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BIM Project Execution Plan Guide

An Introduction For Those New to BIM

Will Ikerd, P.E., CM-BIM, Principal Investigator
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The purpose of this guide is to introduce BIM project Execution Plan concepts to teams on small to midsized projects that may have some team members who have never previously used BIM.

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Executive Summary

The Guide is for building owners and their design and construction teams who are new to Building Information Modeling on small to midsized projects. It is an aid in introducing fundamental concepts of BIM Execution Plans and the BIM aspects of Project Execution Plans (PEP). Teams sometimes abbreviate BIM Execution Plans as either BEP or BxP in industry documents that our taskforce has reviewed. In The Guide we will use the abbreviation "BxP" to refer to BIM Execution Plans or the BIM aspects of Project Execution Plans (PEP). Additionally, we will use "The Guide" to reference this document.

> ***The purpose of The Guide is to introduce BxP concepts to teams on small projects that may have some team members who have never previously used BIM.***

These BxP concepts are also applicable to all project delivery methods at varying levels of effectiveness. The Guide acknowledges that collaboration is improved in more integrated forms of project delivery such as Design Assist, Design Build (DB) and Integrated Project Delivery (IPD). These more integrated forms of delivery can help create the environment to more fully leverage the collaborative benefits of BIM as defined in a project BxP. Additionally, it is understood that Design Bid Build (DBD) is the most common delivery method for small projects as well as for certain project types, such as public sector projects in many regions of the US.

The Guide is for the BIM enabled design team who is introducing an owner to BxP concepts on their three-million-dollar police or fire station project. It is for the general contractor who is introducing a BxP to some of their trades that have never used BIM on a twenty-million-dollar public elementary school. It is for a BIM enabled design and construction team to have as a common reference on a hundred-million-dollar office building with an owner who has never used BIM. In all these examples and many more, The Guide serves to help teams introduce BxP concepts to any project stakeholder who is new to BIM.

The mission of The Guide is to address a need to help companies and individuals new to BIM with a better understanding of fundamental BxP topics. The BIMForum gathered common elements and topics in BxP content from our conferences over the last decade and numerous industry practitioner surveys and interviews. The goal of this effort is to share lessons learned from companies and individuals who have been using BIM and authoring BxP content for many years. Most of the target audience of The Guide has likely never attended a BIMForum conference since the organization began in 2005. The hope is that The Guide will introduce them to both solid BxP concepts and the BIMForum

We look forward to seeing you soon at one of our annual events where we expand on industry best practices in process, innovation, training, and technology, and on our online resources at BIMForum.org.

BIMForum BxP Taskforce

The authors and contributors of the taskforce reviewed sample BIM Execution Plans (The Guide) and case studies from teams around the country. Will Ikerd, P.E. is the project's principal investigator and chair of the BIMForum BxP Taskforce. This taskforce was formed with practitioners who have many years of Building Information Modeling and Virtual Design and Construction (VDC) experience. This team consists of designers, general contractors, trade partners, attorneys, and academics whose broad perspectives provide a deep insight into industry practices, and who have helped define fundamental BxP content and trends for small projects. The content in The Guide was created through investigation of the industry, which included interviews, workshops, sample BIM Execution Plans, and case studies from teams around the country.

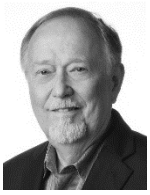
Will Ikerd, P.E.,
Charles Pankow Foundation, Principle Investigator
BIMForum BIM Project Execution Plan (BxP) Guide Taskforce, Chair

Mr. Ikerd is principal at IKERD Consulting, LLC, a firm that specializes in consulting for attorneys, owners, architects, engineers, general contractors, and trade contractors. The firm focuses on the areas of engineering, Virtual Design and Construction (VDC), and Building Information Modeling (BIM). He serves as an expert consultant in design and construction litigation cases involving BIM and VDC processes. Mr. Ikerd is on the board of directors of the BIMForum and has served on the Level of Development (LOD) Specification Taskforce since its inception. He is noted as the original author of the LOD 350 definition in 2009 that was ratified in the 2013 specification. He has won the "Best Speaker" award twice from the International Structures Congress, Structural Engineering Magazine's "Top 10 Leaders in Structural Engineering," Glass Magazine's "Top 30 under 40," and Building Design & Construction's "Top 40 Under 40." He graduated with his bachelor's in civil engineering and master's in structural engineering in the mid-nineties from Washington University in St. Louis with a focus on 3D parametric modeling. In addition to his work as a principal at IKERD, he is currently conducting research in construction management with BIM and VDC at the University of Denver as part of a PhD program.

Michael Czap, AIA
BIM Project Execution Plan (BxP) Taskforce, Vice Chair

Michael has over 35 years of broad experience in all aspects of architectural planning, project delivery and contract administration. Twenty-nine of those years have been focused on Healthcare. He combines a strong technical background with project management expertise. A good problem solver, he is able to clearly communicate complex ideas and direct teams to develop efficient solutions. An early advocate of BIM, he has led efforts to develop Lean workflow strategies and leverage model development while also simplifying the documentation process.
Michael coined the term and introduced the concept of Lean Architecture - the "ongoing process of rethinking and improving architectural methodology" by the application of Lean principles to the practice.

He is a regular speaker on Lean Architecture and advanced project delivery processes as well as Building Information Modeling (BIM). He has presented at over 40 National and Regional venues across the United States since 2004.



David Merrifield
BIM Project Execution Plan (BxP) Taskforce, Vice Chair

Mr. Merrifield has over 50 years of experience in fabrication, engineering, erection and project management of major projects across the United States and in several foreign countries. He joined Alpha Fabrication Services in 1995 as President which is now SteelFab Texas, an AISC Certified Steel Fabricator. He is a Board member of the Nation Institute of Steel Detailing (NISD) and chairman of the Quality Procedures and CD-BIM committees. He is President of the Texas Structural Steel Institute, an AISC affiliate organization. An early member of the BIMForum, David continues to serve on the LOD Core group as co-chair of the structural subgroup and is a member of the BxP task force. As a lecturer and presenter, many of his presentations can be viewed at events such as NASCC, Autodesk University, BIMForum and monthly CD-BIM Webinars. His article "Quality Procedures in Detailing Offices" was published in Modern Steel Construction and the NISD Connection. David was named NISD "Man of the Year" for 2017 at the NISD annual meeting and has been reappointed to the leadership of NISD.

Jamie Davis, P.E., LEED AP
BIM Project Execution Plan (BxP) Taskforce, Member

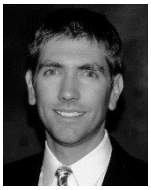
Ms. Davis is Principal and President of Ryan Biggs | Clark Davis Engineering & Surveying, a 40-person consulting firm specializing in structural and civil engineering and surveying. She manages the Finger Lakes Office in Skaneateles Falls, New York. With the firm since 1988, she is a graduate of The Pennsylvania State University. Jamie has provided the structural design of educational facilities, medical buildings, industrial facilities, corporate office buildings, and masonry repair projects. Ms. Davis is a member of the American Society of Civil Engineers in which she has served as President of the Mohawk-Hudson Chapter; the American Concrete Institute; the American Institute of Steel Construction, the Mason Contractors Association of America, and The Masonry Society. Jamie is an affiliate member of The Masonry Society (TMS) Board and is Chair of the BIM-M Committee for TMS, part of the BIM-M Initiative. The BIM-M Initiative is focused on promoting BIM within the masonry industry. Ms. Davis lectures frequently on masonry topics. Jamie is a LEED-accredited professional and is licensed in New York and Connecticut.

Joe Cipra
BIM Project Execution Plan (BxP) Taskforce, Member

Nucor Vulcraft/Verco Group Software Solution leader. Working to improve the process of specification through erection of steel products by using software and technology solutions. Participated in the AISC technology committee working on SteelXML standards. Also provide BIM guidance for the SJI and SDI.

Mark Mergenschroer
BIM Project Execution Plan (BxP) Taskforce, Member

Mark is currently the BIM Application Specialist for Bernhard TME and has 22 years of construction and engineering design experience. He has played a key role in the implementation of Revit for Bernhard TME. He is a former Revit MEP Gunslinger, Revit Alpha and Beta Tester, and has recently worked closely with the Autodesk BIM 360 Ops team. Outside of the office, he is best known for being Caleb's dad. He is heavily involved in the Arkansas Autism Community and Miracle League baseball.



Matthew Sweeney
BIM Project Execution Plan (BxP) Taskforce, Member

Matt has over 15 years of experience in the structural design of government, office, hospitality, healthcare and retail facilities. He is also a registered Autodesk Professional. As BIM Program Manager, his focus is to provide BIM production support; internal/external Revit training; research and development of BIM strategies for future business services; and support BIM marketing and business development initiatives. He works with the A/E/C community to develop innovative, cost-effective solutions for projects while managing the changes in the processes that must occur in order for the successful implementation and adoption of Revit/BIM processes.

Review Board

The Taskforce would like to thank the following for their contributions and input in this document.

Greg Gidez, Hensel Phelps, Chair

Benjamin Crosby, Yates Construction

Douglas C. Green, Esq., Perkins & Will Architecture

Dr. Joe Ales, Walter P. Moore

Dr. John Messner, Penn State University

James Vandezande, AIA, HOK Architecture

Jan Reinhardt, Adept Project Delivery

Joel Hicks, National Institute of Steel Detailers

Luke Faulkner, American Institute of Steel Construction (AISC)

Mike Bolduc, P.E. (MA), Simpson Gumpertz & Heger (SGH)

Roger Becker, P.E., S.E., Precast Concrete Institute (PCI)

South Cole, Ascend Building Knowledge Foundation, CD-BIM.com

Technical Writers

BIMxD Solutions, LLC

Joeseph T. Powell, EIT, IKERD Consulting, IKERD.com (MEP)

Michael G. Perdue, IKERD Consulting, IKERD.com (BIMForum LOA Taskforce)

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Introduction

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> ***The purpose of The Guide is to introduce BxP concepts to teams on the smallest of projects that may have some team members who have never previously used BIM.***

The principles and practices in The Guide were developed based on interviews and survey responses from over five hundred industry practitioners, including Owners' and Facility Management team members, design and construction team members, trade partners, detailers, manufacturers, and legal professionals. Furthermore, the professionals who provided input for The Guide represent a diverse selection of firms with varying sizes and locations. This diversified pool of contributors provided a wide overview of the current use of BxPs in the A/E/C/O/FM industry from which the very best of best practices were distilled. The Guide expands on topics central to a successful BxP by addressing questions of Why, What, and How as they relate to BxPs.

