The State of Collaborative Design in AEC

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Tech-Clarity

Executive Summary

Collaboration in the AEC Industry

Tech-Clarity surveyed 393 people whose companies design, engineer, or construct the built environment to investigate the current state of collaboration and multidisciplinary design in the AEC community. The research focused on current approaches to collaboration, the readiness to adopt advanced design tools, and how these factors impact project success and profitability. The study focused primarily on the design and design coordination phase of the full built-project lifecycle and does not significantly include the experience of the construction community. About three-quarters (72%) of the research respondents are architects and the vast majority of companies offer architectural and/or engineering services.

The study shows that architects must design concepts with strong aesthetics and build their company reputation while also recognizing the need to meet practical project objectives like project cost and schedule. Unfortunately, poor communication and increased design complexity, which emerged as two of the most common challenges to meeting project objectives and outcomes, make this difficult. Beyond this, almost two-thirds of survey respondents report that design complexity has increased over the last five years.

Insufficient Collaboration and Design Integration Approaches

Designers recognize that working collaboratively across disciplines helps manage increased design complexity. However, the most common forms of collaboration include email, in-person meetings, PDFs, and hard-copy sheets. These methods are inefficient and error-prone. In addition, despite the fact that about two-thirds of respondents report that design integration across disciplines is critical or important to project success, the design integration approaches they typically use, like collecting 2D or printed documents, are also insufficient.

Executive Summary

The Multidisciplinary Design Opportunity

Although the AEC industry faces increased complexity, the design and construction community has been hesitant to adopt new technologies and integrated data platforms. Our research shows, however, that surveyed companies are exploring and migrating to multidisciplinary design to drive efficiency, improve project outcomes, and reduce cost (among other drivers).

Multidisciplinary design marries the efforts of different disciplines into a cohesive process. This increases efficiency and provides impact visibility to designers. They can assess the impacts of choices on a design's cost, more efficiently deal with clashes and geometric constraints, and better tackle complexity driven by code upgrades, material improvements, and energy performance.

The Multidisciplinary Design Transition

The study finds that full multidisciplinary design adoption is still relatively low in the architecture and engineering community, with only 22% of respondents using it on all projects. But about two-thirds of respondents have a positive perception of this methodology, and over one-half of companies are using it on at least some projects.

Although there are barriers to adoption, including organizational, technical, and business concerns, companies report valuable benefits. Over two-thirds of companies who have adopted multidisciplinary design for all projects report more complete designs and fewer errors and omissions. About one-half report increased efficiency and improved constructability. The opportunities are compelling and available. Let's jump into the details of our findings.

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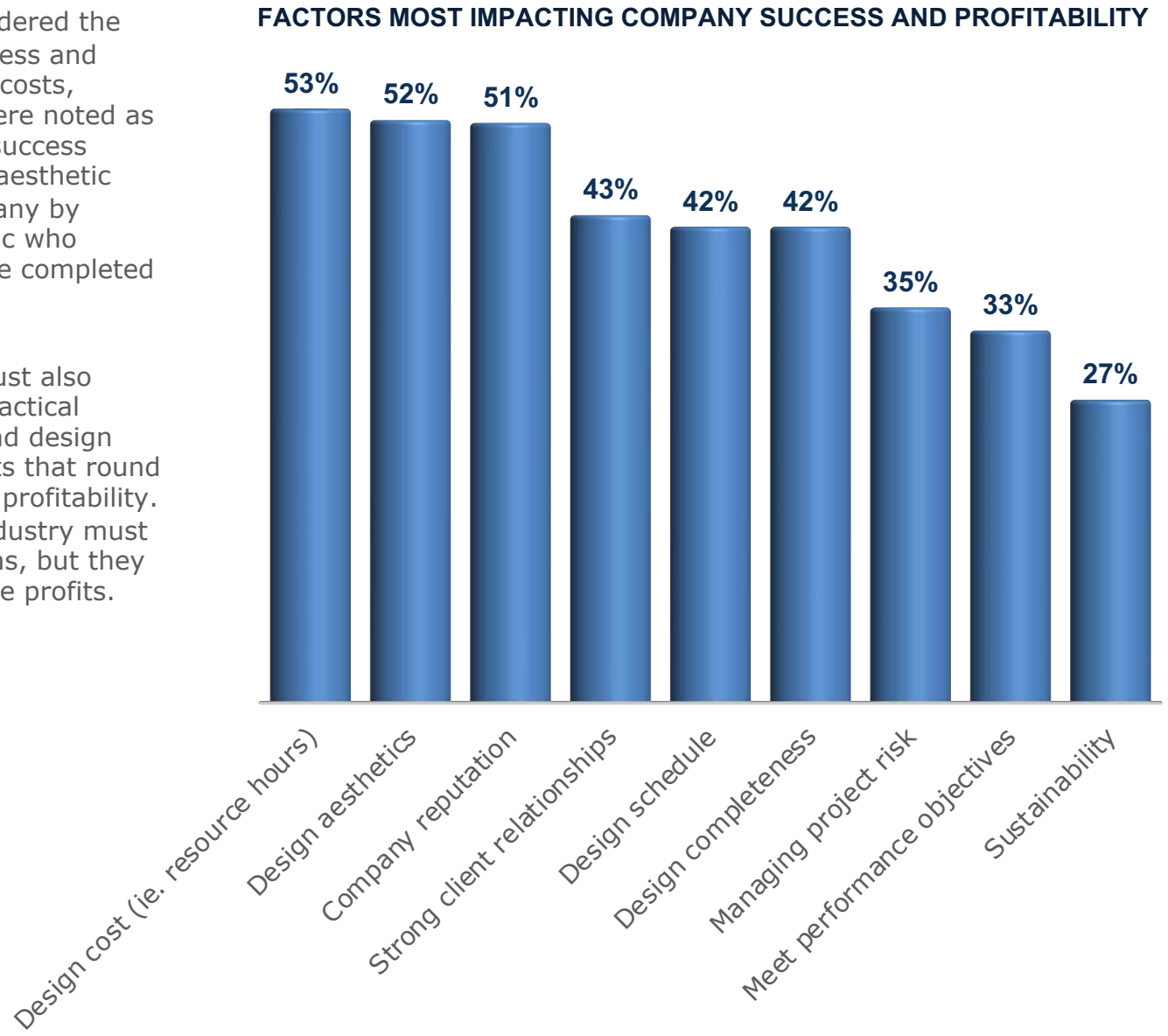
Profitability Demands Compelling Yet Efficient Design

Success and Profitability for AEC Design

We asked participants what they considered the most important drivers leading to success and profitability for their company. Design costs, aesthetics, and company reputation were noted as the top three project profitability and success drivers. This means they must design aesthetic concepts that reflect well on the company by pleasing the customer and/or the public who interact visually and kinetically with the completed project.

The research shows, however, they must also design projects in a way that meets practical project objectives of cost, schedule, and design completeness – the project components that round out the top six drivers for success and profitability. Architects and designers in the AEC industry must collaborate to create compelling designs, but they have to do it in an efficient way to drive profits.



Profitability Demands Compelling Yet Efficient Design

Architects are committed at the onset of a project. Additional design disciplines are hired as the project begins to develop definition and intention. These disciplines have the potential to impact one another as they work to create permit-approved and construction-ready documents.

Local Differences

Based on our experience, we anticipated there would be variations in mindset between geographies. The survey shows that companies headquartered in North America report higher reliance on company reputation (43% more likely), strong client relationships (40% more), design completeness (29% more), and design aesthetics (22% more) than other localities. On the other hand, Eastern Europe, Asia, and Latin America were more driven by schedule.

Demand for Sustainability

Although sustainability is receiving tremendous attention around the globe, participants don't rank sustainability highly as a contributor to profitability and success. Sustainability was mentioned more frequently in North America, Western, and Central Europe than other regions. We expect this to become a larger driver globally over the next decade.

Communication and Complexity are Top Challenges

Communication is the most prevalent challenge to success in construction design projects.

Top Challenges

So, what are the top challenges to meeting design project objectives and outcomes? A significant number (40%) of respondents identified poor communication as a top challenge to successfully achieving project outcomes and delivering on objectives. Project complexity placed second (38%), with managing product offerings and material parameters (37%) ranking closely as additional challenges to success.

Communication is Key

The results of our research indicate that poor communication is a significant issue and one that we believe negatively impacts the key profitability drivers mentioned earlier. The fragmented nature of specialty discipline consultants and variable workforce competency likely contribute to poor communication leading to design errors and omissions. Increased project complexity creates a greater demand for communication. Today's remote work environment probably also contributes to increased needs for, and challenges to, communication.

Europe More Challenged by Sustainability

Not surprisingly, meeting sustainability demands is a more common challenge in Western and Central Europe. Companies headquartered in Western Europe are also much more likely to mention increased design complexity as a challenge. Eastern Europe, on the other hand, has more challenges with poor communication, errors and omissions, and demand for digital delivery.

Design Complexity is Growing

Complexity is Increasing

Our research finds that 63% of designers and constructors say that design complexity has increased over the last five years. Only 25% of respondents feel complexity has remained at a consistent level. Companies with headquarters in Western and Central Europe are even more likely to mention significantly increased design complexity. In other words, increased challenges with complexity, perhaps due to greater sustainability demands, are growing faster there.

