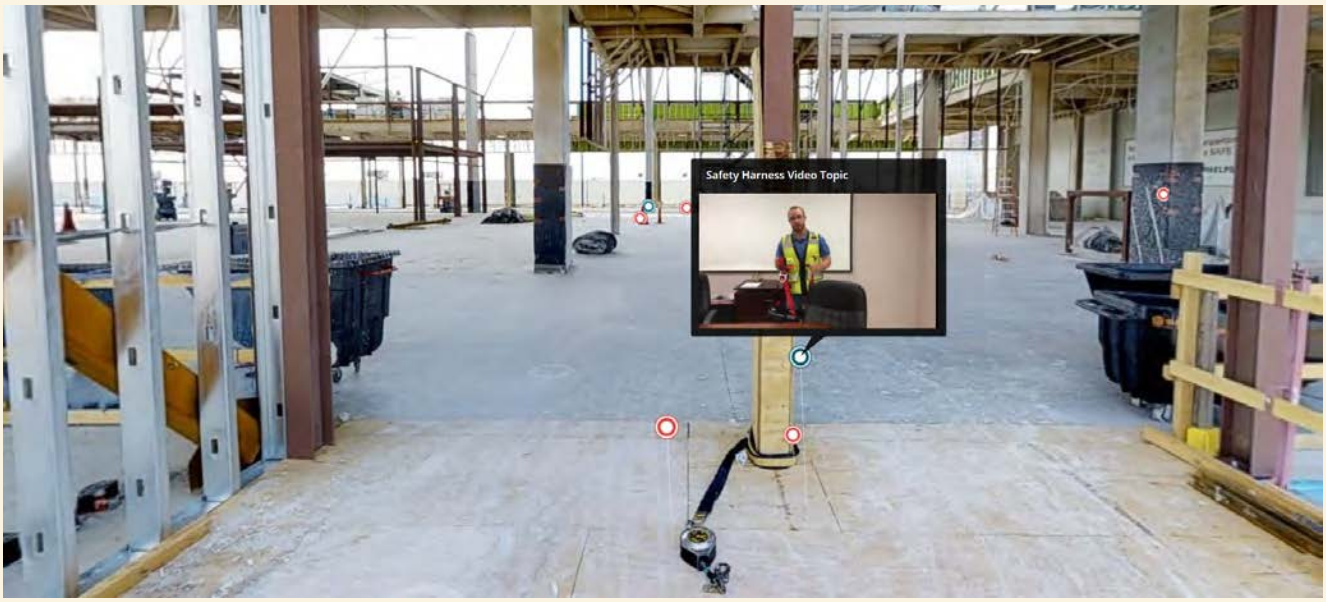
The training tool is self-paced and can be accessed using company computers or by using the worker's own computer. "I've had guys who have been with us for three years go through it and it took them 45 minutes," Merrell says. "For new guys, it can take three to four hours because they don't know the information or how to access it. It's more engaging and more fun. They can drive themselves through our jobsite, find real issues on our jobsite and go figure out where these standards are at."

Merrell says the tool can also be used during the company's weekly "Lunch and Learn" sessions, where workers are given an hour of training on jobsite-related issues. He suggests that the tool could be more efficient than safety audits. "On a typical safety audit, you have one or two people walking around because it's hard to walk 15 people around a job," Merrell says. "So, rather than

CONTINUED

Austin-Bergstrom International Airport

AUSTIN, TEXAS



Videos pop up in the vitual reality environment to explain safety features and practices.

having two people walk around, we can bring the jobsite to the classroom and walk it in here. We can teach 15 to 30 people at a time and do all of this from a classroom setting."

Future Uses

At Austin-Bergstrom International Airport, the tool is being used to train people on the jobsite where they work. However, Plato says that they identified typical safety scenarios that can be encountered on any Hensel Phelps site. The company plans to build a library of these scenarios that can be deployed at other projects.

Merrell say the company tracks its safety performance to identify areas that need additional training. The virtual jobsite tool could be customized to meet current needs. "If we found that a high percentage of recordable incidents were in fall protection, we would be able to put additional focus on fall protection through this program," he adds.

Plato says that more scenarios will need to be created in the future, including excavation because there was no excavation work on the airport site. Scenarios could also be created for specialty work, such as semiconductor manufacturing. "There's so much risk on a semiconductor project," Merrell says. "If you have to hit the emergency stop button, you might be out millions of dollars. Adding in training for these kinds of situations before workers go out there—that's something owners would greatly appreciate."

Although the team is creating typical scenarios that can be customized for use on other jobsites, Plato says it would not be too expensive to create a custom one for a specific project. The camera has already been purchased. The only new cost is time. It took both of them a half day to photograph the site, plus an additional 40 hours to assemble and tag the virtual environment.