The Why section of The Guide details some of the most important benefits to implementing a BxP. A well written BxP will clearly communicate project goals with all team members and function as an agreement on how BIM should be implemented throughout the project to accomplish these goals. Other critical details are communicated to all stakeholders through a BxP, such as the project delivery strategy, Lean processes, and specific project needs.

The What and How sections of The Guide present components that are commonly found in successful BxPs. Although the scope of The Guide focuses on the use of BIM for coordination, each of the provided components creates additional clarity among project team members regardless of the project's use of BIM. Through more than a year of careful research, these components have been identified as common among a majority of BxP implementations and have become a standard for any BxP. Each component includes commentary on how to best introduce that component into a BxP.

Although The Guide is addressed to those who are new to BIM processes, the specifications and principles of a BxP presented in it serve as a defining resource to even the most experienced BIM professionals.

Who this Document is Addressed To

The Guide is for the BIM enabled design teams who are introducing an owner to BxP concepts on their three-million-dollar police or fire station project. It is for the general contractor who is introducing a BxP to some of their trades that have never used BIM on a twenty-million-dollar public elementary school. It is for a BIM enabled design and construction team to have as a common reference on a hundred-million-dollar office building with an owner who has never used BIM. In all these examples and many more, The Guide serves to help teams introduce BxP concepts to any project stakeholder who is new to BIM. Survey data collected as part of the investigation of The Guide shows that there is a wide variety of trade partners and project types that have room for improvement in BIM (reference question thirty-five in the survey data at the end of The Guide). One question provided to the industry practitioners who participated in the survey was *"Which TRADES who are NEEDED IN COORDINATION are the LEAST BIM ENABLED?" (Question 35).* Through some combinations of the categories, the following is a summary of the top twelve trades in order of frequency cited in the survey data that are the least BIM enabled and may benefit from the introductory BxP content in this document.

1) Civil / Utilities
2) Drywall / Cold Formed Metal Framing
3) Masonry
4) Roofing & Exterior Waterproofing
5) Electrical
6) Equipment Manufacturers
7) Fire Protection
8) Concrete (Cast-In-Place, Precast, Tilt-Wall, Concrete Reinforcing)
9) Plumbing
10) Miscellaneous Steel, Stairs, Handrails
11) Curtain Wall and Exterior Metal Panel
12) Wood Framing

The mission of The Guide is to address a need to help companies and individuals new to BIM with a better understanding of fundamental BxP topics. The BIMForum gathered common elements and topics in BxP content from our conferences over the last decade and numerous industry practitioner surveys and interviews. The goal of this effort is to share lessons learned from companies and individuals who have been using BIM and authoring BxP content for many years. Most of the target audience of The Guide has likely never attended a BIMForum conference since the organization began in 2005. The hope is that The Guide will introduce them to both solid BxP concepts and the BIMForum.

The BIMForum BxP Taskforce strongly advocates for firms to have internal BIM capabilities whenever possible as part of their company's transformation to a Virtual Design and Construction (VDC) process.

The Taskforce also acknowledges that many small to midsized firms have used third party consultants for many decades for their Computer Aided Design and Drafting (CADD) production. An example of this would be design firms using third party CADD production services on a contract basis for overflow work. Similarly, smaller general construction firms have used third

party companies for decades in surveying site layout and CADD support needs. Many smaller trade partners such as the twelve categories of trades listed previously have typically used third party production help for their CADD needs since the inception of CADD use in their trades. Additionally, trades with construction side engineering have historically used third party companies for their engineering calculations and CADD shop drawings. Such examples would include structural steel, precast concrete, miscellaneous steel, curtain wall systems, cold formed metal framing, fire protection, metal panel, and many more. The smaller sized companies of the trades listed above have never had engineering or drafting services in-house. For example, 2016 research by the Precast Concrete Institute documented that precast manufacturers with volumes less than fifteen million dollars annually often did not have in-house engineering and Virtual Design and Construction (VDC) capabilities. The precasters, like many other trades, have traditionally used a third party for CADD for decades and will most likely use a third party for VDC as part of the engineering services they contract for their projects in the near future.

Similarly, the Structural Engineering Institute (SEI) 2016 survey on BIM shows the typical Structural Engineering (SE) firm has a staff of less than twenty and typically only uses VDC to create 2D drawings. Some of these firms have great concerns about sharing models with construction teams due to a lack of clarity in BxP topics such as LOD, model origins, and BIM use. The Guide provides these engineers with a common ground for discussing these important topics with architects, owners, builders and trade partners as BxP content is developed and reviewed.

In no way is The Taskforce suggesting that CADD and BIM are equivalent. However, The Taskforce believes there will be some similarities in business models for small firms who have used third party support for production processes. It is highly likely that these smaller companies will use a third-party BIM consultant as part of their first projects with a BxP, similar to the way they have used third party drafting and engineering services for many decades. Because of this, training team members on BxP concepts and verifying their understanding of those concepts are very important as teams are assembled, especially when many teams may have third party support on their first project.

Finally, The Taskforce strongly recommends that smaller companies that are new to BIM evaluate their use of third-party BIM support each year as part of their long-term business model. The goal for any business in the design, construction, and operation of buildings must be to have internal VDC capabilities as part of their company's overall process. This is critical for firms to be considered a viable team member on future projects as expanded BIM uses become the standard of care in firms' respective industries and professions.

Assumptions of the Document

This document is intended as a guide for small to midsized projects, loosely defined as construction projects in the US in which the building being built has less than five stories and the total project cost is less than one hundred fifty million dollars.

This document has a narrow focus. The scope highlights only the highest value uses of BIM based on recent research. The Taskforce considered many factors when reviewing some of the reported highest value uses of building information modeling for initial implementation. However, the focus of this document will remain primarily on those new to BIM with a limited narrow focus of the most frequent BIM uses.

Additionally, The Guide does not address every type of delivery method for a project, but instead focuses on the Design Bid Build delivery method. Although The Guide will not specifically focus on other valuable project delivery methods (i.e., Design-Build, Integrated Project Delivery), it should be noted that the tenants, practices, and recommendations within The Guide will still be applicable to the delivery methods that are outside of its scope. References for further study are given.

This document is meant to work in collaboration with other existing BIM BxP guides, such as the Penn State BIM PEP Guide, which assumes that individuals already understand and have used BIM. The Guide is meant to complement the Penn State guide, serving as an introduction to BIM for those who are otherwise unfamiliar. The Guide will address small but rapidly expanding portions of BIM and, as such, will require annual review by owners and teams regarding the best way to deploy and update their BIM Execution Plans. It will complement other BIM documents previously issued as well.

Background on the Creation of The Guide

The information in The Guide was gathered from industry practitioners. The taskforce represents building owners, architects, engineers, general contractors, and trade partners. The taskforce sent surveys to over 7,000 attendees of past BIMForum conferences. These represented a very broad cross-section of the industry in respect to roles and responsibilities, as well as geographic considerations. In addition to online surveys, one-on-one and phone interviews were conducted. In total over five hundred responses have been collected to date. Along with this broad basis of research, BxPs were gathered from teams over a wide variety of projects. Common trends were then identified and documented from these BxPs. A general consensus developed: there are three key areas that teams on small to midsized projects need to consider when implementing BIM. These considerations are: training (which was a pronounced area that needed to be addressed), consistent specifications, and methods for training-verification. Of these three, training and verification are particularly important as many of the trade partners who are new to BIM have the potential to slow down the entire VDC process.

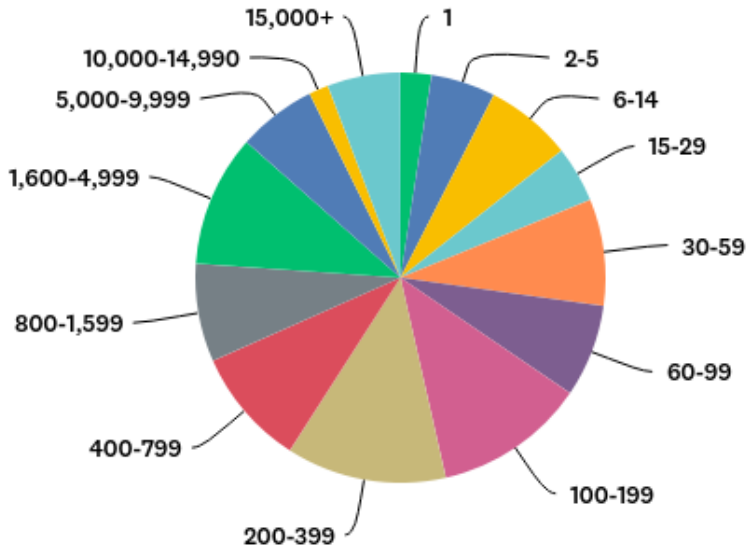


Figure 1: Industry stakeholders who were surveyed on BxP practices. The graph above shows response to Question 3: "What is the size of your firm by number of employees?"

Format and Approach

The Guide will address four key topics for each of the key components of a BxP: why that component is important, what its fundamentals are, what goes into each component respectively, and how it can best be implemented. For each component we will examine the subcategories of why, what, and how. This general philosophy will allow owners and their teams to have meaningful discussions as a BxP is formed. Additionally, The Guide advocates that the BxP is a quality control document for each given scope of work. As such, it is crucial that the design team and each of their stakeholders have their own internal BxPs that are made to work in collaboration with one another. Additionally, the construction team's BxP should function together alongside the design team's BxP. To achieve this, the teams will need to have harmony between terms and key concepts, which is what The Guide will lay out. These topics include but are not limited to:

1) BIM Uses
2) Project Milestones
3) Key Project Contacts
4) Project Origins, Levels, Grids
5) Owners' Information Requirements at the end of the Project
6) Level Of Development (LOD)
7) Coordination Process
8) Software Used
9) File Types and Naming Conventions
10) Project Deliverables
11) BIM Manager and Modeler Requirements
12) Reality Capture
13) Field BIM
14) Open Standards Usage
15) Legal Consideration

For topics such as facilities management information, legal considerations, considerations for open source standards, and LEAN construction concepts, additional reading and research will be necessary. The scope of this document will focus more on the research surrounding the teams who are new to BIM. However, additional information for further reading and background on additional topics will be provided.