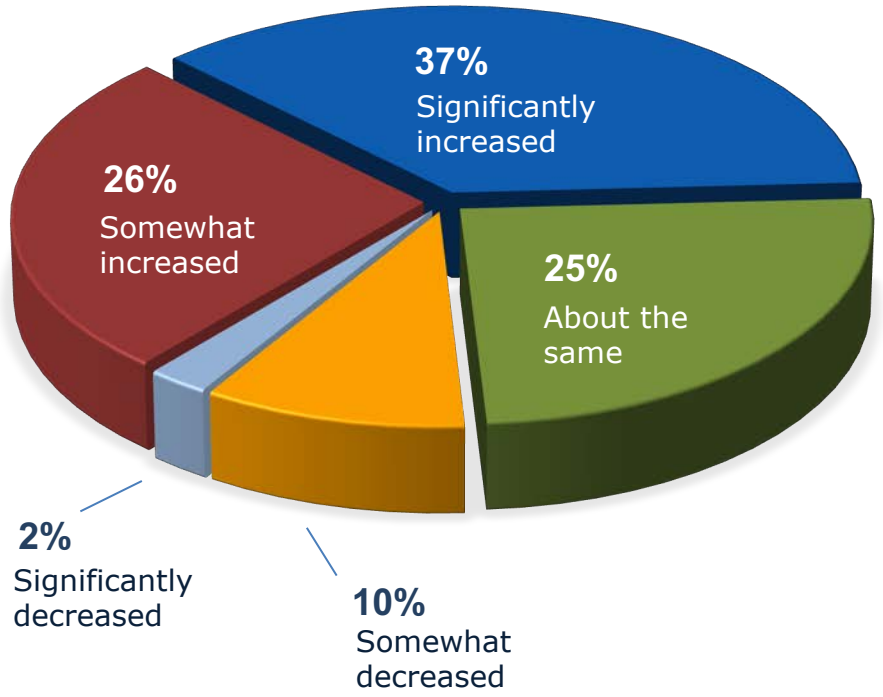
Sources of Complexity

Design and construction have grown significantly in complexity over the last 70 years, and it continues to evolve due to advancements in material and building sciences. The increase in complexity is driven by innovation supporting sustainability, life safety, and energy performance while offering healthier projects for both inhabitants and the environment. More design details and more advanced products lead to more complex designs. Digital technologies, although an improvement for collaboration, actually contribute to a higher level of complexity.

Impact of Complexity on Communication and Collaboration

Complexity requires a greater reliance on experts, whether in architecture, engineering, delivery, or managing the asset once it is complete. This, coupled with a greater propensity for remote work, drives a need to communicate, share expertise, and develop effective collaboration practices.

INCREASED DESIGN COMPLEXITY OVER THE PAST 5 YEARS



Almost two-thirds of respondents (63%) say that project design complexity has increased.

Complexity Requires Multidisciplinary Collaboration

Collaborating Across Design Disciplines

Architects are generally the lead designer and coordinate professionals in a project. They bring together other engineers and designers to achieve project success and profitability. As one would expect, the top design disciplines that respondents work with significantly on a typical design project are:

- Structural Engineers, 63%
- Mechanical Engineers, 57%
- Electrical Engineers, 50%
- Civil Engineers, 46%

The design and building process has always needed some level of collaboration. The practice of architecture originally saw various subject matter experts working together shoulder to shoulder. As society and projects evolved, wages became higher and more difficult to manage. They affected the practice's profitability, and eventually, architects jettisoned specialized experts from their practices resulting in the creation of separate and distinct businesses.

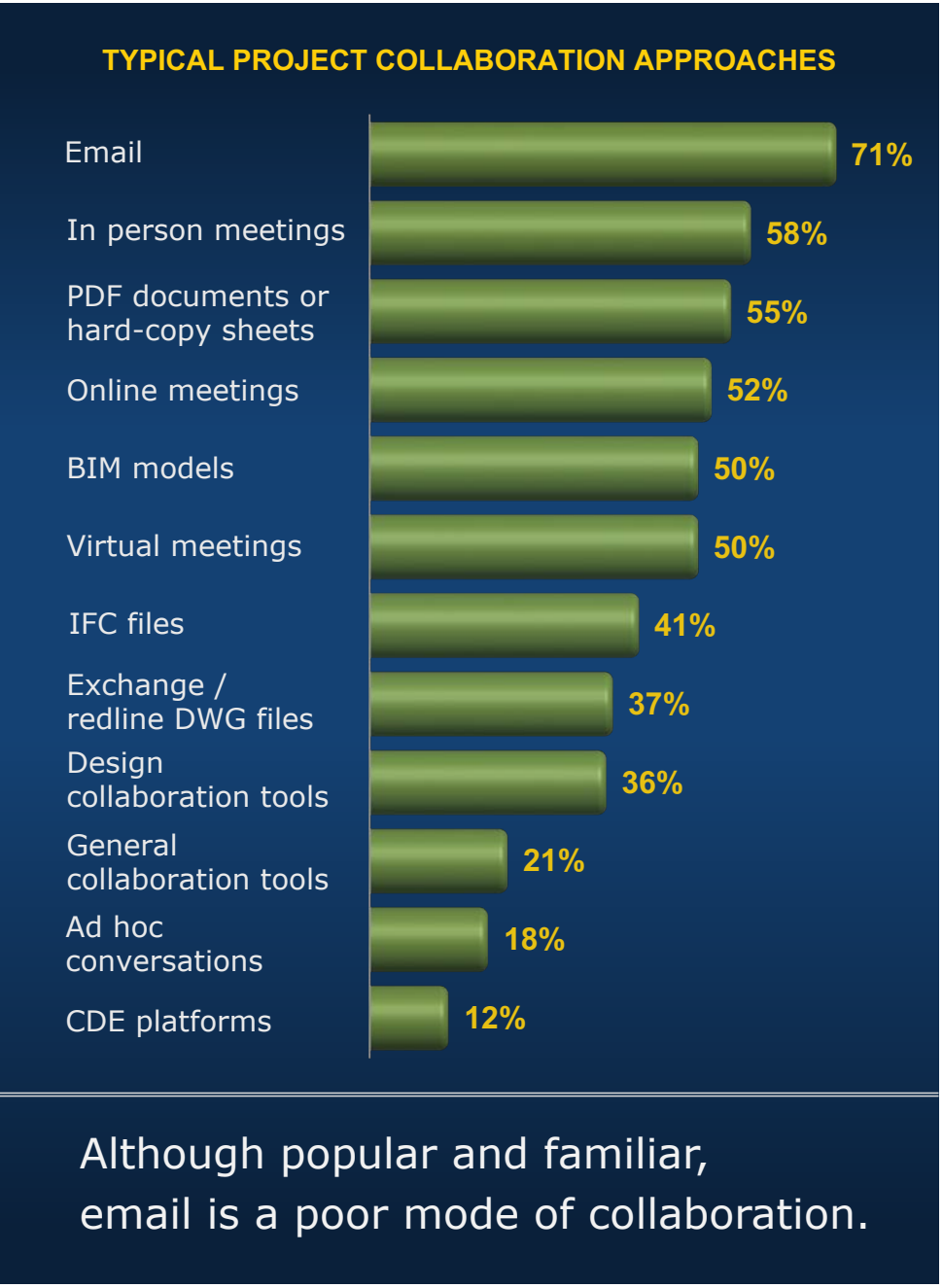
"Collaboration" morphed into an experience of exchanging, redlining, and circulating drawings without working directly together.

Impact on Collaboration

The survey data clearly reflects the multidisciplinary nature of the project design environment and points to the complexity of the communication required between the necessary design disciplines. Challenges with communication across these disciplines can significantly delay the flow of correct information, the completion of designs, and impact construction. Each of these can impact design results, risk cost increases, and cause schedule delays. Overall design complexity will only increase as even more specialized domains are brought into projects, with experts such as landscape design, interior design, energy consultancy, AV design, security, code consultancy, lighting design, and more. Effective cross-discipline collaboration will continue to grow as a core competency required for success.

Architects understand that success requires collaboration between disciplines. Structural, mechanical, and electrical engineers are paramount to design success.

Current Collaboration Has Room to Improve



Although popular and familiar, email is a poor mode of collaboration.

Common Collaboration Approaches Don't Support Effective Communication and Collaboration

Survey respondents report that email is the most commonly used tool for collaborating (71%) in design and construction projects. Although popular and familiar, email is a poor mode of collaboration because it is often asynchronous, difficult to manage, doesn't support multi-party discussions, and fails to allow for contextualizing references to 2D drawings or 3D BIM models. Email also presents a high risk of misinterpretation and does not support timely exchange of design data or opinions, clarifications, and change requests.

Following email, current communication methods rely on in-person meetings (58%) and the exchange of PDF documents (55%). In-person meetings are excellent for idea exchange but not data exchange. While PDFs may be data-rich, data is not easily extractable, and they lack the necessary collaboration tools beyond comments and revisions.

BIM Usage

BIM (Building Information Management), as a paradigm and collection of tools, lends itself to collaboration. One-half of respondents report using BIM models as a platform for collaboration. BIM allows for easy collaboration at the data level.

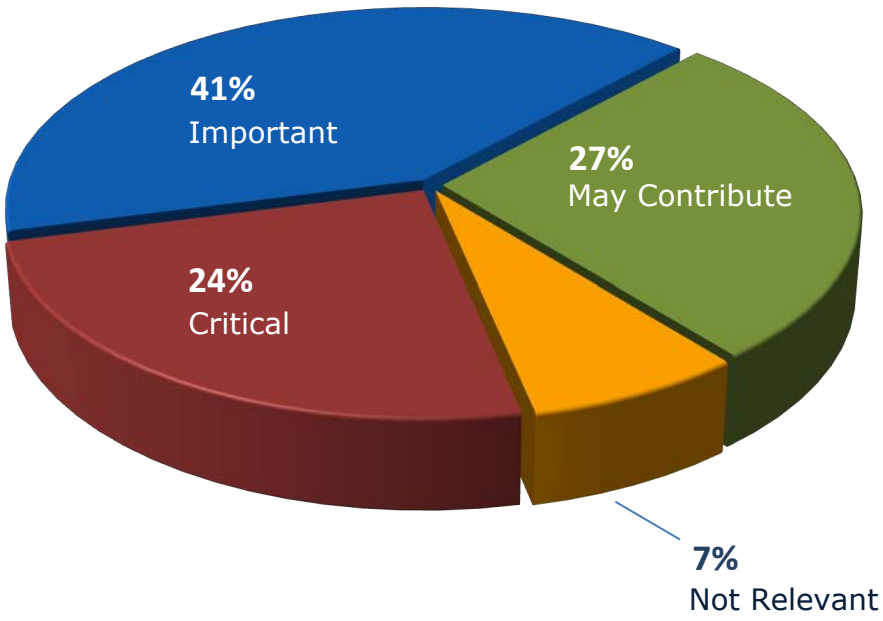
With complexity increasing, and communication seen as the biggest challenge, AEC companies should look to 3D BIM digital toolsets to collaborate. BIM tools are not only visual reference containers but also operate in conjunction with databases.