Merrell sees these virtual scenarios also being useful in future OSHA 10-hour training sessions. For example, currently an hour of excavation training would include 45 minutes of instruction on OSHA standards plus a 15-minute Powerpoint presentation that shows photos with examples of safety violations. Merrell suggests that the Powerpoint presentation could be replaced by navigating a virtual training site.

Although the value of the new tool is hard to track, Merrell says anecdotal feedback has been extremely positive. "What we hear is that there's no way to cheat this," he says. "It forces you to read through the manuals to figure things out." Merrell also says he believes that using visuals, rather than just text, helps workers learn and retain information better. ■

Image Courtesy of Hensel Phelps

Using Foundations for Safety Leadership (FSL) Training to Enhance a Safety Culture

Promoting a strong safety culture is a stated goal among many construction company owners and managers, but getting that culture to take root in the field requires more than directives passed down from upper management. FSL training can help companies achieve leadership in the field.

Research conducted by CPWR, the Center for Construction Research and Training, shows that leadership skills in the field are critical for driving safety culture. Although many companies require foremen to learn leadership skills as part of their OSHA 30-hour training, teaching skills that are focused on safety leadership was not part of that program in the past.

CPWR led a 1.5-year initiative to develop a safety leadership training module to address this that resulted in the Foundations for Safety Leadership (FSL), a 2.5-hour training module that became an elective of the OSHA 30-hour course on January 1, 2017.

FSL Training Offerings

Linda M. Goldenhar, director of research and evaluation at CPWR, says that many companies already understand good safety practices. FSL aims to help companies better implement and support those practices in the field. "FSL is not about safety: It's about leadership and leadership skills," she says. "It's about how to communicate, engage with workers and recognize workers. We're not teaching how to be safe. It's about how to be a leader and the examples are related to safety."

Using real-world scenarios, the module helps teach five essential leadership skills: 1) Lead by example; 2) Engage and empower team members; 3) Actively listen and practice three-way communication; 4) Develop team members through teaching, coaching and feedback; 5) Recognize team members for a job well done.

Early Adoption of FSL Training

The International Masonry Training and Education Foundation (IMTEF) recently incorporated FSL as part of its foreman training program. Bob Arnold, national training director at IMTEF, believes it extends a foreman's perspective about their role in promoting safety.

"Most foremen around the country are required to take the OSHA 30, but it doesn't emphasize the importance of your role as a foreman in regard to safety," he says. "As a foreman, your responsibilities are above and beyond that of a working person on the job. The FSL pushes that. You're in control of this job, and you make it safe. It's a new perspective."

Arnold says four of its instructors have been trained in FSL and there are plans to train all 20 of its instructors around the country.

Dimeo Construction Co. was an early adopter of FSL, using it to train crew leaders and stewards. With roughly 20 trades on many projects, the company will train around 40 people on the program per project, sometimes more. Bob Kunz, corporate safety director at Dimeo, says the skills taught through the FSL module are critical for creating effective communication on project sites and improving outcomes. "This is something the industry needs," he says. "Everyone relies on the innate characteristics of a leader. You know how to read the plans and work the materials. You can drive production out of your crew. But times are changing. You can't speak to people the way you did 10 years ago. People want to know that they are contributing to the betterment of the group and they are adding value. We're having a tough time attracting people to the industry, so this is something we need to do to develop better communication on the job to attain better outcomes, but also help retain people."

Kunz says the company is also targeting managers above the crew-leader level, such as field managers or field superintendents. "It's our feeling that it takes two to have a conversation," he says. "If we're only offering training to the crew leader and the crew leader needs support from management, how can we not include management in that training?"

Kunz says one of the main benefits of FSL is that it helps develop better relationships within crews. "Through that 2.5-hour journey, we're developing a trust with one another, and it creates a foundation from which we can go forward on the project together," he says. "It's been wonderful. The conversation completely changes in the field. The job may not always go as planned, but we have goodwill in the bank. You have respect that you have to earn through FSL training and the ongoing coaching and mentoring." ■

Interview: Thought Leader

Brian Krause, Director, Virtual Design & Construction Clark Construction Group, LLC

Brian Krause leads the development and implementation of Clark's virtual design and construction strategy nationally. He has 16 years of industry experience in project management, business management and construction technology implementation.

What are the main opportunities you see for improving safety training with technology?

KRAUSE: Technology can improve safety training in two main ways. The first is by educating people about hazards so that they "get it" better than with traditional methods. The second is by triggering some sort of emotional reaction so that they're motivated to stay safe.