Stakeholders in the Process

The term 'stakeholder' refers to an individual, group, or company that has vested interest in the procedure or outcome of the construction project. This term can include clients, contractors, designers, subcontractors, government entities, and other organizations and their employees related to the project. Every project stakeholder has a set of functions, desires, and goals for the construction process. The following is a list of the stakeholders who are commonly considered in a BxP:

General contractor (GC) oversees the day-to-day operations of the construction site to maintain quality, safety, and management of vendors and trades. The general contractor is responsible for finishing a project within a specified timeframe and an allotted budget.

Engineers are responsible for the development of the engineering project design documents, considering both the architect's scope of work and the owner's intentions and perspective. They are also focused on the design and analysis of buildings to meet regulations and code requirements as they develop the engineering design intent.

Architects are responsible for the development of the architectural project design documents, considering both the engineer's scope of work and the owner's intentions and perspective. They are also focused on the design and analysis of buildings to meet regulations and code requirements as they develop the architectural design intent.

Trade Contractors are individuals or organizations appointed by clients to provide materials or to perform labor to complete construction work.

Stakeholders can also be considered from both the organizational level and the individual team member level as follows:

Organizational stakeholders are the companies and organizations that are involved in and affected by the project and its BIM use.

Internal / Individual stakeholders are the individuals who work with BIM within a given organization. These individuals could include, but are not limited to, principles, executives, project managers, modelers, detailers, designers, estimators, business development staff, and marketing staff.

Who Should Develop the BxP?

In general, the BIM BxP should be developed by the most experienced, certified, and qualified individual on the team. This individual would ideally be a knowledgeable building owner with appropriate training and some experience from previous BIM projects. When building owners do not have this background, they should consider seeking a consultant who has both design and construction experience and can understand the whole process. A third-party BIM consultant can be especially important as an owner's representative in writing a BxP for a Design Bid Build (DBB) project delivery method. In DBB cases, design and construction teams may limit the BxP development so that it is too strongly focused only on their scope of work with little consideration to Facility Management (FM) and model handoff to the owner. A third-party BIM consultant can aid the owner and team in verifying that the owner's overall interests are addressed from design to construction, and from construction to building commissioning.

Developing the BxP typically begins with a planning team that consists of primary organization members. These individuals could include, but are not limited to, the project owner, engineers, sub-contractors, facility managers, and/or architects who work together in agreement during the BxP development process.

In integrated project delivery types, these stakeholders can work together from the beginning on a combined BxP. In this case, each organization selects key decision makers to represent their agency and its responsibilities. The assembled planning team normally administers a series of meetings to generate a robust execution plan for the operation of the project.

However, on small to mid-sized projects that are delivered in a Design Bid Build (DBB) delivery method, it is not commonly possible to have all stakeholders assembled for a combined BxP. In this case, there are multiple BxPs that would include, but are not limited to, BxPs from the Designers, Owners, General Contractors, and Trades. These are normally the BxPs which are previously developed by each stakeholder's company as an integral part of their organization's internal quality control process. In this case, each stakeholder's own internal BxP would be modified on a case-by-case basis to match the goals of the given owner's project.

For an effective BIM project to be performed, a BxP is ideally developed before initial stages of the production. Project stakeholders must be informed when the document is revised, updated, or edited during the execution of the project. Such amendments are recorded in a revision history in the document. A BxP involves a comprehensive vision and implementation protocol for a construction team to follow. Furthermore, the BxP should clearly define the scope and responsibilities of individual members.

The BxP planning team should include the goals of each stakeholder in the VDC process. Once the goals are determined, a process of exchanging and compiling information should be established between lead BIM coordinators of each organization throughout the project.

Why BxP Content Matters

BxP Goals

The goals of a BIM Execution Plan (BxP) are simple. A BxP exists to provide "ground rules" for BIM coordination and to provide a plan for model creation. These clear rules allow modelers, contractors, detailers, and other contributors to communicate and collaborate efficiently, while also enabling the team to recognize any errors in the model early and correct them. These events will lead to a good model that can be a guide for construction. The BxP serves as both a guide and an agreement that ensures BIM success through clash detection and clash avoidance.

Why Is Having A BxP In Your Project Delivery Strategy Important?

A BxP is important to Project Delivery Strategy (PDS) because it specifies the delivery strategy and clarifies responsibilities, formatting, and schedule. While there are several different PDSs, some are more common than others.

A BxP provides clarity on projects with multiple contributors. When there are many organizations involved, this clarity can help give direction to the contributors, and will be useful in both the technical aspects of the project as well as the nontechnical ones. The technical aspects include, but are not limited to, LOD requirements, origin location, project delivery requirements (such as file types), and project constraints. With multiple contributors and disciplines collaborating on a project, a singular source with the necessary specifics can be crucial for project success. The nontechnical aspects of the project include team organizational structure, team assembly considerations, and other related items. This additional clarity is important to the PDS because it can save time spent on resolving errors made due to lack of direction or organization.

The effective BxP includes a schedule and contact information for all parties involved. This provides accountability and direction for contributors, encouraging everyone to continue to be responsible for their tasks. The additional accountability can be critical for staying on schedule, since all contributors are aware of who is responsible for what part of the project. With penalties clearly stated in the BxP, contributors are discouraged from falling behind on their tasks. If legal issues arise for the head of the PDS, the BxP incorporated into the project contracts can help determine the responsible party. This is particularly helpful in Design-Bid-Build (DBB) projects. The BxP is important to the PDS because, in addition to keeping the project on schedule, it has a direct and positive effect on the project budget.

For the nontechnical aspects of a project, the BxP can provide guidance in organizing and selecting a team for the project. While the BxP will already include each trades' contact for contributors, this guidance can be helpful for each company's internal team selection. For more information on team selection, please refer to the section titled "BIM Manager and Modeler Requirements".

The concepts discussed above are all important in the Project Delivery. By providing the contributors with clear information, miscommunication and missing information are avoided, while accountability and direction are provided by SMART (Specific, Measurable, Attainable, Reasonable, and Time-bound) schedules. Direction in team requirements help BIM coordinators

assemble competent teams for their portion of the project. These can benefit the project's time effectiveness and allows the project to stay on schedule and within budget.

Lean Process and the BxP

Lean construction is the concept of reducing waste that can be represented by many forms. BIM and the process of using Lean technology as defined in a BxP are the heart of a modern Lean construction process. Lean is a very relevant and tangential topic to BIM and construction. It is beyond the scope of this introductory BxP Guide. However, the BxP Taskforce encourages owners and their teams to become well versed in Lean and use their BxP development as part of their team's larger Lean improvement process.

To learn more about Lean, please visit ***BIMForum.org/Lean***

BIM Uses

While the reasons for using BIM may be broad, common goals include improving design management processes, schedule efficiency, and constructability. Essentially, a BxP must state why BIM is being used so that everyone involved with the project can have a clear goal to work towards. This will limit extraneous work and keep the contributors focused on the same goals.

There are many use cases of BIM as teams begin considering their BxPs. Penn State University is a leader in BIM research and has studied the use of BIM across organizations. Their results (http://bim.psu.edu/bim_uses/) identify four main life-cycle stages of a project: Planning, Design, Construction and Operations. Some of the most common uses of BIM identified are 3D coordination, site layout drawings, assistance in marketing, and the creation of design and construction ("shop") drawings. Although any of the identified uses can be addressed in a BxP, The Guide will focus on the use of BIM for design review, construction drawings, and 3D coordination. Further discussion of BIM uses can be found in the Penn State study referenced above and at http://www.bimforum.org/uses.

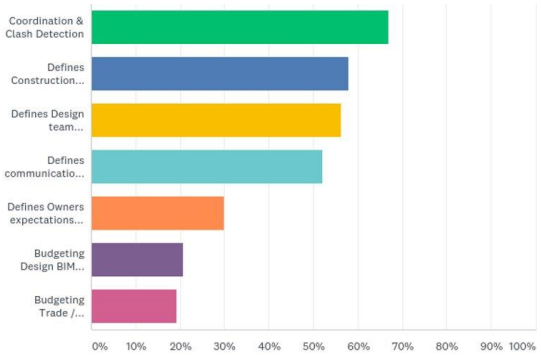


Figure 2: Industry stakeholders who were surveyed. The graph above shows response to Question 21: "What are the most important benefits you see from a well written BxP on current projects (Check your top 3 selections)?" When asked to select the top three benefits of using a well-written BxP on projects, respondents chose: 1) Coordination and Clash Detection, 2) Defines the Construction Team's expectations, scope, and processes involving BIM, and 3) Defines Design Team's expectations, scope, and BIM processes. Defines A Communication Plan for the BIM Team closely followed in fourth place.

3D Coordination, Clash Detection, and Clash Avoidance

3D Coordination, Clash Detection, and Clash Avoidance are common BIM uses defined in a BxP.

BxP processes should be detailed and followed to allow for effective coordination and construction. Modeled elements are equivalent to space in the building for construction. This

means that modelers cannot move or create elements at their discretion because the system may clash with another trade's system. Independent work would need to be redone, costing both valuable time and money. Additionally, failure to keep pace with other trades' models may result in clashes in the field. Trades that did not coordinate will be responsible for moving their material, again costing the group resources. By following the rules agreed upon in a BxP, every trade will be obligated to share their work and collaborate with other trades in order to detect clashes and eventually develop a fully-integrated building model. A BIM BxP aids in improving model cohesion and success for every trade involved in the coordination process by providing a common plan for the process.

Any clashes that arise during the design stage will be acknowledged and addressed; however, these clashes can be minimized through a well-coordinated modeling process. If a BxP is in place at the beginning of a project, coordination will be active in the basic development of a model. Each trade can use the other trades' models to guide the formation of their own. This allows the rest of the modeling process to have much fewer errors and clashes, as each model reflects the others. This close coordination not only allows for clash detection but also provides clash avoidance. In short, a BxP will streamline the modeling process and maximize the chances for a high-quality building to be produced.

Project Needs

The project needs related to BIM should be clearly defined before assembling a BxP. Due to varying needs in different projects, general project needs, such as client expectations and delivery type, will likely be addressed before writing a BxP. Other project needs, such as the desired LOD, file exchange, and design coordination, would likely need to be discussed among the different project stakeholders during the BxP creation.