Importance of Design Integration

Multidisciplinary Design Integration is Critical

Communication and collaboration are viewed as keys to success and profitability. But how critical is multidisciplinary design and integration? Integrating designs from different design disciplines significantly impacts the success and profitability of a design team's projects. Survey results show that two-thirds (65%) of respondents see integrating designs across disciplines as critical or important. A mere 7% of respondents, in fact, find it not relevant. This criticality is likely due to increased complexity and the number of design disciplines required to support today's projects.

IMPORTANCE OF INTEGRATING DESIGNS ACROSS DISCIPLINES



Why Integration is Important

Traditionally, a lot of changes and extra costs have resulted from lack of coordination of separate design disciplines working in silos to achieve their respective design obligations. With 2D document production and geographically separated offices, it was cost-prohibitive for consultants to meet regularly in one location to compare documentation and initiate alterations to the design. Oversights were often handled during construction at the behest of the client. Today, given technology and the move away from server-based management of design information, designers can overlay digital layers and run comparisons or clash detections to determine conflicts. Working through the necessary changes is the work of "integrating." Doing this in a digital environment is essentially ensuring the integration of a digital model beyond conventional 2D sheets.

Difference by Respondents

Companies in North America place higher criticality on integrating design disciplines to drive project success and profitability. BIM or Virtual Design and Construction (VDC) lead/managers view integration as critical and put even more value on transparency. This may be because they have more knowledge of what's really happening, or potentially it's because companies that have this role are doing things differently (this is likely the case).

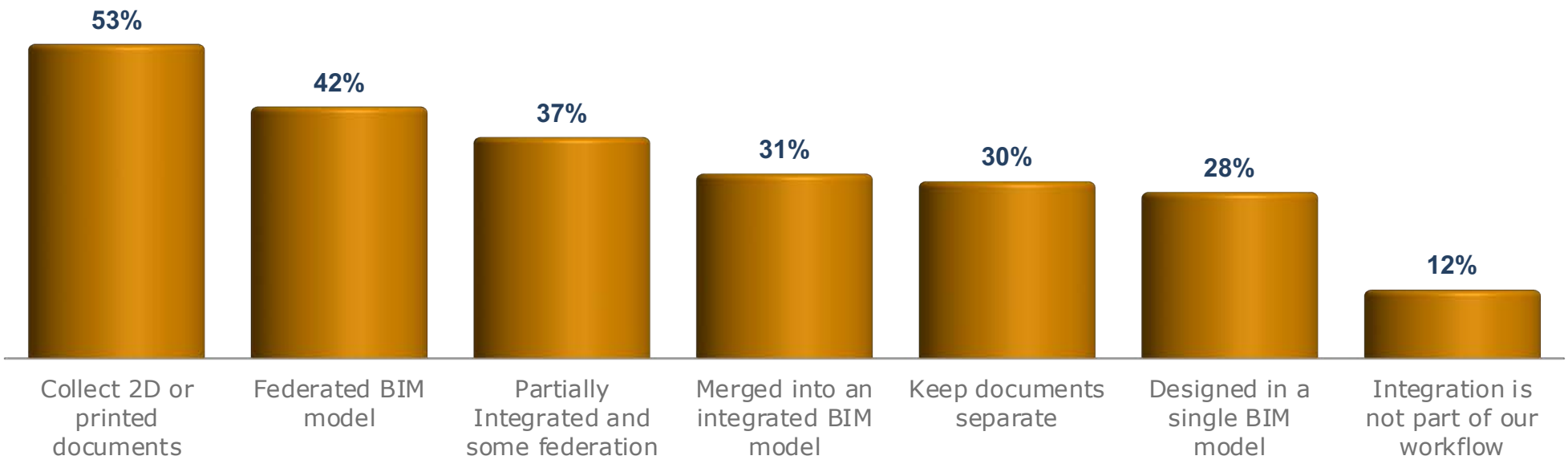
Integration Approaches are Insufficient

Few Use an Integrated Design Tool

Design is the work of many design consultants in parallel to the work of the architect. For some level of projects, there is no great imperative to evolve the work beyond traditional CAD tools. Respondents have made it clear with their comments that sophisticated BIM tools are not necessarily for everyone on small projects such as single-family homes or ADUs (accessory dwelling units). Others choose to work in 3D regardless of project simplicity because they recognize the utility and the potential to eventually scale their business through reputation and pleasing aesthetics.

Design professionals report using a variety of approaches to integrating design data. 2D CAD remains a reality whether operating in silos or operating in a multidisciplinary environment. This is mainly because owners and general contractors still predominantly navigate contractually in 2D. The move to 3D is truly a multi-generational one. But based on the research, integration is seen as essential, so companies rely on a variety of methods for importing and integrating data. In fact, companies use two or more methods, on average, to accomplish it. This can cause errors and delays. Lastly, integrating 2D CAD or PDF drawings is inefficient and results in poor communication and insufficient data flow. Yet, 2D remains the predominant method for integrating design.

PRIMARY METHOD OF DESIGN INTEGRATION



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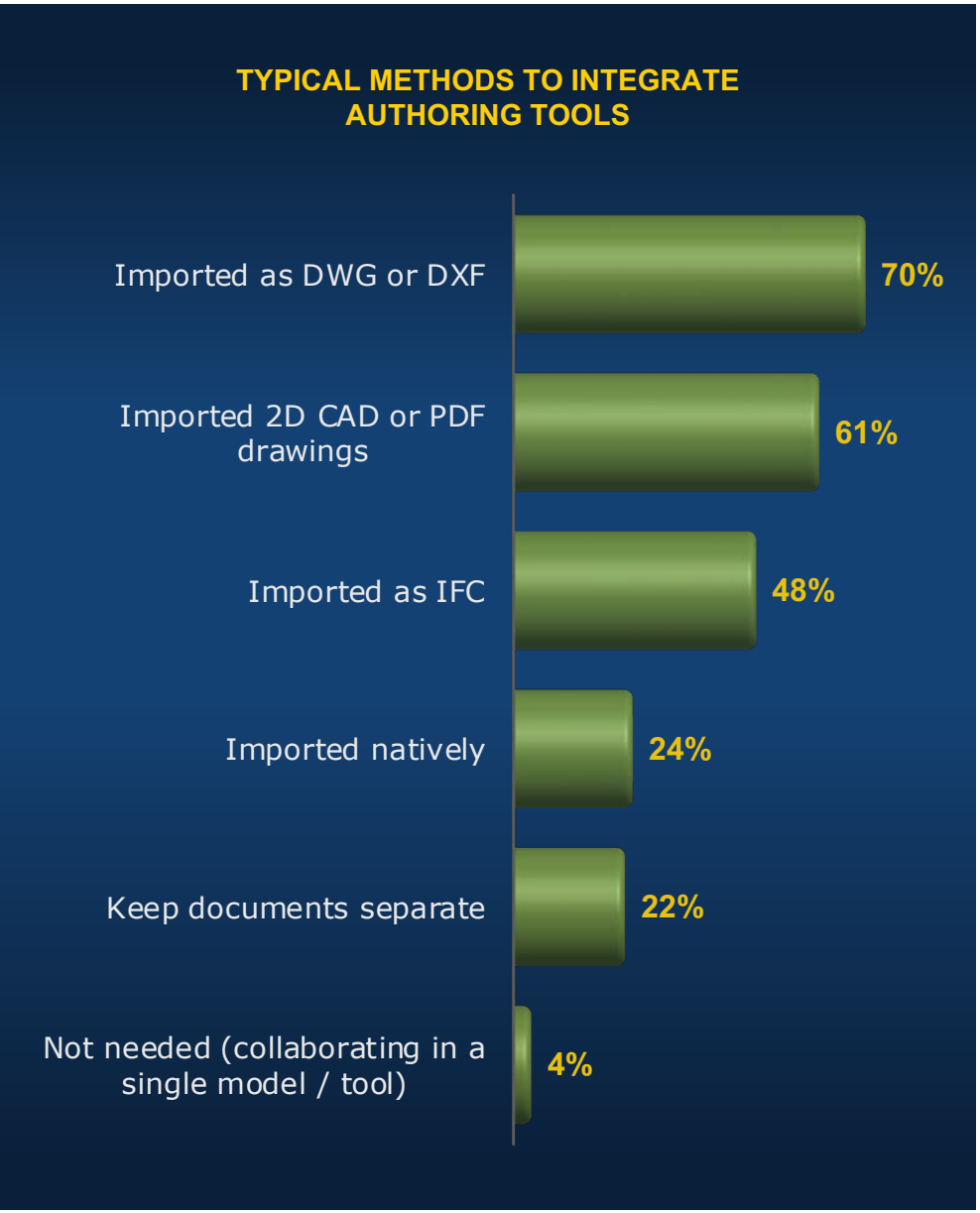


BIM Use for Integration

The industry is evolving. Typical design integration approaches are limited, but the use of BIM to integrate is growing. The most common form of integration has been manually assembling 2D documents. This form of physical design integration is a literal aggregation of information. What the research demonstrates is the growing use of tool protocols to combine multidisciplinary designs into a single environment. Almost one-half (48%) of respondents report importing design data using IFC. This, to ingrate 2D CAD, may not yet rank to the same level, but it is significant. The findings confirm that BIM is evolving as an authoring environment not only for design and rendering but also for integration.