To provide an example from the first bucket, something simple we've done at Clark is to model specific safety hazards into the BIM model we receive from the architect. So now, instead of talking about hazards generally at the start of a job, people can see for themselves that they're going to have a specific hazard in a specific place at a specific time: on this day we'll have just poured the slab, and we won't have put the handrails up yet, so there'll be a fall hazard. We're communicating in a different way.

We can also interrogate the model to have it identify hazards for us. Using scripts based on a set of rules, we can look for times when particular hazards will be present and highlight them. So if the concrete will have been poured and there's no skin on the building, that equals a fall hazard. Or you can ask the computer to look for slab penetrations that will be larger than a couple of inches: That's a fall or tripping hazard, and we'll need to put a sheet of plywood over it.

Another example from the first bucket is video game technology that puts trainees into a model building and challenges them to find hazards within a certain time. Instead of a written test, they actually experience the process of walking a jobsite and identifying hazards.

Moving to the second bucket—that's triggering an emotional reaction to motivate safe behavior—we can now set up a 2x8 [piece of wood] on the ground and use virtual reality to simulate walking on a steel beam 10 stories up. People get scared! It makes them want to tie off, and having experienced that virtually, they might now tie off more readily in the field.

What impacts or results are you seeing?

KRAUSE: All of these technologies are currently in some degree of use at Clark, but right now we're still in the exploration stage. We're trying a lot of things and testing them with different people, both as a general contractor and in our self-perform divisions, to decide which ones we want to roll out.

What do you see coming over the horizon?

KRAUSE: Safety technologies that are here now but not yet mainstream include real-time sensor data that alerts us to movement or voltage, or uses an algorithm to aggregate images from the field and identify hazards. Another is smart jobsite tools, such as a hammer drill that shuts off before you hit an electric wire, or a safety vest that flashes when you bend inappropriately. Finally, there's robotics—a way to take workers right out of unsafe work situations.

These new technologies are going to need a different kind of training. We'll still have to identify hazards, and we'll still have to trigger a reaction. The new part is going to be teaching people how to use these intelligent tools correctly.

Is there a technology that's not out there yet that you'd like to see?

KRAUSE: A guardian angel! Everything still requires the workers to protect themselves to some degree. So there's still room for human error. What would be great is something that accounts for the human judgement that says, "I want to do it faster and easier, and I don't care about safety," and then doesn't allow you to do it. ■

Data: Communicating
About Safety

Most Effective Ways to Communicate Safety Messages
To Jobsite Workers

From a list of seven possible options, contractors were asked to rank the top three most effective ways that they communicate safety messages to jobsite workers. All of the options ranked first by at least one percent of respondents are shown in the chart at right.

As in 2015, using toolbox talks far outranks any other means of communicating safety messages to jobsite workers, ranked first by nearly half (44%) of contractors. These findings are not only consistent across years, but also across types of companies and number of employees. In particular, vice presidents at contracting companies are enthusiastic about these, with 72% ranking them first.

Training is ranked first by nearly one third (31%) of contractors, and is the other top means of communicating with jobsite workers.

Chain of command, while only third overall, is ranked first by nearly one third (30%) of those who work in small companies with fewer than 20 employees, demonstrating the importance of leadership involvement in safety at those organizations.

Very few rank indirect means of communication like text alerts, email alerts or flyers first in effectiveness.

Most Effective Ways to Communicate Safety Messages to Jobsite Workers
(According to All Contractors)

Dodge Data & Analytics, 2017

Top Means of Providing Information

On Safer Tools, Equipment, Materials and Processes

Contractors were asked how they provide information on safer tools, equipment, materials and work processes. They were allowed to select all the approaches that they use and were then asked to rank the top three most effective among those. The chart at right indicates the methods used to provide information by more than 10% of contractors, and it shows the percentage who ranked each of the items first.

The findings suggest that while contractors use a variety of methods, they find a few particularly valuable.