A successful BxP will address each stakeholder's expectations. Expectations that cannot be met must be addressed during the initial development of the BxP. Depending on the client's desired accuracy of model elements, different LOD specifications can be used. The BxP should clearly define what LOD is needed and whether a higher or lower LOD is desired for certain disciplines.

The delivery type will also be taken into consideration. For example, an IPD BxP will be different from a Design-Bid-Build BxP. For DBB projects it is helpful to use sample model BxPs, such as the Certificate of Development in BIM Sample BxP, as a reference. Because the full construction team is not known during design, it is valuable to have publicly available references that can be cited in the design document that other stakeholders will use for bidding and developing their construction BxP.

Determining how BIM will be used on the project is an important BxP consideration. Different levels of accuracy are needed for different goals. For instance, modeling for systems coordination requires a higher level of development than modeling for general cost estimation. Time frames should also be considered in a BxP. For coordination meetings to be utilized fully, all trades must have their files submitted to the BIM manager in time for the files to be compiled.

Each team (or company) involved with BIM will likely utilize different software. Therefore, it is imperative to define file exchange needs in a BxP. Items such as naming conventions, file types, and file sharing services must be agreed upon by all parties and finalized within a BxP.

Benefits of a BxP to Stakeholders

A well-written BxP encourages an integrated exchange of information between stakeholders throughout the design and construction process. Each organization can utilize similar sections of the combined BxP to effectively plan, organize, and execute the project goals in their own trade-level BxP from design to construction to operation. By creating a combined BxP, clear objectives can be established and tracked to perpetuate effective collaboration between construction and design team members. Each participant of the project can operate within a joint workflow by maintaining the same rational boundaries and continuing unilateral communication between the organizations.

A BxP provides general provisions, including agreement on a file sharing site to which documents and models can be uploaded and exchanged between the organizations on the project. Upload deadlines can be created to sustain project progression as development continues. Furthermore, a model delivery schedule can be produced to ensure models are available to all team members in a timely fashion.

Each trade should develop their own internal BxP as part of their quality control procedures. These trade-level BxPs should function with the overall combined BxP of the general contractor, owner and design team. These trade partner firms each have their own set of tolerance limitations to work within, so they develop models with a predetermined set of permitted tolerances for their given materials. Unlike construction material, the digital model itself does not need to conform to physical tolerances, but the BxP provides the benefit of clarifying the tolerances the team should consider when modeling.

BxP Components and Implementation

The following are sections that are common to BxPs and should be considered by owners and their teams.

Introduction Section of BxP Content

The beginning of a BxP document needs to include some explanation of the purpose, goals, and BIM uses specific to the project. Much of this content will be generic and overlap between projects, with minor modifications made as needed. It is important to discuss particular benefits of utilizing BIM at the start of a BxP, such as reduction of risk, improved communication, enhanced safety, elevated profits, and more. The BxP should also mention key concepts like model sharing, clash detection, and the goal of working towards a final coordinated model (or models) as a contract for space.

Project Information Section

Project information should be shown at or near the beginning of the BxP document. This section should include information such as the project owner, project name, project address, project details and/or description.

Milestone Section

Establishing BIM milestones will require following the owner's occupancy, design, and construction schedules closely in order to confirm critical information will be available to the relevant project stakeholders.

The design BxP should consider showing milestones such as model reviews three to four weeks before the Design Development (DD), 50% construction documentation (CD), 75%CD, 90%CD, and final Issued For Construction documents.

For the construction BxP, one consideration for inclusion should be requiring the BIM shop/installation drawings to be completed with sufficient lead time for review and subsequent revisions before they are needed by the field team for installation. Another consideration should be allowing reasonable time to receive RFI responses by the Design Team before coordination is signed off on for a particular project zone. A lack of reasonable milestones can cause undue stress on the entire project team and weaken the accountability aspect of this metric.

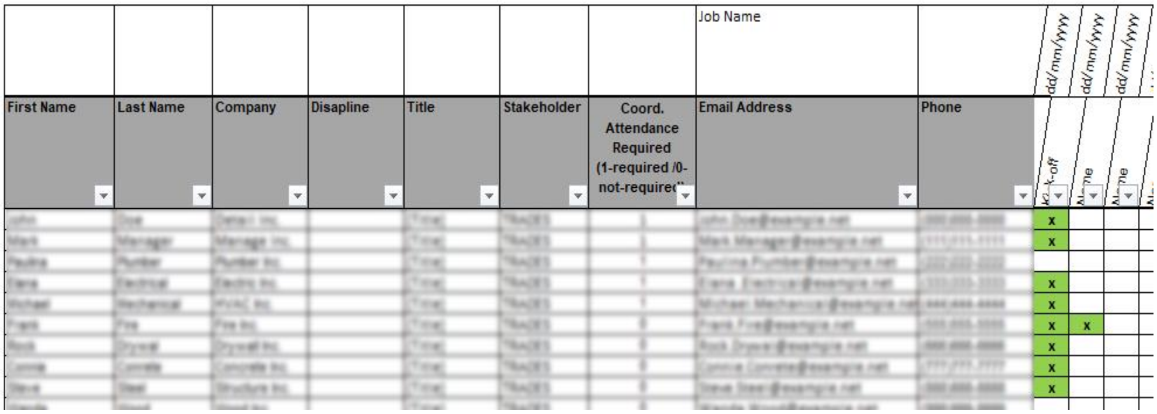
1. Project Name:	[illegible]
2. Project Address:	[illegible]
3. Contract Type/Delivery Method:	[illegible]
4. Brief Project Description:	[illegible]
5. General Contractor Project Number:	[illegible]
6. BxP Author:	[illegible]

Project Phase / Milestone	Estimated Start Date	Estimated Completion Date	Stakeholders Involved
Notice to Proceed	[illegible]	[illegible]	All BIM Stakeholders
A/E GIM Kickoff Meeting	[illegible]	[illegible]	GC, A/E
100% CDs Complete (Building)	[illegible]	[illegible]	GC, A/E
Permit Issued	[illegible]	[illegible]	GC, A/E
Construction BIM Kickoff Meeting	[illegible]	[illegible]	Electrical, Underground Utilities
Construction BIM Coordination Start	[illegible]	[illegible]	Electrical, Underground Utilities
Construction BIM Kickoff Meeting	[illegible]	[illegible]	Above ground trades
Construction BIM Coordination Start	[illegible]	[illegible]	Above ground trades
Construction BIM Coordination Complete	[illegible]	[illegible]	All Coordination Team Members
GC Site Mobilization	[illegible]	[illegible]	All BIM Stakeholders
GC Construction Complete	[illegible]	[illegible]	All

Figure 3: Sample project information and milestone table from sample BIM Project Execution Plan provided at the end of this document. Image from Ascend Building Knowledge Foundation (AscendBKF.org, CD-BIM.com), 2018. This is provided with permission from The Author under the Creative Commons Attribution-NonCommercial 4.0 International License. https://creativecommons.org/licenses/by-nc/4.0/.

Key Project Contacts Section

A project contacts list must be developed and made readily available to each team member as soon as each contact is established. Without this component, communication cannot happen effectively, and time is wasted as members seek to gather that information individually. This list in the BxP should show each contact's name, company, title, discipline, email, and phone number.



							Job Name		dd/mm/yyyy	dd/mm/yyyy	dd/mm/yyyy
First Name	Last Name	Company	Disapline	Title	Stakeholder	Coord. Attendance Required (1-required /0-not-required)	Email Address	Phone	Kick-off	Name	Name
[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	x		
[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	x		
[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			
[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	x		
[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	x		
[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	x	x	
[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	x		
[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	x		
[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	x		
[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			

Figure 4: Sample contact table from sample BIM Project Execution Plan provided at the end of this document. Image from Ascend Building Knowledge Foundation (AscendBKF.org, CD-BIM.com), 2019. This is provided with permission from The Author under the Creative Commons Attribution-NonCommercial 4.0 International License. https://creativecommons.org/licenses/by-nc/4.0/

Project Coordinates, Origin & Levels

Origins

The project general notes of the design drawings and specification should clearly define the local relative Building X, Y, Z coordinates that other trades will use in construction and that are coordinated with the structural model. Generally, the X,Y coordinates of the origin should be defined relative to the Southwest most column grid intersection with a South and West offset of 10,100 or 1000 feet depending on the project size. The Southwest column intersection is chosen so the structure is in a positive X-Y coordinate system (i.e. quadrant 1 of a cartesian coordinate grid system). The offsets of 10, 100 or 1000 feet South and West of the origin are so that any portions of the building that extend South or West of the project origin grid intersections will also be within a positive X-Y coordinate system. Reference the figures to the right on this page.

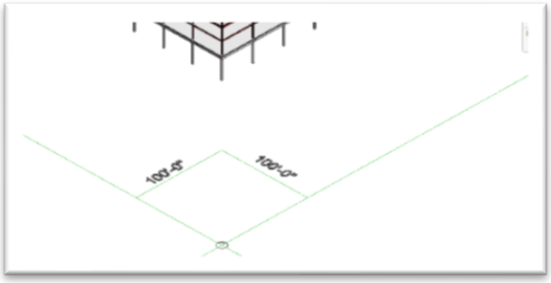


Figure 5: 3D isometric view showing origin clearly defined. Image courtesy Ascend Building Knowledge Foundation (AscendBKF.org, CD-BIM.com), 2018. https://creativecommons.org/licenses/by-nc/4.0/.

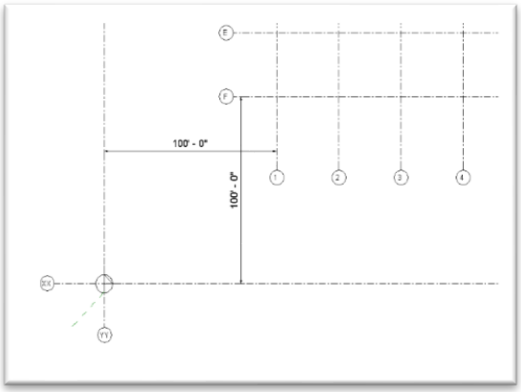


Figure 6: Plan view showing origin clearly defined. Image courtesy Ascend Building Knowledge Foundation (AscendBKF.org, CD-BIM.com), 2018. https://creativecommons.org/licenses/by-nc/4.0/

The Z elevation should be defined as 0, 100' or absolute elevation depending on firm preference. It is common to use a relative 100’ elevation. Plan North is established as being in the positive Y direction. Many firms will define grids “XX” and “YY” that locate The Origin point of 0,0 relative to the project’s other grid systems shown in the construction document. Additionally, these elements should be modeled to scale without rounding in their associated dimension strings.