BIM as a Solution for Design Integration

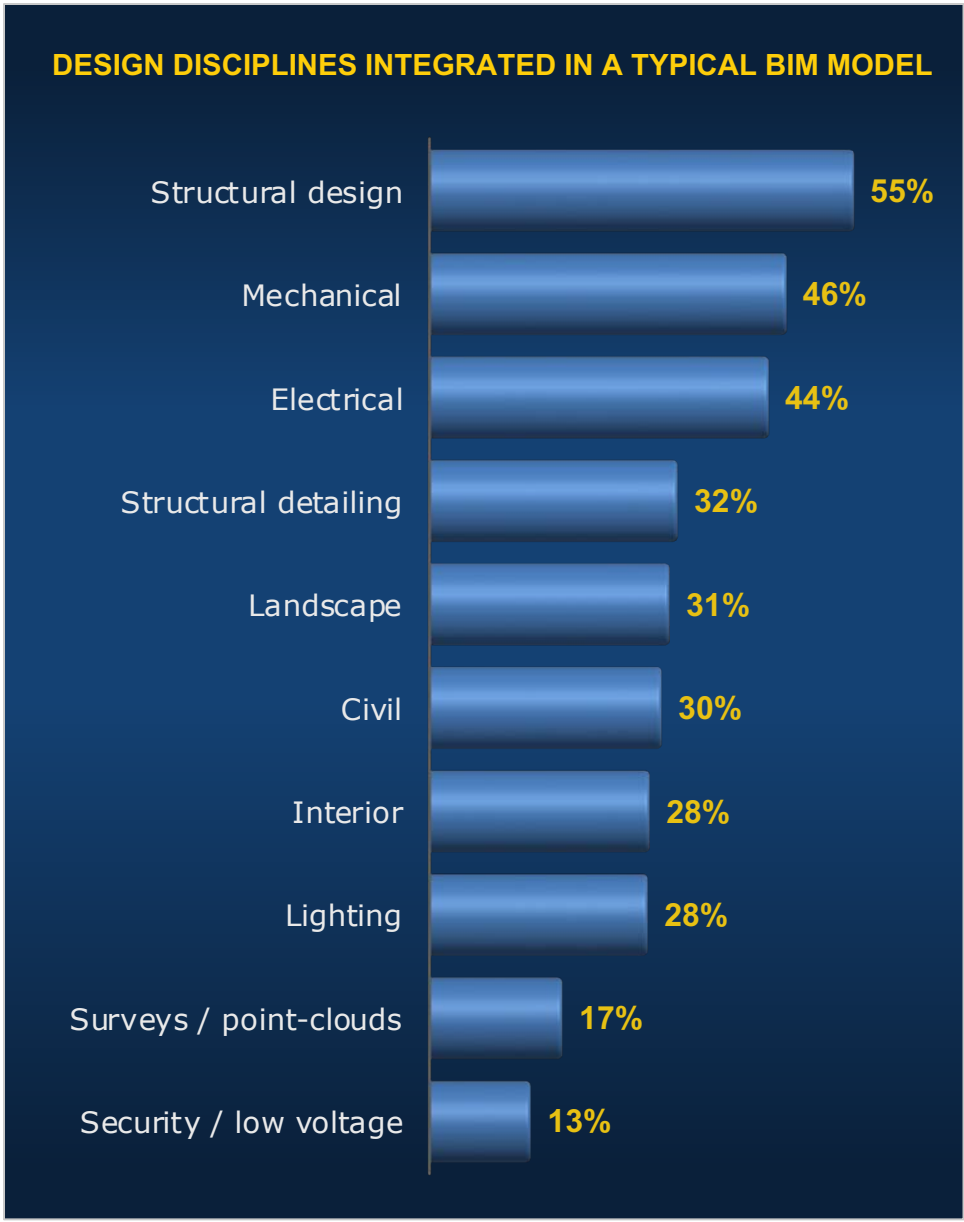
BIM Use for Integration

As seen on the prior pages, some companies are using BIM for both collaboration and design integration. The federated BIM model involves design disciplines working in separate discipline-specific models and then having a designated individual or team integrate them into a single model made of separate layers. This approach ranks second as a primary form of integration (42%, see diagram on page 12). The federated model, however, only provides the opportunity to run clash reports. It does not support the concept of then altering the design going forward within the model. Changes need to be made in independent discipline models and then re-federated again at a later stage to determine whether clashes were eliminated or not.

BIM is designed to enhance collaboration and design efficiency in AEC. Architects and BIM managers are able to integrate many different sub-discipline models into the architectural model. This drives increased visibility and opportunities for collaboration, such as clash detection, geometry adjustments, and visibility of omissions. BIM also enhances communication because an integrated BIM model is visibly and graphically rich in addition to providing access to data.

BIM Combines Multidiscipline Designs

Structural models represent 55% of sub-disciplines typically integrated, reflecting the importance of structural models as the basis of design collaboration. Mechanical engineering, typically delivered as line drawings and specifications, is commonly included such that 46% of the survey pool acknowledged its uptake within BIM. Electrical engineering design appears in BIM models 44% of the time. A decade ago, our experience showed that mechanical and electrical design was rarely, if ever, visible within BIM models.



BIM is Maturing to Become the System of Record

History of BIM

BIM has evolved through a long maturity curve. Apart from early adopters and computational designers, the 1990s and 2000s saw BIM more as a rendering and marketing tool than a commercial tool for useful collaboration and design coordination. BIM's traction in the last 5 to 7 years has been driven by the realization by general contractors and owners that BIM offers significant value with visualization and product attribute data management.

Evolving Role of BIM

The role of BIM is changing. Prior data in the survey shows that firms are using BIM for both collaboration and design integration. Currently, about one-half of respondents use BIM for visual and data communication. One-third, 33%, use BIM as a system of record today. In the future, however, 51% of respondents see BIM acting as the system of record. This trend illustrates that BIM is being used as a form of communication among design teams and project stakeholders. And it is becoming an essential part of the design workflow.

The Role of BIM / VDC Managers

The increasing role of BIM is likely supported by a growing number of design technology experts in architectural studios and other design disciplines. General contractors and subcontractors are creating BIM or VDC managers and technicians roles. These professionals are bridging the divide between convention (2D drawings and specifications) and digital twins and digital threads. They are much more likely to see BIM as the future system of record.

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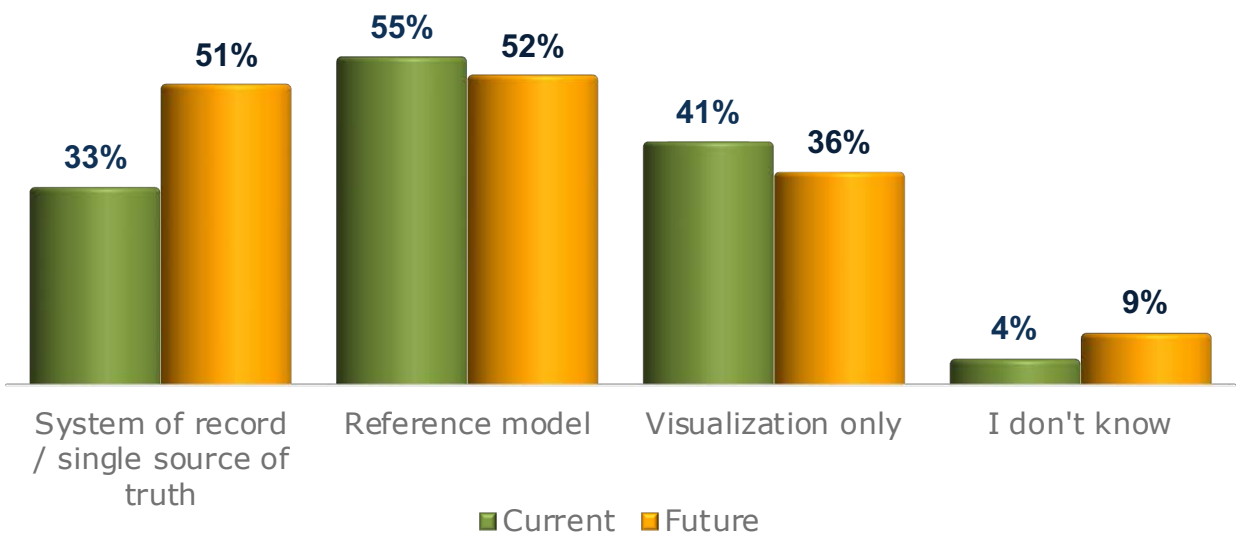
ROLE OF INTEGRATED BIM MODELS



Importance of Design Integration Approaches

Interoperability is Essential

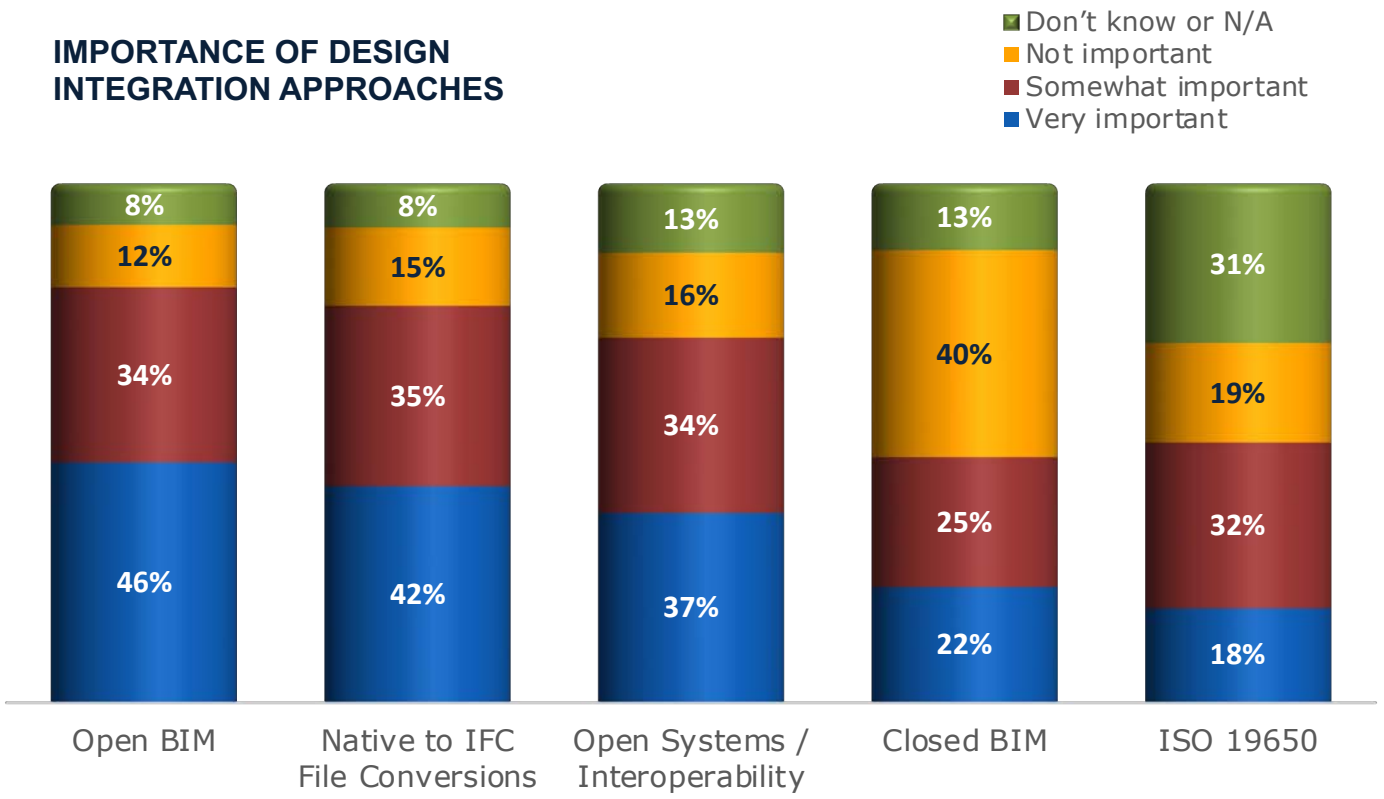
We wanted to understand how firms view the importance of interoperability for navigating and integrating BIM projects. It is no surprise that 71% of respondents see authoring tool interoperability as important. When it comes to interoperability, 80% recognize open BIM as important or very important. The IFC protocol is also seen as important (77% of respondents). Openness is valued. Fewer companies, about 50%, feel a closed-BIM environment is important. Closed BIM was deemed less important to respondents from North America and Western Europe. Only 16% of respondents from these geographies reported it as very important.