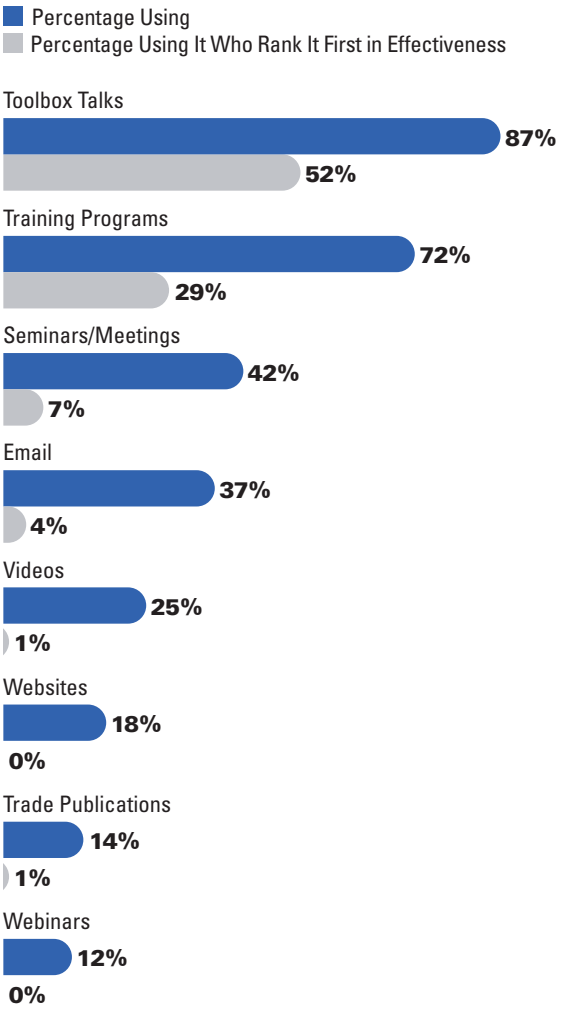
- **Toolbox talks are the top means of providing information on safer tools, equipment, materials and work processes.** They are not only used by 87% of contractors, but they are also ranked first in effectiveness by over half (52%) of those using them. This echoes the finding about how contractors communicate safety messages to jobsite workers (see page 62) and demonstrates the overall effectiveness of this approach.
- **Training programs are also widely used,** although more by GCs (77%) than trade contractors (66%). They are also ranked first for effectiveness by nearly one third (29%), which demonstrates their importance.
  - **Size of Company:** Less than half (45%) of the smallest companies (fewer than 20 employees) use these as a means of providing information on safer tools, equipment, materials and work processes.
  - **Role:** Nearly all those in safety leadership roles at companies (91%) use these to provide information. It is likely that safety training programs are more common at companies with safety leadership roles, and it is likely that safety leaders are more familiar with training programs, which may account for this disparity.
- **Seminars and meetings are used by close to half (42%) of contractors, but only 7% of those who use them rank them as most effective.** They are used most commonly by the largest companies (500 or more employees) (58%) and by those in safety leadership roles (65%).

The other factors used by 10% or more of contractors are rarely ranked first for effectiveness. Contractors seeking to maximize their efforts may best focus on the kinds of intensive, focused experiences that can directly engage workers like toolbox talks, training programs, and seminars and meetings.

Providing Information on Safer Tools, Equiment Materials and Processes

(Top Methods and the Percentage of Users Who Rank Them First for Effectiveness)

Dodge Data & Analytics, 2017



Obtaining Information on Health and Safety

From a list of thirteen possible options, contractors were asked to select the sources from which they obtain information about health and safety. They were then asked to rank the most effective sources for information from the ones they use. The chart at right shows the sources of information about safety and health used by over one quarter of the respondents and the percentage using each who ranked it first for effectiveness.

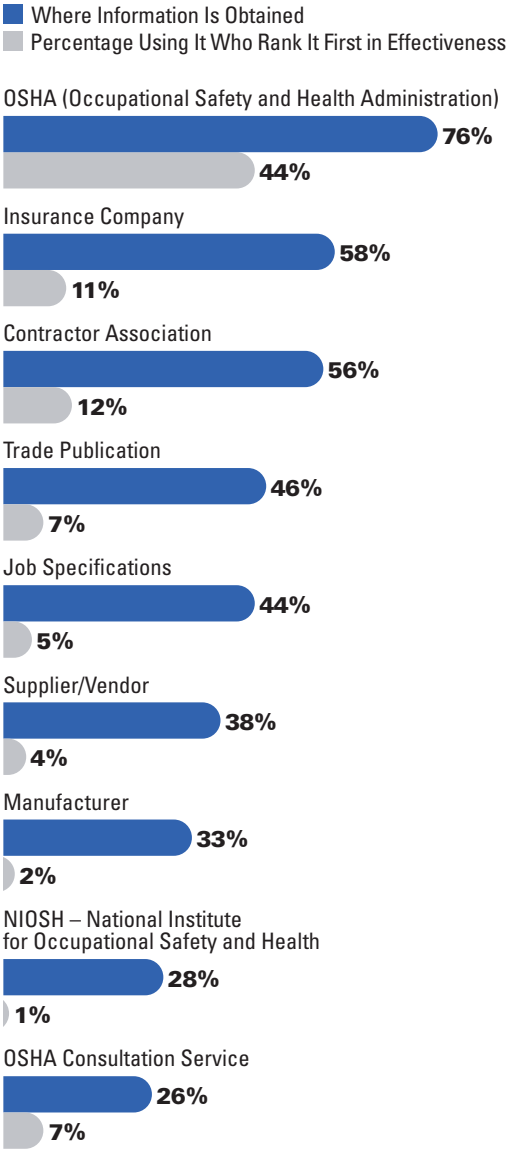
The chart makes evident that contractors typically get safety information from multiple sources, with at least 25% citing nine different sources. However, the chart also makes it clear that despite the widespread use of different sources, only a few are considered highly effective.