The BIM BxP should document the relationship between Object, Building, Campus, and State Plane coordinate systems.

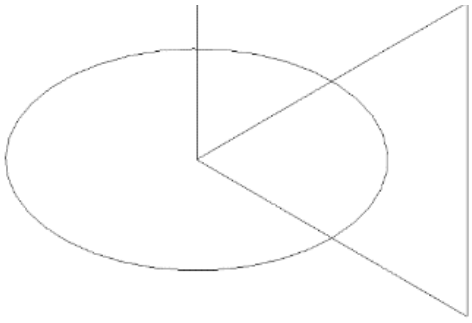


Figure 7: Origin linework that shows in both plan and 3D view of models. Image courtesy Ascend Building Knowledge Foundation (AscendBKF.org, CD-BIM.com), 2018. https://creativecommons.org/licenses/by-nc/4.0/

The rules above form the basis of the project’s “local” relative Building coordinate system that can become part of the legal definition in the construction documents and contracts related to the model and references to LOD. It is recommended that the design BxP clearly state the project origin information and that this design BxP is transmitted with the BIM to the owner and construction team when the models are shared. This process aids in linking the structural model to third party applications that are based on traditional CAD coordinate systems and, later, to field layout during

construction. A benefit of defining the local relative origin early and stating it in the project's general notes is that other models that are developed for shop drawings from the construction documents have a point of reference to follow when they are submitted for review. This local relative building coordinate system is also tied back to the civil engineers' state plane coordinate system, which is referred to as the state plane coordinates.

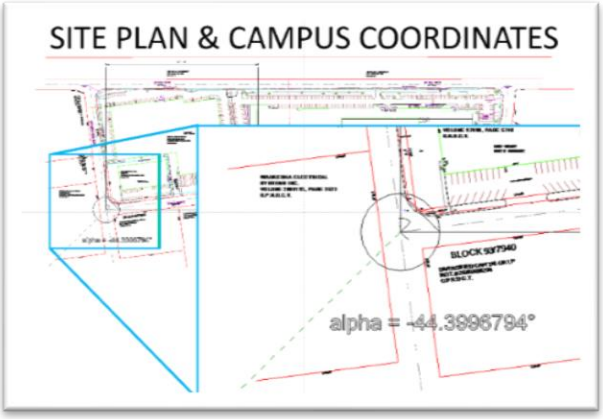


Figure 8: Image show relationship between State Plane, Campus, and Local Building Coordinates. Image courtesy Ascend Building Knowledge Foundation (AscendBKF.org, CD-BIM.com), 2018. https://creativecommons.org/licenses/by-nc/4.0/

Projects may also have a Campus coordinate system normally near the Southwest corner of the project site. There can also be an Object coordinate system used for items such as equipment models. This Object coordinate system is typically referenced relative to the Local Building coordinate system in the form of a grid line offset and floor elevation offset. The Civil coordinate system defined by the state plane absolute coordinate system will then have a set relationship of an X, Y, and Z offset and a Z-axis rotation with The Local Building coordinate system as defined by the Design Team. Using this set relationship between the Civil absolute and relative Building coordinate systems, all federated project models can be easily converted to absolute or relative systems depending on the owner's preference in their facility management models. Ideally, the owner will have clearly written documentation in the BIM Execution Plan that accurately defines the relationship between Object, Building, Campus, and Civil coordinate systems.

In summary, these 5 coordinate systems are:

Object: relative system that defines items such as assemblies and equipment in the structure. For example, the Air Handler Unit will have a relative Object coordinate that references the Local Building coordinate, which defines the mechanical room it resides in.

Building Local: relative coordinate system of the building defined so that the entire building is in positive point coordinates.

Campus, Site: relative coordinate system of the building's site defined so that the entire site is in positive point coordinates.

State Plane: Absolute coordinate system with Northing and Easting used by surveyors and civil engineers. This is also used by owners tying in their BIM to GIS applications.

GPS: Absolute coordinate system with Northing and Easting used by surveyors and civil engineers. This is also used by owners tying in their BIM to GIS applications.

Importance of Structural and Civil Engineers' Input in Grid Line Systems

A Project's structural engineer needs to be able to set the LOD of the origin of the project with the Architect at the end of the DD phase of the project. The entire construction process will begin with the structural engineer's foundation systems and the gridlines shown on the structural design drawings. Unless differences are discovered in the design and modeling process between structural and architectural grid lines, actual architectural content will be formed around the in-place structure that is built. This is an important reason for teams to invest time in verifying that origins and grid systems are confirmed and coordinated in the design models. Additionally, this needs to be coordinated with the civil engineer and site surveyor's state plane coordinates. Following this, manufacturers will reference the building coordinates for the placing of their content.

Levels

The BIM should be broken up and coordinated by levels over the project. It is recommended that The Project Team define this in their BxP for both design and construction. Typically each level is defined as the model space from finish floor (FF) of one level to finish floor (FF) of the level above. An example from the CD-BIM Sample BxP, based on the CD-BIM Sample Model, is as follows:

Zone L00: Below 100'-0"
Zone L01: EL= 100'-0" to 116'-4"
Zone L02: EL= 116'-4" to 130'-4"
Zone L03: EL= 130'-4" to 144'-4"
Zone L04: EL= 144'-4" to 161'-0"

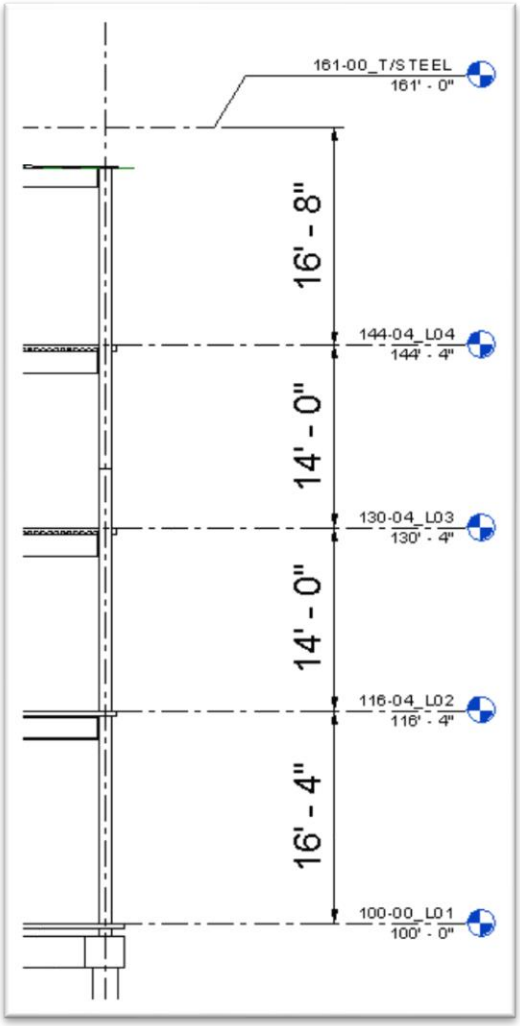


Figure 9: Example Levels in a BxP. Image courtesy Ascend Building Knowledge Foundation (AscendBKF.org, CD-BIM.com), 2018. https://creativecommons.org/licenses/by-nc/4.0/

Project Plan Areas and Zones

Defining project zones helps the VDC effort by dividing the model levels into manageable portions of the building that can be reasonably analyzed for coordination. It is recommended that the zones of the levels follow the labels of the plan areas used in the construction documentation. A zone typically consists of a portion of the building that fits on an architectural E1 30"x 42" plan sheet at 1/8" = 1'-0" scale. This would typically be equivalent to approximately 30,000 to 36,000 square feet of space. For example, if one level of a building design used 3 plan sheets at 1/8" scale noted as areas A, B, and C for the second floor, then the BxP could have zones L2-A, L2-B, and L2-C, respectively, defined by the plan areas and extending from the finish floor of level 2 to the finish floor of level 3 in the model. This general rule of thumb may vary considerably from project to project and from team to team. Many industry practitioners who have contributed to The Guide have noted that the amount of model content in a zone over one level of the building is an appropriate amount of content to address in a 1 to 2-hour construction coordination meeting. Some construction teams may coordinate more than one zone per meeting for simple building types. More complex building types, such as hospitals, may require multiple meetings per zone to coordinate.

COBie

Construction Operations Building Information Exchange (COBie) is a schema typically implemented in a spreadsheet format with information related to the building space and assets. To learn more about COBie and its importance in BIM Project Execution Plans, visit BIMForum.org/COBie and BIMForum.org/OpenBIM

Level Of Development (LOD)

Note: A free download of the Level of Development (LOD) Specification is available at http://bimforum.org/LOD/

LOD is a set of definitions that allows project teams to clearly define content development expectations for BIM and the characteristics of BIM elements in the models. The BIMForum LOD Specification expands upon the LOD schema developed by the American Institute of Architects (AIA) for its E202-2008 BIM and Digital Data Exhibit (and the updated AIA G202-2013 Project BIM Protocol Form) by providing definitions and illustrations of BIM elements of varying building systems at different stages of their development and use in the design, construction, and facility management processes.

Building Information Modeling presents information about a construction project in the form of three-dimensional (3D) graphical representations of elements (e.g., doors, beams, etc.), which can be further associated with information about other characteristics of those elements. It is possible for the graphical representation of an element, taken alone, to suggest that greater accuracy or intention can be attributed to the element than is in fact the case. The AIA's LOD Schema was developed to provide a more systematic way of conveying the extent of reliance that may be placed on an element. Many participants in the design and construction process felt, however, that the AIA's LOD Schema, which consisted of brief verbal descriptions without illustrations, was too general and left too much room for miscommunication of the extent of reliance that can be placed on elements in models at different stages of the design process. In addition,

development of the individual elements that make up more complex assemblies generally does not proceed in a lockstep fashion. A whole assembly provides a clearer and substantially more extensive common vocabulary for communication among members of project teams than that which is provided by the AIA's simple narrative LOD Schema.