Evolving Integration Standards

ISO 19650 is gaining a lot of visibility as a structured guideline. ISO19650 is not a protocol but rather a standard of how to approach BIM. We asked about ISO 19650 to understand whether companies view this standard as important or not. Almost one-third of respondents say ISO 19650 is something they do not understand or have working knowledge about. One-half felt it is an important standard. BIM or VDC lead/managers, however, see higher importance and put more value on openness and using native to IFC file conversions. They also put more emphasis on ISO 19650, as about one-third of respondents in those roles believe it's very important, almost twice as likely as others, such as architects. People in these roles are likely more aware of the challenges that poor interoperability and integration cause.

80% believe that Open BIM standards are important.

IMPORTANCE OF DESIGN INTEGRATION APPROACHES



Tech-Clarity

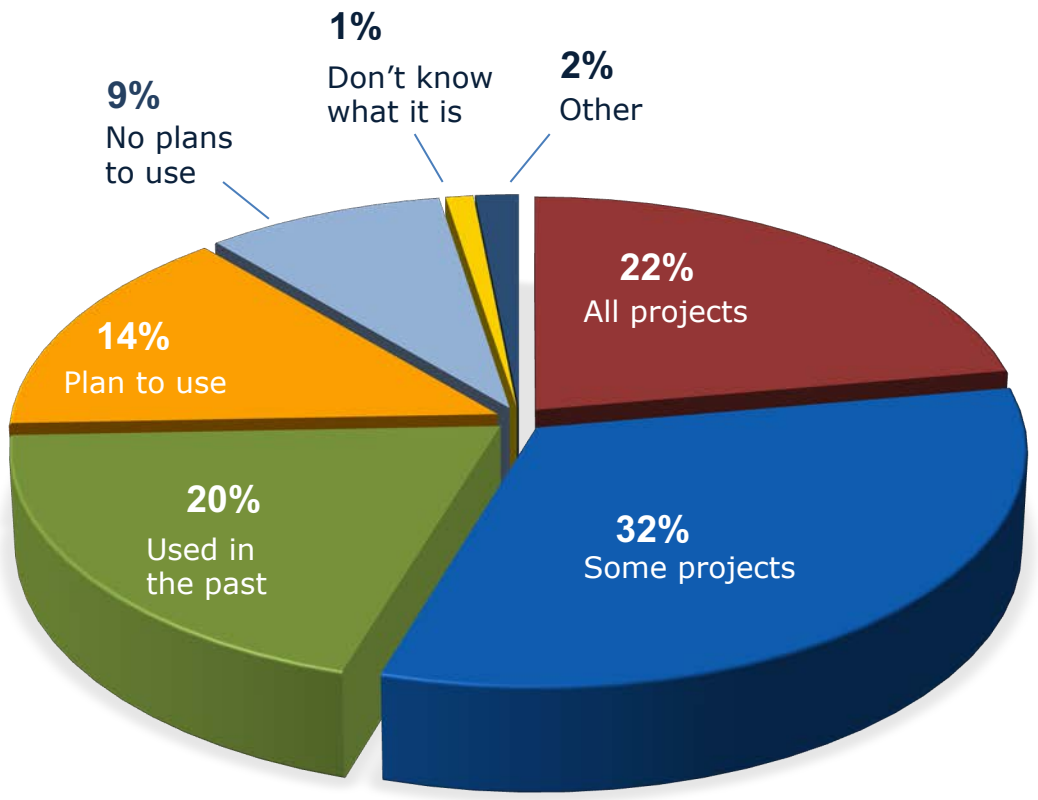
Companies are Adopting Multidisciplinary Design

Multidisciplinary Design is Happening

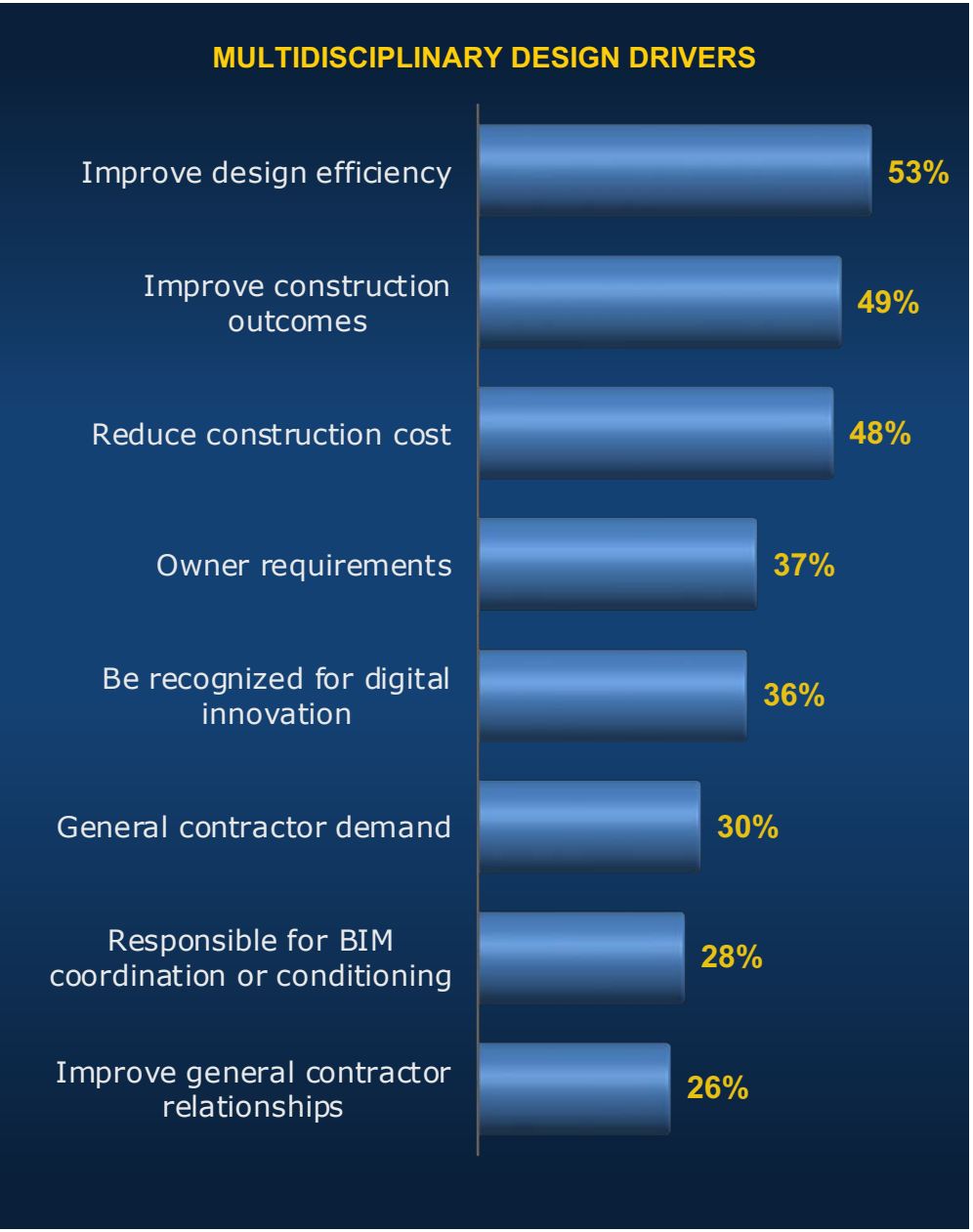
Survey responses indicate a clear adoption of multidisciplinary design, 22% say they use it on all projects and over one-half are using it on at least some. This means that design professionals are choosing more collaborative frameworks. Different roles, such as architects, engineers, and specialized discipline design consultants, are brought together and work interdependently, reporting to one lead. In more multi-stakeholder work and planning groups, urban planners, landscapers, environmental engineers, construction experts, and other professionals are brought together early in projects for integrated design strategies and workflows that result in faster and better design outcomes.

For the purposes of this survey, we define multidisciplinary design as combining the capabilities and skillsets associated with building and project design. It means that professionals work collaboratively. Different roles such as architects, engineers, and specialized discipline design consultants are brought together and work interdependently, reporting to one lead.