- **OSHA is the most frequently used source of information and is ranked first for effectiveness by a high percentage of respondents.** In fact, with nearly half (44%) of those who use it ranking it first, and its relatively ubiquitous use across the construction industry, OSHA is clearly the dominant source of information.
  - **Type of Company:** It is used more frequently by GCs (81%) than trade contractors (69%), but it is considered equally valuable by both when they use it.
  - **Size of Company:** A lower percentage of contractors with fewer than 20 employees (57%) use OSHA for information than larger companies, but it is still their top resource.
- **Over half get information on health and safety from insurance companies (58%) and contractor associations (56%).** It is not surprising that insurance companies would be widely used sources of information, given the importance that insurance rates have on promoting the use of safety practices (see pages 45 and 46). Associations often provide research and other information to support their members' safety efforts.
  - **Size of Company:** A higher percentage of those who work at companies with more than 100 employees (68%) get information from contractor associations than do those who work for companies with fewer than 50 employees (38%). This may have to do with patterns in membership based on size, but it represents a missed opportunity for small companies to take advantage of resources for data to supplement their own efforts.

Obtaining Information on Health and Safety

(Top Sources of Information and the Percentage of Users Who Rank Them First for Effectiveness)

Dodge Data & Analytics, 2017



- **Role:** A high percentage of safety leadership (74%) and vice presidents (78%) get information from associations, demonstrating their effectiveness in influencing company leadership, which can have a large impact on the safety strategies that companies invest in.

- **Just under one half use trade publications (46%) and project specifications (44%) for information about health and safety.** However, less than 10% of those who use them rank them first for effectiveness. Trade publications will help keep readers informed on the latest safety trends, and thus are a proactive source of information, while project specifications are more likely to include prescriptive requirements, a more reactive approach to safety.
  - **Role:** Both trade publications and project specifications are widely utilized for information by safety leadership for information (85% and 71%, respectively).
- **Around one third use suppliers/vendors (38%) and building product manufacturers (33%) to obtain information.** Less than 5% rank these as their most useful resources, probably because the information is specific to product safety, and therefore other sources that provide a broader understanding of safety practices as well, such as OSHA and associations, are more likely to be selected as the most effective. Still, this finding suggests an excellent opportunity for manufacturers to provide their suppliers and vendors with more targeted information for contractors about how their products impact health and safety.
- **About one quarter use NIOSH and consultation services from OSHA for information.** OSHA consultation services has a higher percentage of those who rank it first (7%), in spite of its lower level of use. This suggests that wider use of these services could prove beneficial to the industry.
  - **Role:** 71% of safety leadership uses NIOSH for information on health and safety, far more than any other role.
- **Several other sources of information were used by less than 25% of respondents.** These include trade shows and unions. Since well over half of the respondents work for companies that either employ only union craftworkers (27%) or employ both union and non-union craftworkers (33%), the fact that only 23% use the unions as a resource for information on safety suggests that further outreach in this area could be beneficial.
  - **Role:** Half of those in safety leadership (50%) report that they get information from trade shows, making them a good means to reach out to that audience.

Participation in the Falls Awareness Campaign and National Stand-Down Day

The Occupational Safety and Health Administration (OSHA) in 2012 partnered with the National Institute for Occupational Safety and Health (NIOSH) and the National Occupational Resource Agenda (NORA) on a falls prevention campaign to provide contractors with information about how to prevent injuries and death from falls. OSHA reports that in 2012, falls accounted for approximately one third of the total fatalities in the construction industry. This campaign includes an annual National Safety Stand-Down Day in the spring. For more information on this event and this effort, see page 67.

Awareness

Contractors were asked a series of questions about this campaign, starting with whether they were aware of it. Over half of GCs (52%) are aware of the campaign, significantly more than trade contractors (40%).

Nearly three quarters (74%) of those who work for very large companies (500 or more employees) are aware of the campaign, and more than half (53%) of those working for companies with 100 to 499 employees are also aware. This is in sharp contrast to those at smaller firms, especially those with fewer than 20 employees, where only 27% are aware of it.

Importantly, nearly all of those in safety leadership positions (94%) report being aware of the campaign.