Users of the LOD Specification are cautioned that the LOD Specification does not prescribe the necessary LOD's for different steps in the construction process. The determination of which LOD is necessary at different steps is left to each project team in their BxP. The availability of more precise definitions of model elements through the BIMForum LOD Specification will reduce the risks of miscommunication among members of project teams when the expectations for different stages in the design and construction process are established. This is done by easier identification of what each member of the team is expected to deliver and greater predictability of the level of effort that is required to create each member's deliverables.

The LOD Specification is organized by CSI Uniformat 2010, with the subclasses expanded to Level 4 to provide a detailed breakdown and more clarity to the element definitions. The LOD Specification at present addresses only LOD 100 through LOD 400 of the AIA's LOD Schema, along with a new level – LOD 350 – which was added to better address the levels of information required for effective trade coordination. The following are the definitions from the 2019 BIMForum LOD Specification.

> **LOD 100:** *The Model Element may be graphically represented in the Model with a symbol or other generic representation, but does not satisfy the requirements or LOD 200. Information related to the Model Element (i.e. cost per square foot, tonnage of HVAC, etc.) can be derived from other Model Elements.*
>
> BIMForum Interpretation: LOD 100 elements are not geometric representations. Examples are information attached to other model elements or symbols showing the existence of a component but not its shape, size, or precise location. Any information derived from LOD 100 elements must be considered approximate.
>
> **LOD 200:** *The Model Element is graphically represented within the Model as a generic system, object, or assembly with approximate quantities, size, shape, location, and orientation. Non-graphic information may also be attached to the Model Element.*
>
> BIMForum interpretation: At this LOD elements are generic placeholders. They may be recognizable as the components they represent, or they may be volumes for space reservation. Any information derived from LOD 200 elements must be considered approximate.
>
> **LOD 300:** *The Model Element is graphically represented within the Model as a specific system, object or assembly in terms of quantity, size, shape, location, and orientation. Non-graphic information may also be attached to the Model Element.*
>
> BIMForum interpretation: The quantity, size, shape, location, and orientation of the element as designed can be measured directly from the model without referring to non-modeled information such as notes or dimension call-outs. The project origin is defined and the element is located accurately with respect to the project origin.

LOD 350: *The Model Element is graphically represented within the Model as a specific system, object, or assembly in terms of quantity, size, shape, location, orientation, and interfaces with other building systems. Non-graphic information may also be attached to the Model Element.*

BIMForum interpretation: Parts necessary for coordination of the element with nearby or attached elements are modeled. These parts will include such items as supports and connections. The quantity, size, shape, location, and orientation of the element as designed can be measured directly from the model without referring to non-modeled information such as notes or dimension call-outs.

LOD 400: *The Model Element is graphically represented within the Model as a specific system, object or assembly in terms of size, shape, location, quantity, and orientation with detailing, fabrication, assembly, and installation information. Non-graphic information may also be attached to the Model Element.*

BIMForum interpretation: An LOD 400 element is modeled at sufficient detail and accuracy for fabrication of the represented component. The quantity, size, shape, location, and orientation of the element as designed can be measured directly from the model without referring to non-modeled information such as notes or dimension call-outs.

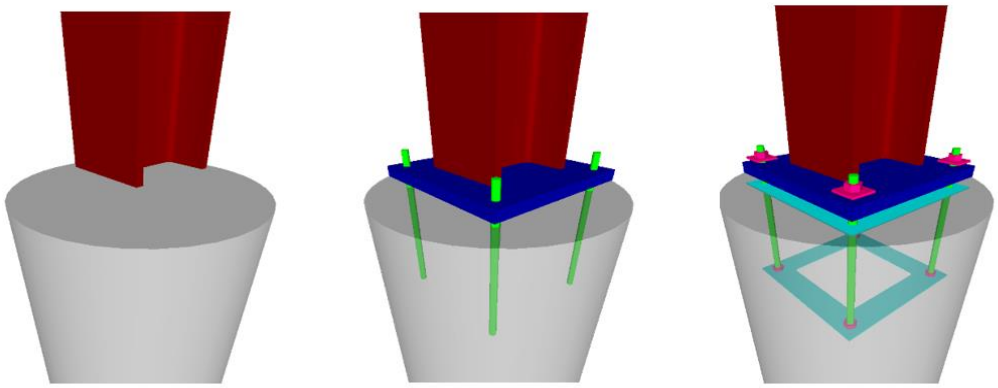


Figure 10: Samples of a column base showing LOD 300, 350, 400. This image was used in Ikerd's original proposal for the development of LOD 350 definition that was ratified in the 2013 BIMForum LOD Specification. Image courtesy of IKERD.com, 2008-2019

The LOD Specification does not presently address the last level in the AIA's LOD Schema – LOD 500 – which covers end-of-construction in the graphical section of Part I. This information is addressed in Part II model element data tables.

The LOD Specification does not prescribe who the author of a particular component at a given LOD should be, as that will vary from one project to another. However, in the interest of improving communication among model users, the document does provide a concise schematic means for a project team to identify model element authors, via the spreadsheet provided in Part II of the specification. In addition, the LOD Specification Task Force has been working with

software developers to provide a means of tagging individual model elements with their current LOD within the modeling software.

For additional information on this topic, visit ***BIMForum.org/LOD.***

Clearances

Not all model objects must be items that would be physically installed in the field. Clearance spaces are an important example of non-physical model elements. There are many cases in which space needs to be reserved in such a way that if another model object is intruding on that space, it would be discoverable via clash detection. Therefore, modeling of access/clearance spaces should generally be required in the BxP for things such as Air Handling Unit access, VAV access, lighting clearances, electrical panel access, junction box access, and even situations such as required minimum garage clearances in order to confirm no building content is impeding on driving or parking spaces. These access/clearance objects are typically made to be transparent in order to quickly identify them as non-physical space reserves.

Software Used

A BxP should establish the various authoring, federating, and free viewer software platforms that will be used for a project. This information will need to be established early in the VDC process so that the requirements are made clear before the trades' modelers are chosen. This information will help by allowing subcontractors to seek out third-party modeling assistance if they do not have in-house capabilities for modeling in a particular software. The referenced image to the right on this page shows a sample Software Usage table in a BxP.

Instructions:

Document Control Software					
	All				
		BIM Process	Discipline	Software	Version
		Document Control (Final documents only)	All	[SOFTWARE NAME]	Most Current
		Document Control (Commissioning)	GC, Subs	[SOFTWARE NAME]	Most Current
		Document Control (All 3D model files)	All	[SOFTWARE NAME]	Most Current
		Document Control (Native Design Models)	All	[SOFTWARE NAME]	Most Current
		PDF Viewer/Editor (All 2D PDF)	GC, Subs	[SOFTWARE NAME]	Most Current
Authoring and Collaboration Software					
	Design				
		BIM Process	Discipline	Software	Version
		3D Authoring Models	Architect	[SOFTWARE NAME]	2018
		3D Authoring Models	Structural	[SOFTWARE NAME]	2018
		3D Authoring Models	Mechanical	[SOFTWARE NAME]	2018
		3D Authoring Models	Plumbing	[SOFTWARE NAME]	2018
		3D Authoring Models	Electrical	[SOFTWARE NAME]	2018
		3D Authoring Models	Technology	[SOFTWARE NAME]	2018
		3D Authoring Models	Special Equipment	[SOFTWARE NAME]	2018
		3D Authoring Models	Sitework & Utilities	[SOFTWARE NAME]	2018
		3D Model Coordination	All	[SOFTWARE NAME]	Most Current
	Construction				
		BIM Process	Discipline	Software	Version
		3D Authoring Models	Mechanical and Plumbing	[SOFTWARE NAME]	2018
		3D Authoring Models	Electrical	[SOFTWARE NAME]	2018
		3D Authoring Models	Structural Steel	[SOFTWARE NAME]	2018
		3D Authoring Models	Fire Protection	[SOFTWARE NAME]	2018
		3D Viewing Only	All	[SOFTWARE NAME]	2018
		3D Model Coordination	GC, Subs	[SOFTWARE NAME]	2018
		3D Field Validation	GC, Subs	[SOFTWARE NAME]	2018
		3D Model As-Builts	GC, Subs	[SOFTWARE NAME]	2018
		3D Record Model	GC, Subs	[SOFTWARE NAME]	2018
		4D Simulation	GC	[SOFTWARE NAME]	2018
		5D Simulation + Cost	GC	[SOFTWARE NAME]	2018
		Point Coordinates	All	[SOFTWARE NAME]	2018
		6D Facilites Management	All	[SOFTWARE NAME]	2018

NOTES:
1) 3D CAD - Solid, This coudl be Autodesk AutoCAD 3D solids for example. If using a CAD package with object enablers on top of AutoCAD, export out a *.DWG file that has all model geometry fully expressed in the single file so that the enablers are not required for viewing.

Figure 11: Sample Software Table for BxP. Image courtesy Ascend Building Knowledge Foundation (AscendBKF.org, CD-BIM.com), 2018. https://creativecommons.org/licenses/by-nc/4.0/

File Naming Conventions

Maintaining a strict file naming convention is very important to project organization and for expediting the BIM effort. By maintaining consistent file names, the BIM Manager can save time that would otherwise be spent manually renaming files or tracking down which files are the most current. This enables them to focus solely on updating the clash tests without losing any prior clash groupings when utilizing BIM for model coordination.

Coordination Hierarchies

The coordination hierarchy is typically established with the objects that are most difficult or expensive to move as having precedence. This allows the team to make quick decisions on which items a given trade should seek to adjust in any clash situation, depending on the other trade they are clashing with. A clash matrix shows which disciplines take precedence based on which ones are furthest to the top and left of the matrix (see example image below). This is a concept that some practitioners include in their BxP and use as a tool in their coordination process.

This information is provided as a reference in The Guide and an item for teams to consider if it is appropriate for their team and project. Additionally, it is noted that the clash matrix is not directly correlated to coordination. For example, if a discipline models little of their model element content, then they will show a very low 'clash count' in this matrix.