MULTIDISCIPLINARY DESIGN ADOPTION



Companies are Adopting Multidisciplinary Design

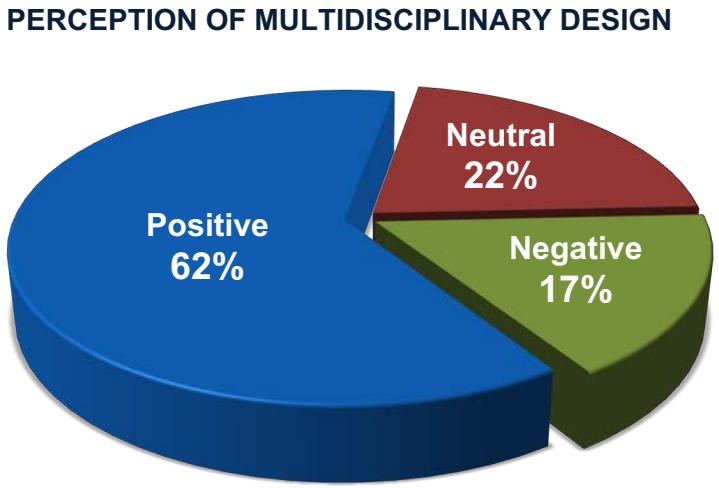


Perception of Multidisciplinary Design is Mostly Positive

Almost two-thirds of companies that shared their perception and openness to multidisciplinary design expressed positivity. Overall, responding companies are favorable about the potential of this approach.

Multidisciplinary Design Drivers

Why are they choosing to adopt multidisciplinary design? About one-half (53%) see it as improving design efficiency. This directly impacts profitability because team members are not caught up in the inefficiencies of email or circulating 2D PDF drawings for redlining and comment. Other drivers include results-oriented factors such as improving construction outcomes (49%) and reducing construction costs (48%). Companies also report business priorities such as owner requirements, being recognized for digital innovation, and general contractor demand. Multidisciplinary design drivers are plentiful. On average, companies report three or more drivers.



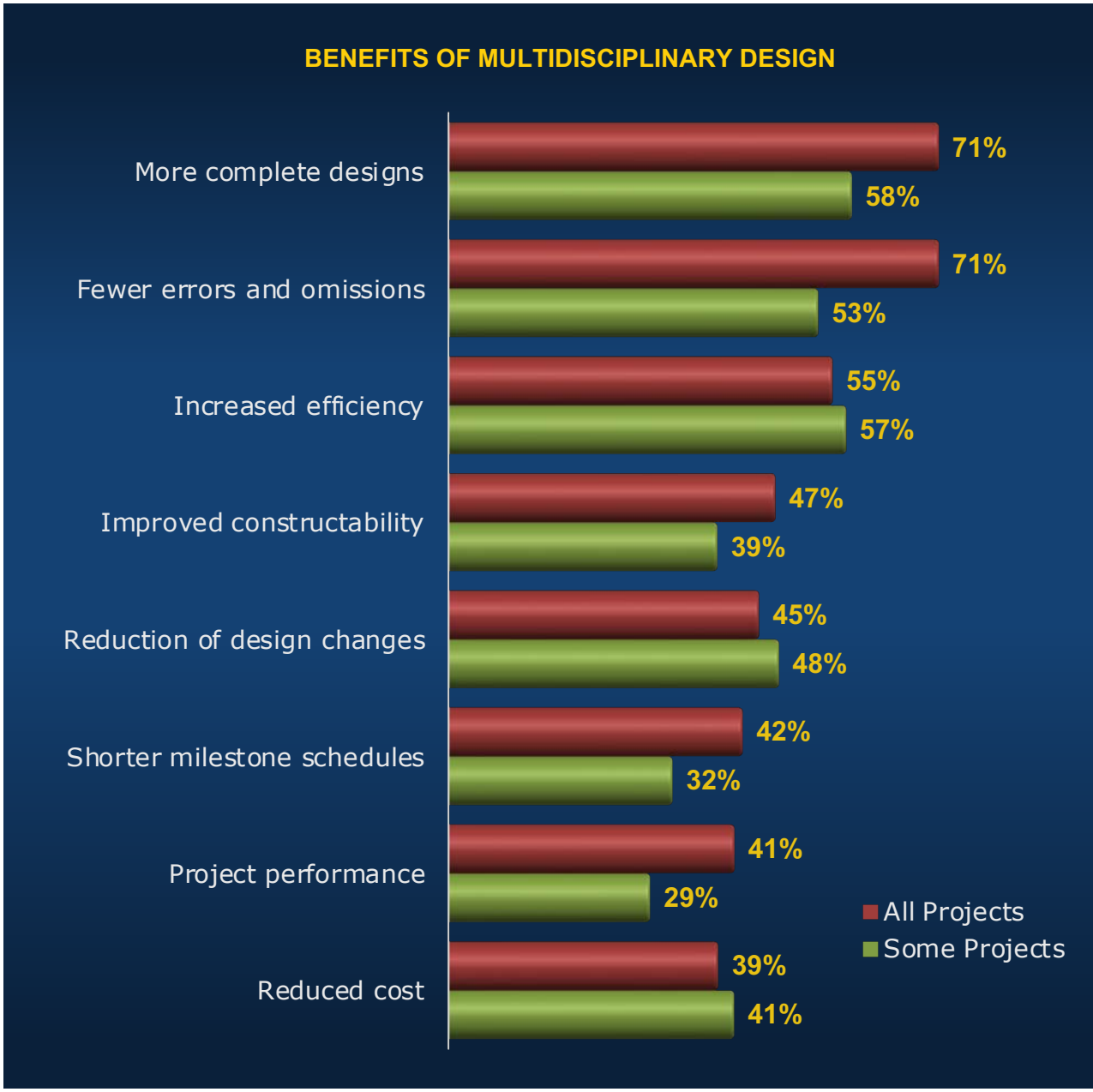
Multidisciplinary Design Provides Valuable Benefits

Multidisciplinary Design Benefits Drive Success and Profitability

More importantly than perception, the research indicates that there are considerable benefits achieved from taking a multidisciplinary design approach. Almost three-quarters of companies that use multidisciplinary design on all projects report fewer errors and omissions. The same number report more complete designs. Complete designs keep constructors and clients happy because they lead to projects with fewer delays and fewer change order requests. This helps improve four of the most commonly reported factors that impact project success and profitability, company reputation, strong client relationships, design schedules, and design completeness.

Multidisciplinary Design Improves Efficiency

One potentially surprising finding is that companies aren't sacrificing efficiency for better designs. In fact, just over one-half of respondents report increased efficiency. This supports the most commonly reported driver impacting project success and profitability, design cost. These findings highlight the important business benefits of multidisciplinary design to support today's more complex, demanding AEC industry.



Perspectives on Multidisciplinary Design

What is your company's perception of, and openness to, multidisciplinary design?

We find BIM models to be cumbersome for our needs, we would like for all of our consultants to supply 3D of their work to fit into our model – but we don't really need all the other data associated with the 3D forms.

We stand in the "no man's land" between BIM and GIS. For us, multidisciplinary working is both a core competency and a requirement.

We are open to multidisciplinary design. However, client requirements and/or contract structures don't always allow for it.

It is necessary. Industrialized construction plus constructed (Construction 4.0) will force a more integrated multidisciplinary design and operation.

BIM is impossible without this. It has to change.

Without a doubt, there are differing opinions across project size / type and design or construction company size.

This is not of commercial interest for small design practices.

It still takes a long time to adapt, (around 5-10 years), due to current contracting systems and strong separations between architects and engineers in office/company structure.

It would be nice right away but it's not workable practically.

Multidisciplinary design will always be critical - but it is unrealistic to think that procurement systems will be perfect or that large companies with every discipline will be awarded design contracts for everything in a building. The assumption should be that specialists will contribute, they will require their own tools, and these need to be able to interoperate successfully to realize a design

For BIM to truly work all parties should be able to work on one base platform. This would include the construction side.

We are a design and engineering (multidisciplinary) studio. We see the move to multidisciplinary design as increasing.

If desired, we can include all specialist disciplines in our contract and act as the responsible general planner.

We are very open to multidisciplinary design and encourage it as much as possible to clients and our consultants. Currently in our office, all projects are teamworked. The biggest challenge is to get consultants to integrate and general contractors to understand the value of the integration.

Multidisciplinary Design Faces Challenges

Perceptions versus Risks

Regardless of benefits, the architectural, engineering, and construction communities are slow to adopt new workflows and tools. And for good reason. There is a lot at stake: money, company livelihood, jobs, reputation, and life safety. This is compounded by the fact that no project is the same as any other. There are many stakeholders, and the concern for public safety can never be diminished. The industry remains risk averse, and when in doubt about adopting new methodologies, the tendency is to stay the course of familiar methods regardless of possible efficiency gains. This view is changing slowly with an abundance of caution and awareness.

Cultural Resistance

Multidisciplinary design offers benefits, but it also presents challenges to the status quo. The survey demonstrates that cultural resistance is seen as the most common risk to adopting a multidisciplinary approach (39%). Technology incompatibility is also seen as a large challenge, including versioning of tools (34%).