Participation

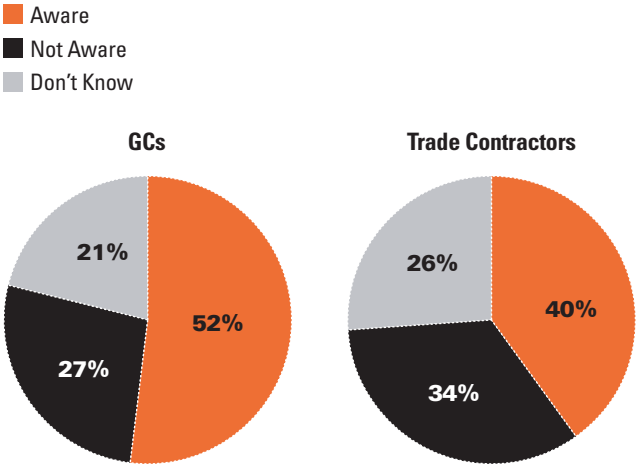
Contractors aware of the campaign were asked if they participate in it, and over two thirds (68%) indicate that they do. Of those, over half participate in both, and those who participate in only the stand-down outnumber those who only participate in the campaign. The pattern of participation is similar in terms of company size, with significantly more participation in both events from those who work for companies with 100 or more employees.

Effectiveness

Among the 108 contractors who report some form of participation, 70% consider it effective in increasing awareness of hazards. While slightly more GCs think it is effective than do trade contractors, the difference is not large enough to be statistically significant.

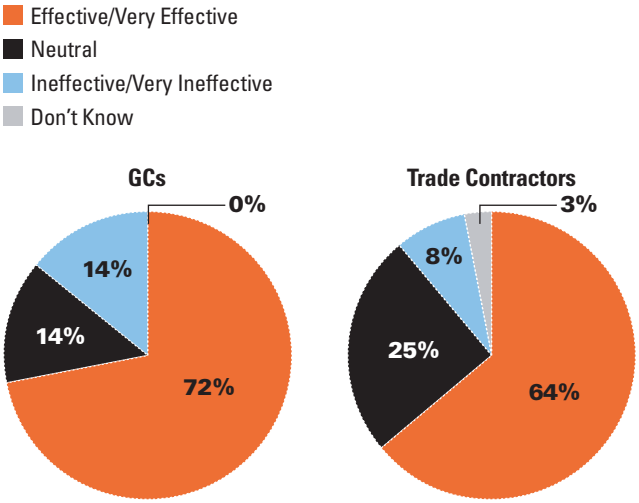
Awareness of the Falls Awareness Campaign and National Safety Stand-Down Day (According to GCs and Trade Contractors)

Dodge Data & Analytics, 2017



Effectiveness of Falls Awareness Campaign and National Safety Stand-Down (According to Participating GCs and Trade Contractors)

Dodge Data & Analytics, 2017



Universal, Accessible, Real:

Why the Falls Campaign Works

For the first couple of years of the National Campaign to Prevent Falls in Construction,* the American Road and Transportation Builders Association (ARTBA) stayed on the sidelines: Campaign posters showed workers on a roof; ARTBA's membership works on the ground. But as the campaign grew, ARTBA's Senior Vice President of Safety and Education, Bradley Sant, took another look at his sector's data.

All Falls Count

Falls aren't Heavy and Highway's number one fatality hazard (as they are for the construction industry as a whole), but they do rank: number two, in fact. Bridges, overpasses and equipment all provide heights from which to fall. And even on the ground, earth moving, deep tracks and excavations full of utilities make slips, trips and falls an issue. Sant applied for an OSHA Susan HarwoodTraining Grant to develop materials that would help ARTBA's membership to see itself in the campaign.

Like ARTBA itself, Sant's grant contact was initially skeptical: "Falls? You do roads!" But when Sant showed him the data, ARTBA got the grant. Over the next couple of years, the Association developed some compelling materials to educate its members on fall hazards in their sector. After a slow start (the members were skeptical too), the program took off. Last year, ARTBA trained nearly 1,000 people. "It's been an educational process for us and our members," says Sant, a process ARTBA is now extending to its clients.

The universality of the falls prevention message, and the support of the campaign's partners for adapting the message to the specific circumstances of the industry's various sectors, account for much of the campaign's effectiveness, says Wayne Creasap, Senior Director of Environmental Health and Safety with The Association of Union Constructors (TAUC). Like ARTBA, TAUC didn't initially see its membership of industrial workers in a campaign that seemed geared to small companies and the residential market. "But the wisdom of the people involved allowed our folks to make it their own, and to recognize that falls impact everyone across our industry," says Creasap. "We've seen more participation in recent years as a result of that expansion."