ALL ZONES	Structure	Ductwork	Plumbing	Electrical	Fire Protection	Tech	Food Service	
Structure	X							
Ductwork	0	X						
Plumbing	0	0	X					
Electrical	0	0	0	X				
Fire Protection	0	0	0	0	X			
Tech	0	0	0	0	0	X		
Food Service	0	0	0	0	0	0	X	
BUILDING TOTAL:	0							

Figure 12 Sample of a clash matrix used to evaluate the number of clashes between disciplines for a given zone. Note that Structure would take precedence over Ductwork, and Ductwork over Plumbing, etc. as it would be more difficult to relocate. Image courtesy Ascend Building Knowledge Foundation (AscendBKF.org, CD-BIM.com), 2019. https://creativecommons.org/licenses/by-nc/4.0/

However, there are some cases in which an object that is normally higher up on the hierarchy will be moved or otherwise revised, due to special constraints. For example, consider an instance where the Design Team decides that they cannot change a ceiling height, but there is a plumbing roof drain pipe that clashes with a structural beam. If the ceiling is unable to be lowered, then in some special cases the structural engineer can design a penetration around mid-span of the beam for the roof drain pipe to pass through.

Coordination

To provide clarity in the communication process, a BxP should include clear and specific collaboration procedures and a plan for utilizing BIM information exchanges to prevent 'lost' or 'late' files due to deliverables either not being where they need to be or in the wrong format. Some BIM information exchanges will even complement your file naming conventions by allowing you the ability to force naming conventions for specific file uploads. This is especially helpful when utilizing clash detection in your BIM coordination process.

On many projects, not all geometrical or informational content can be represented within the BIM for a variety of reasons (as-built conditions that have not yet been confirmed, content at lower LOD's due to a system that is still in design development, etc.). One example would be the joist webbing profiles when seeking to coordinate MEPFP systems through the joist members. Often the webbing profiles are not established until later in the project when coordination between MEPFP systems, Architectural, and Structural elements at higher LOD's have already reached substantial completion. In this case, finalizing coordination between MEPFP systems and the joist webbing might need to take place in-field.

For more information on coordination, visit: ***BIMForum.org/Coord.***

Reality Capture

Reality capture is an emerging technology in the design, construction, and building ownership industries. While laser scanning is predominantly thought of as being synonymous with reality capture, reality capture encompasses many other technologies as well. Reality capture in the A/E/C/O/FM industry addresses the documentation of the real-world geometry of buildings and their related objects. Such documentation is obviously important for existing structures and historic buildings as a part of documenting their as-built conditions. Equally valid uses of reality capture include documenting new construction and key milestones. An example of this could be using reality capture to document anchor rod placement before structural steel is shipped to the site. Such anchor rod reality capture documentation could be vital for confirming key interface geometry and alignment of steel base plates with the anchor rods cast into the concrete. Other examples include documenting the square footage of buildings for architects or owners who are considering renovating, providing a tenant finish out with new construction, or space accounting for the management, leasing, or sale of the property. Additionally, reality capture addresses issues such as documenting sub grade utilities or structural reinforcing and concrete. Other forms of reality capture might include measurements that are to a conceptual level of accuracy for creating mass models for general building layout and design during a schematic design phase. An in-depth review of all reality capture technology is beyond the scope of this section of The Guide. The following is a brief introduction to these dimensional data capturing technologies as concepts to be considered for anyone writing and updating their BIM Execution Plans. Such technologies include, but are not limited to:

- LiDAR Scanning
- Photogrammetry
- Drones and UAV
- Ground Penetrating Radar (GPR)

- Ultrasound rebar scanning
- Distance meter and traditional building documentation
- Robotic total station surveying
- Thermal imaging
- Augmented Reality Technology
- Point Layout with points in the field
- GPS data collection

For an expanded discussion on these topics and selected BIMForum presentations related to reality capture, visit ***BIMForum.org/Reality***

Project Deliverables

List the specific model files and documents required at the close of the project effort in this section. The project deliverables should, at least in part, satisfy the project goals. Some goals, such as improved communication, would not be satisfied by the model deliverables, but rather those deliverables would be a by-product of improved communication achieved on the project. Deliverable formats and method of file submission should also be clearly outlined

Part of securing the buy-in of each VDC participant includes having sign off sheets for the BxP and the final BIM(s). The sign off sheet for the BxP is there to ensure each trade agrees with the plan and is ready to move forward as a willing contributor with the same objectives in mind. The sign off sheet(s) for the final BIM(s) are to confirm that each trade is satisfied with the spatial reservations that have been agreed upon through the coordination process. These documents should also seek to outline appropriate steps of action should a particular trade's field installation deviate from what is represented in the signed off model(s) and result in field issues with other trade content.

BIM Manager & Modeler Requirements

BxPs should contain minimum requirements for both the BIM Manager and trade modelers, as stated by almost two thirds of the industry practitioners surveyed and interviewed for The Guide. The requirements must be established to correspond with the BIM goals for the project. Minimum requirements for computer hardware should also be presented in this section to confirm that each responsible party is able to handle the software requirements of the software being used for the VDC process.

When assembling a VDC team, many ideas that are common to most team formations must be considered. Personal attributes such as skills, strengths, and experience must be considered as well as outside factors such as availability. The obvious consideration when selecting team members is their skills and strengths. Each team member's skills must meet or exceed the requirements for the role to be filled. Team members with skills such as problem-solving or ideation should be assigned to modeling roles. Others skilled in reviewing or revising could be assigned to coordination roles. There are numerous other less obvious skills to consider and all skills required for successful execution of the project must be represented in the team assembled. Strengths are generally more straightforward. In most project delivery types, however, the team selections have not been finalized and, as such, the BxP should reference clear team member capability requirements.

For instance, an AGC Certificate of Management in BIM (CM-BIM) may be a reasonable requirement for the BIM Manager in the BxP. At the modeler level role, teams may consider requiring the Certificate of Development in BIM (CD-BIM.com) which i

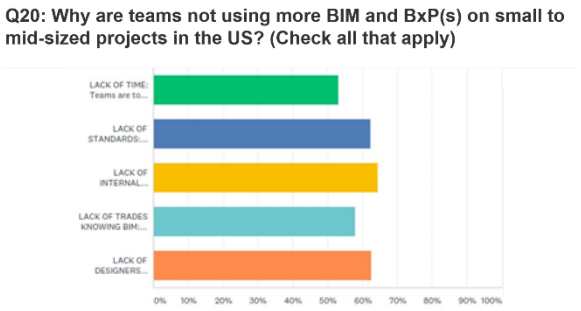


Figure 13: Teams are not using BIM and BxPs on small-to-midsized projects due to a lack of training, Standards, and knowledge among both designers and trades according to survey results and phone interviews conducted by The Taskforce.

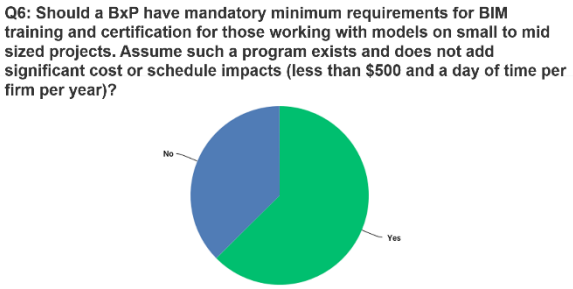


Figure 15: Industry stakeholders who were surveyed. The graph above shows response to question on BIM certification requirements.

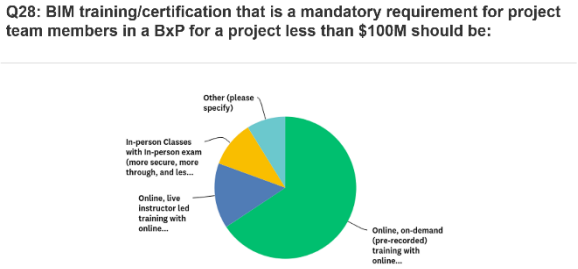


Figure16: Roughly 72% of respondents answered that BIM training/ certification should be "Online, on-demand training (pre-recorded) with an online test" in The Taskforce survey.

s a four hour online, on demand course with a short exam to validate completion. It provides a baseline for understanding the VDC process for key terms in the BxP. If reality capture is used, the BIM Fourm Reality Capture Specification, Level of Accuracy certification for reality capture may be considered.

All these certification programs, when properly referenced in a BxP, address the qualities of capabilities, strengths, skills, communication, safety, and experience of team members.

Field BIM

Field BIM entails the process of point layout and other aspects of using the model in the field with an emerging array of mobile tools. This is a topic that teams should review and address as appropriate for their projects in their BxP. To learn more about the topic of Field BIM, visit ***BIMForum.org/Field***.

Organizational Structure and Communication Plan

There are several key organizational goals and considerations to be mindful of when assembling a team as it relates to a BxP. BIM managers, coordinators, and technicians are the foundation of the team, so they must be coordinated into a team correctly to be used to their full potential. It is important to note that the different team roles can be divided further into subsections, referred to by different names, or have new positions created entirely. The BxP should clearly show the organizational structure of the team. This is often done with an organizational diagram that is part of a communication plan including stakeholder's names and contact information.

The BIM manager is responsible for leading the entire team. Technical modeling experience is not necessarily required, but it is beneficial to have. At the very least, a BIM manager should be able to navigate a model. The manager will be involved with the project from its inception until after construction is completed and will also attend meetings with clients. BIM managers receive most of their information about the project from BIM coordinators.

BIM coordinators oversee the technicians and give progress updates to the BIM manager. Ideally, the coordinators are fully knowledgeable of the primary BIM applications they use and are familiar with the other stakeholders' applications. If any issues arise, the coordinators are responsible for resolving the issues within parameters set by the manager. Depending on the project size, there can be multiple coordinators assigned to a project. For larger projects where a single company is responsible for multiple BIM facets, a coordinator might be assigned to each team covering a different facet of the project.

Open Standards and the BxP

When planning for the use of BIM on any project, the stakeholders involved may not all use the same software applications. To ensure that project data is not lost in translation between applications, all team members should be knowledgeable about interoperability.