Liability

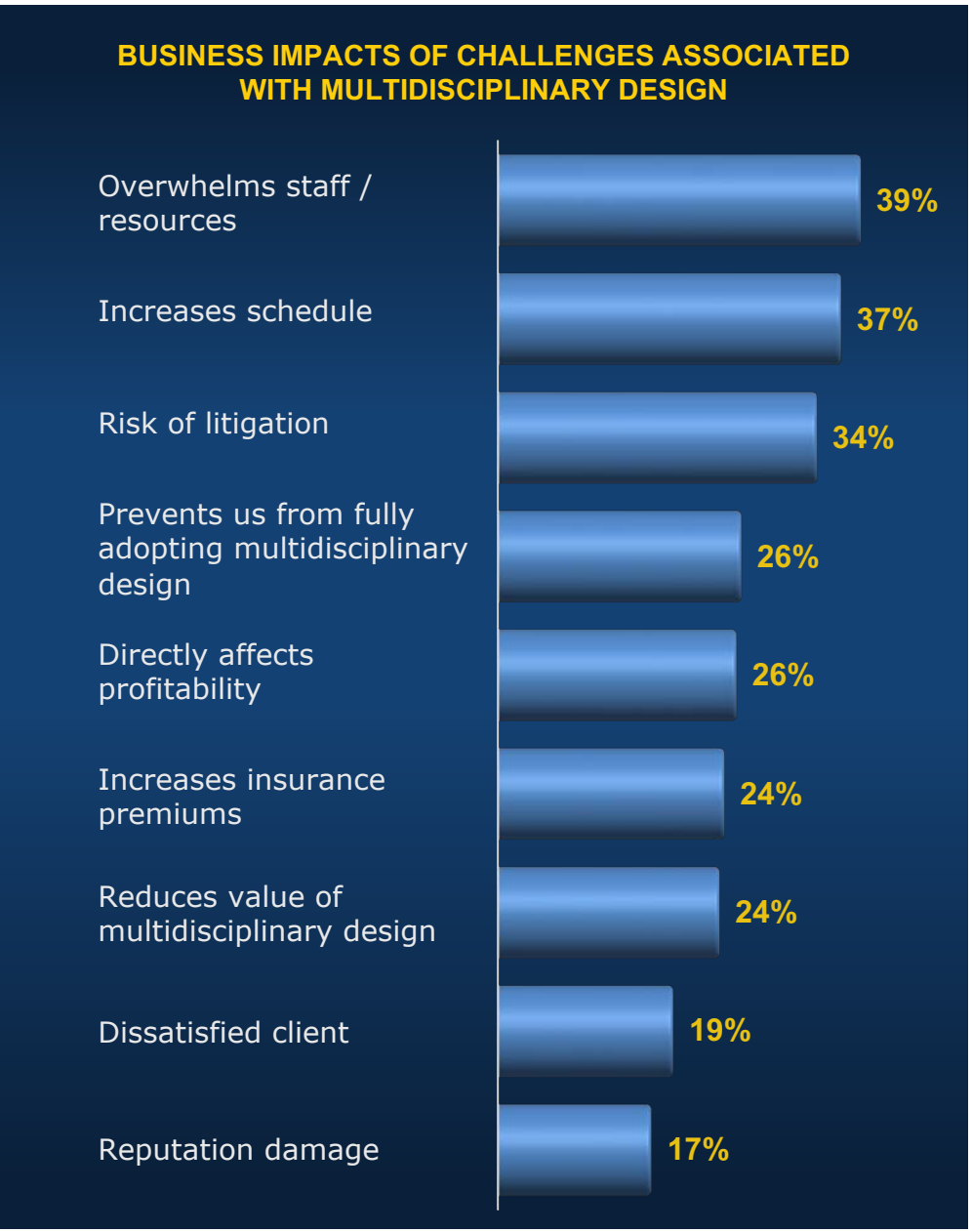
Other factors seen as posing challenges to adopting a multidisciplinary design approach include contract structures with clear delineations of accountability (31%), legal Liability (29%), and surety (28%) concerns. The design and construction industry remains confrontational and with clear domains of accountability. Despite a drive towards collaboration, the business rules determined by lawmakers and precedents set boundaries with regard to preventing overlaps of accountability and erroneous efforts to resolve omissions and mistakes. It is appreciable that those underwriting professional services would drive to limit exposure often against the ambition to look for better ways to work as a team.

Regional Factors

North America is more challenged by legal and contract structure issues, along with incompatible applications/versions. This prevents adoption and reduces value even more than average. Eastern Europe experiences fewer legal and contractual issues but faces strong cultural resistance.

Cultural resistance is the greatest barrier to adopting multidisciplinary design.

Challenges Lead to Business Impacts



Resource Competency Limitations is Seen as a Risk

The product of design consultants is their staff. Any disruption to workflow and delivery of service would have an immediate impact on the success and profitability of a design studio. The benefits of multidisciplinary design can be appealing, but first, the challenges have to be addressed or at least minimized. Staff competency and ability to deliver within a multidisciplinary design environment is a risk. Staff not being able to work in these types of collaborative environments could easily overwhelm resources. Training, mentoring, and senior management support will go a long way to smoothing the roadmap to multidisciplinary design.

Litigation and Increasing Insurance Premiums in the face of Claims

The concerns of litigation and increasing insurance premiums are real. Some of the challenges may have to be addressed by regulators and lawmakers alike. The UK, as a prime example, has a government mandate to deploy BIM. Countries such as Germany, where there is a lower propensity to seek resolution of disputes through the courts, offers less risky environments to adopt innovative technologies and encourage a greater level of collaboration amongst the work of others. Regardless, litigation (or the risk of it) continues to rank high in the minds of respondents.

Design Schedules

Schedules could be impacted if one does not address and create awareness of the challenges facing multidisciplinary design. Some also believe that if challenges are not abated, then multidisciplinary design is seen as possibly contributing to schedule delays in the design process. Not addressing these challenges would put the benefits and profitability associated with collaboration and multidisciplinary design at risk.

Value of a Single BIM Authoring Environment

Enabling Multidisciplinary Design

We define "BIM" as the building information model and the "authoring environment" as the software package chosen for the purposes of designing, monitoring, and archiving BIM data. The study investigated the perceptions of using a single BIM authoring environment. A single BIM authoring tool eliminates or reduces the need to integrate designs from different authoring tools. This better supports multidisciplinary design because all parties are designing in a common environment. This encourages collaboration and provides rapid feedback about conflicts and clashes.

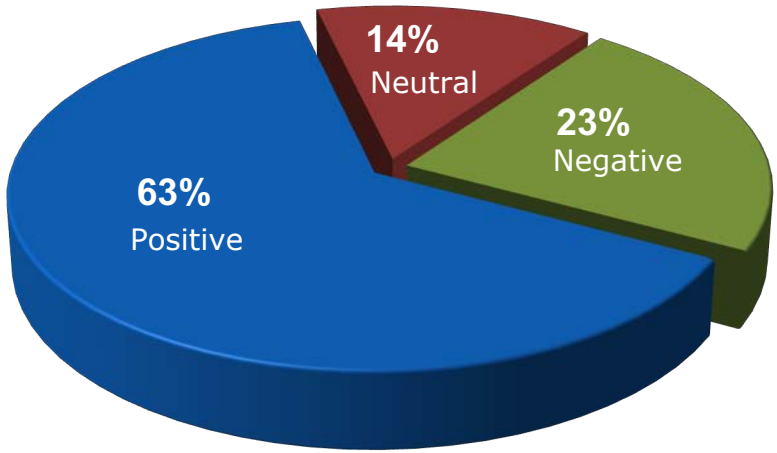
Similar to multidisciplinary design, the majority of companies express positive sentiments about working within one authoring tool. Specifically, 63% of respondents had a positive view towards having one single BIM authoring environment. However, almost one-quarter held negative viewpoints, and another 14% were neutral. Note that this does not imply that companies do not value openness (see page 16). An open single authoring environment can also give them the choice to incorporate designs from other applications.

Views of integrated design are relatively consistent, however, over one-third of Central and Western European participants have a negative view of an integrated design environment. North America is more positive than others.

The Reality of a Single BIM Tool

Despite the positive view of a single authoring tool, our experience shows that it is difficult to achieve due to a variety of organizational, personnel, process, implementation, and technology issues. The study did not look into those directly, but we expect that they would echo many of the challenges reported for multidisciplinary design. The transition to navigate design efforts in a comprehensive BIM environment is a journey for most companies. They will still face the need to integrate designs from others into their BIM model simply because of competing technical delivery objectives.

VIEW ON THE VALUE OF A SINGLE BIM AUTHORING ENVIRONMENT



We define "**BIM**" as the building information model and the "authoring environment" as the software package chosen for the purposes of design, monitoring, and archiving BIM data.

Views on a Single BIM Authoring Environment

Would your company see value in having a single BIM authoring environment that supports all, or most, of the typical project design disciplines?

Yes, for some applications, such as energy management and MEP design and calculation.

Yes, however the current scenario we are managing with basic CAD tools and unless we get bigger projects, financial constraints are restricting adoption of newer technologies and methods.

Yes, if "stage setting" (workflow preparation and full furniture and design library integration) would be provided as an offered service.

We can see the value as long as it does not impede the creative process in our work. Integrated project design and coordination looks good on paper but requires careful implementation. There is a view that "integrated" is better, which is only true if all involved disciplines can work in their respective fields without having to consciously care about other disciplines in the same authoring tool.

It is more important to have interfaces in an everchanging landscape. We script and develop code for different tasks. One authoring tool is more of a burden and not required.

Yes, it would present value, however, we are bound to long-term software license contracts.

No. Walled garden reduces creativity, optionality and competitiveness.

Yes, it would be fantastic if all disciplines were on a software that was compatible and easily updated. But again, many of the really smart BIM software are great at the building information part but not great as a design tool.

Yes, it would be an advantage.

Yes, definitely.

No, discipline specific software is better.

Not very important because all disciplines should be able to convert all BIM authoring environment models to IFC based on a CDE for design coordination. Normally, every discipline should use the BIM software that supports their work and workflow best so that the project benefits from an optimum design in each discipline.

IPD is Growing and Requires Multidisciplinary Design

IPD is Structured Around Collaboration

There are multiple forms of contractual engagement between owners, design consultants, construction contractors, and trade-specialized contractors. Whether design only, design-bid-build, design-build, or other formats, industry constituents are generally quite familiar with these approaches. Some of these working frameworks drive greater collaboration by their very nature. One form of contracting relationship is gaining momentum and uptake among owners, design consultants, and contractors alike: Integrated Project Delivery (IPD). IPD remains a new way of approaching risk-share and, in turn, forces collaboration and integration. However, there are critics of IPD.

The IPD Philosophy

Construction is an industry where risk is typically pushed down the supply chain. Each participant seeks to avoid and transfer risk to other parties. The IPD approach employs a different philosophy: share risk. Share the upside and the downside. The project participants accept and manage design and construction risks as a team. The IPD method often does this with a single, multi-party contract that is typically spearheaded by the owner but co-agreed by design consultants, general contractors, and subcontractors. Risks and rewards are distributed using a profit/incentive pool that is based on measurable project outcomes. Team members collaborate on how the profit and incentive pool is structured to ensure that each member is accountable for their contribution to the project outcome. The goal is to motivate each member in a way that encourages candid communication and accountability for overall design and construction.