The Falls Campaign in the Field

Alberici Constructors finds that extending that same leeway to the company's individual projects enables jobsites to maximize their engagement. Kathleen Dobson, Safety Director at Alberici, appreciates the adaptability and amount of educational materials and resources available from campaign partners, and the range of opportunities to get involved a little or a lot. About a month and a half before the campaign's annual stand-down week, Alberici starts identifying options for individual projects to participate. Activities may include vendor and supplier engagement, talks and demonstrations using media in multiple languages, identification of hazards at work and at home, a ladder demo, or even opportunities for workers to use 3D goggles to simulate working at height.

The biggest impact Dobson sees comes from hands-on opportunities: for a worker to put on a harness and have it properly fitted, for example, and perhaps to understand for the first time how it should really be worn, or to try out a fall simulator, and experience just a 2-foot drop from 10 feet up: "It's an eye-opener," says Dobson.

The importance of direct experience resonates with Zachary Penich too. Penich is Director of Environmental Safety with McCarl's Inc. In his experience, workers learning how to inspect harness webbing, D-rings, and buckle and grommet attachments with a harness in hand, for example, or seeing a dummy fall before their eyes, find the safety information more vivid, and are more likely to apply it in the field.

Experiential learning is also an element of what Penich sees as perhaps the single most important theme, not just of fall prevention, but of any safety initiative: the participation of workers themselves in defining, delivering, and experiencing the safety message. "I can't stress enough that companies should try their best to engage the workforce in the safety challenges that they are exposed to," he says. "That's where the most power for the message comes from, and stronger acceptance too." ■

*The National Campaign to Prevent Falls in Construction is a government-labor-management partnership that includes CPWR, NIOSH, OSHA, state government, private industry, trade associations, academia, professional and labor organizations.

Methodology:

Safety in Construction Study Research

Contractor Study

Dodge Data & Analytics conducted an online survey of contractors from June 14 to August 1, 2017 on the use of specific safety practices and their impact on project safety and outcomes, safety management activity and opportunity, productivity benefits, influence factors, Prevention Through Design, technology and safety management, and training practices.

Aspects of this study were conducted to provide longitudinal comparisons to previous studies conducted in 2012 and 2015.

SURVEY RESPONDENTS

The survey data was collected from the Dodge Data & Analytics Contractor Panel, which contains a representative sample of construction contractors across the U.S., and from the members of the following industry associations:

- American Road and Transportation Builders Association (ARTBA)
- International Council of Employers of Bricklayers and Allied Craftworkers (ICE)
- National Electrical Contractors Association (NECA)
- Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
- The Association for Union Contractors (TAUC)

334 contractors responded to the survey. Respondents work on projects across the commercial, institutional, manufacturing, and non-building sectors. The total sample size (n = 334) benchmarks at a 95% confidence interval with a margin of error of 5.3% for dichotomous inquiries.

Four analytical variables were used for the majority of the analysis in this report.

- **Company Type:** The respondents were divided into two groups, GCs and trade contractors. The GC category includes general contractors, construction managers and design-builders. The trade contractor category includes engineering and trade contractors.
  - 151 general contractors (45%)
  - 139 trade contractors (42%)
  - 20 construction management firms (6%)
  - 17 design-build contractors (5%)
  - 7 engineering contractors (2%)
- **Company Size:** Number of employees was used to determine company size.
  - Less than 20: 17% of respondents
  - 20–49: 14% of respondents
  - 50–99: 17% of respondents
  - 100–499: 29% of respondents
  - 500 or more: 23% of respondents
- **Use of BIM:** Contractors were identified as using BIM if they create their own models and/or work with models created by others.
  - Use BIM: 51% of respondents
  - Don't use BIM: 49% of respondents
- **Role at Company:** Contractors selected numerous roles that they work in at their company, and these were combined together into 7 categories for analysis.
  - C-Level: 15% of respondents
  - Safety leadership: 10% of respondents
  - SVP/VP (other than safety leadership): 10% of respondents
  - Director (other than safety leadership): 9% of respondents
  - Project manager: 19%
  - Other type of manager: 11% of respondents
  - Estimators: 21% of respondents

Architect Study

Dodge Data & Analytics also conducted an online survey of architects from June 21 to June 23, 2017, on their familiarity with, interest in and use of Prevention Through Design (PtD), drivers and barriers to PtD wider adoption, PtD LEED pilot credit, and general use of and barriers to using LEED certification and credits.

The survey data was collected using the Dodge Data & Analytics Architect Panel. This panel contains a representative sample of architects across the U.S. The panelists are identified by many categories, including size, region, types of projects undertaken and specialty.