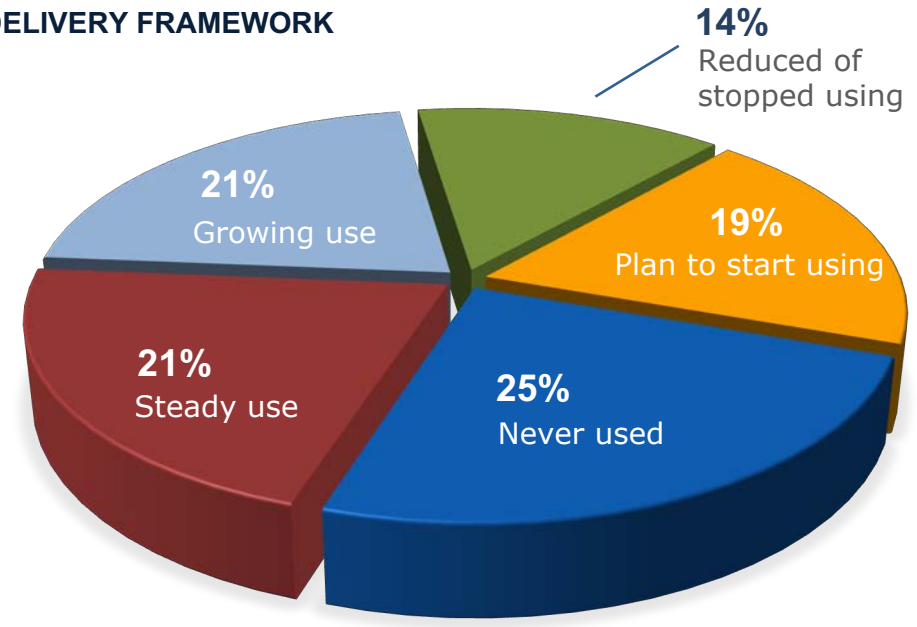
IPD Adoption

Integrated project delivery (IPD) is used regularly by 21% of respondents. Another 21% see growing use, and 19% plan to start using this contract method.

IPD demands enhanced collaboration as designers, constructors, and clients share risk and profit. Sharing risk and profit drives the need to communicate.

Design only and Design-Bid-Build also remain in high use as the form of contracting type in the AEC community, but we believe the increased use of IPD will naturally drive more collaboration and multidisciplinary design. IPD use is growing more in North America (29%), with more steady use in Central Europe, Australia, and the Middle East.

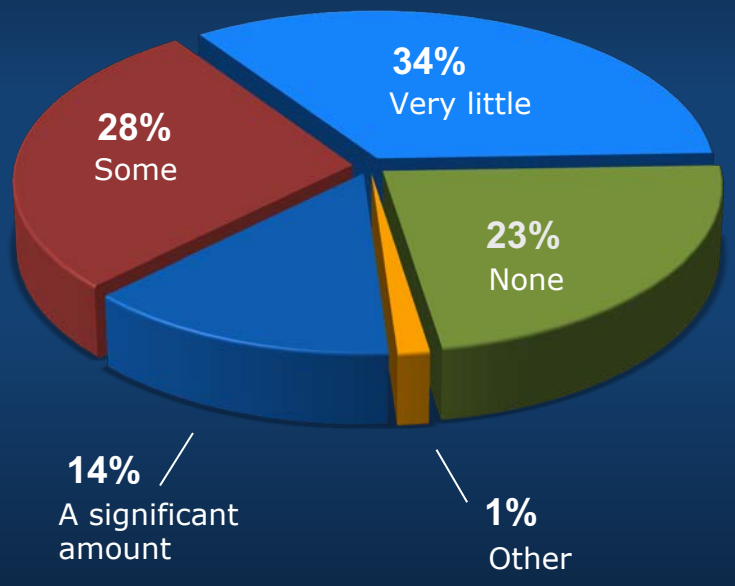
USE OF INTEGRATED PROJECT DELIVERY FRAMEWORK



Fear of Trading off Capabilities

57% are not prepared to accept limitations to design functionality for the benefit of teams being able to use one BIM authoring environment.

WILLINGNESS TO SACRIFICE DESIGN FUNCTIONALITY TO WORK IN ONE BIM AUTHORING ENVIRONMENT



Unwillingness to Sacrifice Design Functionality for One BIM Authoring Environment

The research data demonstrates that there is value in multidisciplinary design and a single BIM authoring environment. However, the bulk of respondents (57%) are not prepared to sacrifice more than "very little" design functionality to achieve it. This is very common in our surveys when we ask whether companies are willing to trade individual productivity for organizational success. We believe that resistance to multidisciplinary design may revolve around the fear of losing architectural or discipline-specific design capabilities as opposed to direct objections to multidisciplinary design.

For example, a structural engineer who is used to preparing their work in the marketing leading structural design tools is typically not willing to move over to architectural BIM tools if it means they will lose design capabilities. Similarly speaking, a mechanical trade contractor would prefer to redraw the mechanical engineer's design from a BIM tool into a 3D spooling tool to ensure he leverages the benefits of manufacturing (bill of materials, Shop drawings, etc.), which is to establish spooling drawings. Another example would be BIM to CAM. Specialty trade contractors that preassemble components are motivated to make money through operating equipment effectiveness (OEE), not by working towards all stakeholders navigating and procuring from one BIM authoring environment.

For Some, Benefits Outweigh Design Capabilities

The results, however, are mixed. Not everyone is unwilling to sacrifice for the greater benefits of collaboration. Well over one-third (42%) are willing to give up at least some functionality, and 14% are willing to trade a significant amount of functionality for the benefit of working in one authoring tool.

Regional Variations

The survey uncovered differences from a geographic perspective. Western European respondents are less like than average to sacrifice design capabilities. About two-thirds (67%) said they are willing to trade off very little or no design functionality for the benefits of a single BIM authoring application. On the other hand, Central Europe is more likely than average to be willing to trade off a significant amount. In fact, about one-half would give up some or a significant amount.

Conclusions

Communication is the Biggest Challenge

The design and construction industry is highly fragmented. Companies range in size and the cross-section of industry segments they serve. Project participants often span regional, country, language, and cultural boundaries. Multiple disciplines rarely share common offices, which only exacerbates the challenge of communication. With increasing project complexity and shrinking access to well-trained resources, communication is strained. The industry must uncover ways to become more effective.

Greater Collaboration is the Key

Architecture and engineering companies must increase their ability to effectively collaborate across design disciplines. Traditional collaboration approaches are insufficient. Fortunately, there are proven benefits to digitally integrating designs across disciplines. Typical integration methods must also improve, and the data demonstrates that the AEC design community is moving towards more enhanced collaboration workflows leveraging tools based on BIM. The role of BIM is also maturing to be a system of record. Although the domains of design are vast, our research concludes that companies are exploring and migrating to multidisciplinary design to drive better project outcomes and profitability.

Multidisciplinary Design Remains Novel in the Maturity Cycle

Full multidisciplinary design adoption is still relatively low, but those adopting it are achieving significant benefits. The overall perception of multidisciplinary design and BIM is positive, yet it faces a number of challenges. Most companies are not willing to trade off significant design functionality for those benefits. We expect to see greater adoption of multidisciplinary design as systems mature, but also expect that companies must maintain an open approach to BIM tools to accommodate an environment consisting of multiple authoring tools.

About the Research

Data Gathering

Tech-Clarity gathered and analyzed 393 responses from people whose companies design, engineer, or construct the built environment. Survey responses were gathered by direct e-mail, social media, 3rd party data collection, and online postings by Tech-Clarity and Graphisoft.

Headquarters

The respondents are from North America (24%), Western Europe (21%), Central Europe (15%), Asia (10%), and others from Australia, Eastern Europe, Latin America, Middle East, and Africa.

Project Types

Respondents are involved in a variety of projects; commercial (61%), multifamily (47%), single family (40%), institutional (28%), industrial (28%), infrastructure (22%), healthcare (14%), and others (6%).*

Floor Plate Size

Responding companies report a range of typical sizes (in sq m); < 280 (8%), 280 – 950 (25%), 1,000 – 4,500 sq m, (19%), 5,000 – 10,000 sq m (27%), 11,000 – 25,000 sq m (14%), and over 26,000 (8%).

Company Size

Respondents were from company sizes by number of architects / technicians 0 (2%), 1 (12%), 2 to 5 (25%), 6 to 20 (17%), 21 to 50 (17%), 51 to 100 (13%), and over 100 (14%) and number of engineers 0 (38%), 1 (6%), 2 to 5 (11%), 6 to 20 (8%), 21 to 50 (17%), 51 to 100 (7%), 101 to 500 (5%), over 500 (8%)

Title / Role

The respondents were comprised of principal / partners (23%), owner / sole proprietors (20%), BIM or VDC leads / managers (10%), project leader / manager level (10%), designers (9%), executives (8%), directors (7%), VPs (7%), and others including BIM modeler / VDC coordinators, CAD technician / drafting technicians.

Organizational Function

The respondents are architects (72%), BIM manager / BIM modelers (10%), and others including structural engineers, interior designers, urban designers, project / program management, landscape architects, mechanical engineers, civil engineers, IT, electrical engineers, general management, energy consultants, and low-voltage controls.

* Note that the values may total greater than 100% because companies reported doing business in multiple industries and geographies.

SERVICES OFFERED

	DIRECT (EMPLOYEES)	CONTRACT (CONSULTANTS)
Architectural Design Services	90%	25%
Structural Engineering Services	46%	67%
BIM Services	78%	39%
Electrical Engineering Services	37%	72%
Mechanical Engineering Services	33%	78%

About three-quarters (72%) of the research respondents are architects and the vast majority of companies offer architectural and/or engineering services.

Acknowledgments

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About the Authors

Steffen Waite is the VP of Research for AECO and Industrialized Construction Software for independent research firm Tech-Clarity. His areas of expertise include BIM, digital twin, DfMA, ERP, PM, FM, and leveraging off-site pre-fab solutions for maximum build efficiency.

Steffen has over 30 years of experience, including construction management, product manufacturing, systems development, and virtual design and construction (VDC). When he's not focused on technology, he is an avid mountain enthusiast (hiking, biking, and skiing) and spends time on the water either boating or surfing.

Jim Brown founded Tech-Clarity in 2002 and has over 30 years of experience in the software industry. Jim is an experienced researcher, author, and speaker and enjoys engaging with people with a passion to improve business performance through digital enterprise strategies and supporting software technology.

Jim is actively researching the impact of digital transformation and technology convergence in industrial settings.

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