108 architects responded to the study. Respondents work on projects across the commercial, institutional, manufacturing and non-building sectors. The total sample size (n = 108) benchmarks at a 95% confidence interval with a margin of error of 9.5% for dichotomous inquiries.

Respondents identified themselves as working at the following types of companies.

- 85 architecture firms (79%)
- 15 architectural/engineering firms (14%)
- 8 multidisciplinary design firms with architecture as lead (7%)

No analytic variables were used in the analysis of this data. ■

Resources

Organizations, websites and publications to help you get smarter about improving the safety performance of the construction industry.

DODGE DATA & ANALYTICS

Dodge Data & Analytics

Main Website: **www.construction.com**

Dodge Global Network: **www.construction.com/products/dodge-global-network**

Research & Analytics: **www.construction.com/products/dodge-research-analytics**

Sweets: **www.construction.com/products/sweets**

SmartMarket Reports: **analyticsstore.construction.com**

ACKNOWLEDGEMENTS:

We greatly thank our premier partners, the Center for Construction Research and Training (CPWR) and United Rentals, for their leadership in helping us to bring this valuable information on safety to the industry.

We also thank our association research partners for their feedback on the contents of the survey and for sharing the survey with their membership, including American Road and Transportation Builders Association (ARTBA. International Council of Employers of Bricklayers and Allied Craftworkers (ICE), National Electrical Contractors Association (NECA), Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) and The Association for Union Contractors (TAUC).

In addition, we thank all those who participated in case studies and shared their insights and images with us.

CPWR THE CENTER FOR CONSTRUCTION RESEARCH AND TRAINING

www.cpwr.com
www.elcosh.org
www.cpwrconstructionsolutions.org
http://stopconstructionfalls.com

United Rentals

www.unitedrentals.com

Association Research Partners

American Road and Transportation Builders Association (ARTBA): **www.artba.org**

International Council of Employers of Bricklayers and Allied Craftworkers (ICE): **www.icebac.org**

National Electrical Contractors Association (NECA): **www.necanet.org**

Sheet Metal and Air Conditioning Contractors' National Association (SMACNA): **www.smacna.org**

The Association for Union Contractors (TAUC): **www.tauc.org**

Prevention Through Design Resources

CPWR Construction Solutions, Prevention through Design: **www.cpwrconstructionsolutions.org/hazard_solutions/ptd/prevention-through-design-ptd**

National Institute for Occupational Health and Safety (NIOSH) Prevention through Design Program: **www.cdc.gov/niosh/programs/ptdesign/default.html**

Prevention through Design: **designforconstructionsafety.org**

USGBC Prevention through Design Credit: **www.usgbc.org/credits/preventionthroughdesign**

Other Resources:

BIMForum: **bimforum.org**

buildingSMART International: **www.buildingsmart.org**

Construction Safety Council: **www.buildsafe.org**

International Code Council: **www.iccsafe.org**

Lean Construction Institute: **www.leanconstruction.org**

National Institute of Building Sciences: **www.nibs.org**

National Institute of Occupational Safety and Health: **www.cdc.gov/niosh**

National Institute of Standards and Building Technology: **www.nist.gov**

Occupational Safety and Health Administration: **www.osha.gov**

U.S. Bureau of Labor Statistics: **www.bls.gov**

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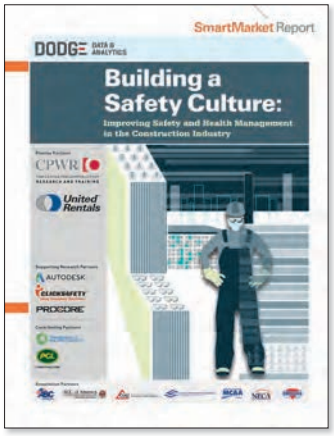

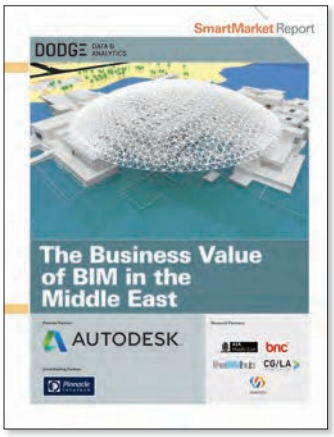

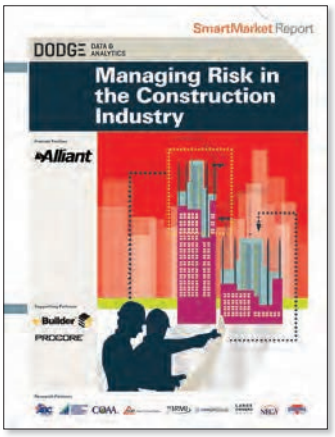

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