In "BIM Handbook" (Eastman, Teicholz, Sacks, Liston; published by John Wiley & Sons, Inc., 2011) interoperability is defined as follows:

> *"Interoperability is the ability to pass data between applications, and for multiple applications to jointly contribute to the work at hand. Interoperability, at the minimum, eliminates the need to manually copy data already generated in another application."*

One of the best methods for ensuring interoperability is to understand and implement openBIM standards. These standards are developed and maintained by an international consortium known as buildingSMART (www.buildingsmart.org). They describe openBIM as follows (https://www.buildingsmart.org/standards/technical-vision/):

> *"openBIM is a universal approach to the collaborative design, realization and operation of buildings based on open standards and workflows. openBIM is an initiative of buildingSMART and several leading software vendors using the open buildingSMART Data Model.*
>
> *buildingSMART's purpose is to allow the sharing of information throughout the lifecycle of any built environment asset, between all the participants, regardless of which software application they are using."*

The buildingSMART standards are file-based exchange schemas developed specifically for building projects. The current standards that most BIM software applications can use are IFC (Industry Foundation Classes) and BCF (BIM Collaboration Format).

IFC is the common data schema that makes it possible to hold and exchange relevant data about the built environment. It is also a standard that is recognized by the International Organization for Standardization (ISO 16739: https://www.iso.org/standard/51622.html). The software applications that have been certified for IFC import and/or export are listed at http://buildingsmart.org/compliance/certified-software/.

BCF stands for "BIM Collaboration Format" and is a subset of IFC designed to support clash detection and 3D coordination. It is a much lighter and more portable format because it only uses the IDs of model elements, virtual camera positions and other textual information about the affected model elements (http://www.buildingsmart-tech.org/specifications/bcf-releases).

Establishing the use of open standards such as IFC and BCF in the BxP will allow teams to collaborate their models regardless of the software platform they are working in. To learn more about the above topics, please visit ***BIMForum.org/OpenBIM***

Legal and Insurance Topics

Legal and Insurance Topics are highly dependent upon the scope of BIM services to be utilized on the project and the project delivery method. Team make-up, project types, design and construction budget, and other extenuating factors also impact BxP best practices. As such, the rigorous treatment of this topic is beyond the scope of this introductory BxP Guide. Nevertheless, there are some trends in The Guide that will help owners and their teams in their discussions with legal counsel and insurance agents and carriers. There are several available model contract forms that provide templates for both general contract terms and terms specific to BIM. The major families of contracts currently available are those published by the American Institute of Architects, the Design Build Institute of America, the Counsel of American Consulting Engineers, and ConsensusDocs.

To learn more about the key decisions and important topics in this area, please visit the BIMForum's legal subforum website at www.BIMForum.org/legal. The BIMForum's legal subforum page provides reference links to the model contracts referenced above, recognizing that many model contracts tie in to project delivery through reference to the BIM Execution Plan. The BxP needs to be treated consistent with other documents having legal implications. The BIMForum's legal subforum page also includes excerpts from BIMForum presentations on these topics and information on cybersecurity and appropriate insurance coverages on BIM-related projects.

Conclusion

The purpose of The Guide is to introduce BxP concepts to teams on the smallest of projects that may have some team members who have never previously used BIM.

These BxP concepts are also applicable to all project delivery methods at varying levels of effectiveness. The Guide acknowledges that collaboration is improved in more integrated forms of project delivery such as Design Assist, Design Build (DB) and Integrated Project Delivery (IPD). These more integrated forms of delivery can help create the environment to more fully leverage the collaborative benefits of BIM as defined in a project BxP. Additionally, it is understood that Design Bid Build (DBD) is the most common delivery method for small projects as well as for certain project types, such as public sector projects in many regions of the US.

The Guide is for the BIM enabled design team who is introducing an owner to BxP concepts on their three-million-dollar police or fire station project. It is for the general contractor who is introducing a BxP to some of their trades that have never used BIM on a twenty-million-dollar public elementary school. It is for a BIM enabled design and construction team to have as a common reference on a hundred-million-dollar office building with an owner who has never used BIM. In all these examples and many more, The Guide serves to help teams introduce BxP concepts to any project stakeholder who is new to BIM.

BIMForum gathered common elements and topics in BxP content from our conferences over the last decade and numerous industry practitioner surveys and interviews. The goal of this effort is to share lessons learned from companies and individuals who have been using BIM and authoring BxP content for many years. Most of the target audience of The Guide has likely never attended a BIMForum conference since the organization began in 2005. The hope is that The Guide will introduce them to both solid BxP concepts and the BIMForum

We look forward to seeing you soon at one of our annual events where we expand on industry best practices in process, innovation, training, and technology, and on our online resources at BIMForum.org.

Please take a moment to provide feedback on The Guide by using the link in the footer of this page. When you do provide feedback, please reference the page number if applicable to your feedback.

Appendix A: Resources

The following are resources cited in The Guide.

BIM Project Execution Plan Resources

BIMForum.org/BxP

BIM.psu.edu/

CD-bim.com/bxp/

LOD Resources

BIMForum.org/LOD

CD-BIM.org/LOD

Training Resources

BIMForum.org/Events

BIMForum.org/Learn

Pathlms.com/BIMForum

AGC.org/learn/education-training/building-information-modeling/cm-bim

CD-BIM.org

Reality Capture

BIMForum.org/Reality & BIMForum.org/LOA

CD-BIM.com/Reality

Legal, Insurance and Risk

BIMForum.org/Legal

AmericanBar.org/groups/construction_industry.html

NationalBondclaims.org

scinst.org

Open Standards

BIMForum.org/OpenBIM

BuildingSmart.org

BIMForum.org/IFC

BIMForum.org/COBie

Field BIM

BIMForum.org/FieldBIM

Facility Management

BIMForum.org/FM

Coordination

BIMForum.org/COORD

CD-BIM.com/COORD

Appendix B1: Survey Data Summary

The Charles Pankow Foundation and BIMForum sent out a survey to professionals across the industry to create the BIMForum BxP Guide as a practitioner-led document. Survey questions and results are in the following pages. The goal of this data collection was to find recommendations from practitioners for those who are new to BIM on small projects. ***The survey data has been provided in a de-identified version removing personal identifying information. This research data set is made available to aid in further industry research.***

Summary of Survey Data

A total of 565 professionals in the A/E/C/O/FM industry were surveyed online between October 2017 through the end of 2018. The following data was collected.

Early trends include data from a cross-section of the building industry professional population, including but not limited to: construction managers, general contractors, laser scanning/ reality capture providers, BIM consultants, design community members (architects, designers, engineers), detailers and trade partners.

A notable trend identified was the lack of BIM training. Approximately 71% of the survey population was aware of the AGC's Certificate of Management in BIM (CM-BIM); however, only about 23% of people took the classes or passed the exam.

Those surveyed work for firms or organizations from a wide variety of sizes, ranging from 1 employee to 15,000+ employees. The age ranges of participants ranged from 31-45 years (53%), 46-60 years (27%), 60+ years (9%), and 30 years or younger (11%).

Survey data revealed that most firms either have NON-EXISTENT BxP training (roughly 27%) or MODERATELY EFFECTIVE BxP training (roughly 41%). VERY EFFECTIVE/ EXCEPTIONAL internal BxP training accounted for about 17% of the survey population, and INEFFECTIVE/ VERY INEFFECTIVE for approximately 15%.

Certification for BIM in BxP Content

When asked: Should a BxP have mandatory minimum requirements for BIM training and certification for those working with models on small-to-midsized projects? Roughly 62% of people answered YES.

With specific regards to the design phase of a project, participants were asked at what stage of the process lead designers (e.g., the architect) should make their BxP available to the sub-consulting designers (e.g., the engineer). A resounding 66% answered, "At the Request for Proposal/ Fee Negotiation Stage" (Before BIM starts), roughly 21-22% said, "At the Start of Work with BIM," approximately 6-7% said, "At Design Development," and about .1% said, "Not Applicable" (Designers don't use BxPs during design). When asked the same question in regard to the construction phase of a project, the results were similar. Roughly 70-71% answered, "At the Pre-Bid Meeting Before BIM Starts," approximately 18% said, "During the Bid Phase," and roughly 9% said either "After All Trades Have Been Selected," or "When Given A Notice to Proceed," respectively.

Most respondents (~85%) said they viewed their BxPs as a Quality Procedure Documents for the modeling process (as a part of an overall QA/QC plan); roughly 15% said they did not. Similarly, about 86% of participants felt that using a well-written and implemented BxP reduced financial risk within their firms; and about 13% felt that they did not. Interestingly, when asked whether or not BxPs reduce financial risk for the project overall, approximately 93% answered YES.

Participants were then asked whether they felt a well-written and implemented BxP by the General Contractor improved physical construction safety as a part of creating an organized and well-planned jobsite and lay-down area. Roughly 71% answered YES. The similar question was asked regarding a GC's BxP improving upon the project's quality of in-place trade work. About 91% answered YES.

When asked to select the top three benefits of using a well-written BxP on projects, respondents chose: 1) Coordination and Clash Detection, 2) Defines the Construction Team's expectations, scope, and processes involving BIM, and 3) Defines Design Team's expectations, scope, and BIM processes. Defines A Communication Plan for the BIM Team closely followed in fourth place.

Training

As mentioned previously, the causality of teams not using BIM and BxPs on small-to-midsized projects was mostly due to a lack of internal training, according to survey results and phone interviews.

The top organization development tools utilized when assembling teams for BIM collaboration to improve team communication included a Myers Briggs Type Indicator (MBTI) and D.I.S.C. Profile (both around 42%), StrengthsFinder (about 30%), and the Maxwell Leadership Assessment (roughly 15%).

When asked how BIM training/certification SHOULD be delivered, roughly 65% of respondents said, "Online, on-demand training with an online test" (pre-recorded), approximately 15% said, "Online, live instructor-led training with an online test," and about 8-11% chose either, "In-person classes with an in-person exam" (for additional security), or "Other," respectively.

Approximately 31% said they utilize free online videos for fundamental BxP training, and about 26% utilize past BIMForum webinars. 24% of respondents use books or printed material, 25% train via software-user conferences (which are live and in-person), 17% prefer BIMForum live, in-person conferences, 13% utilize LinkedIn Learning (Lynda), 17% use the AGC's CM-BIM curriculum, and roughly 6-10% use CD-BIM.com.

Model File Types

Survey data showed the preferred base file type for BIM coordination/clash detection on small-to-midsized projects to be NWC (with roughly 39%). RVT trailed closely in second place with approximately 27%, followed next by IFC (14%), then DWG (solids) with about 8%, and, lastly, DWF and DXF with 3% or less usage.

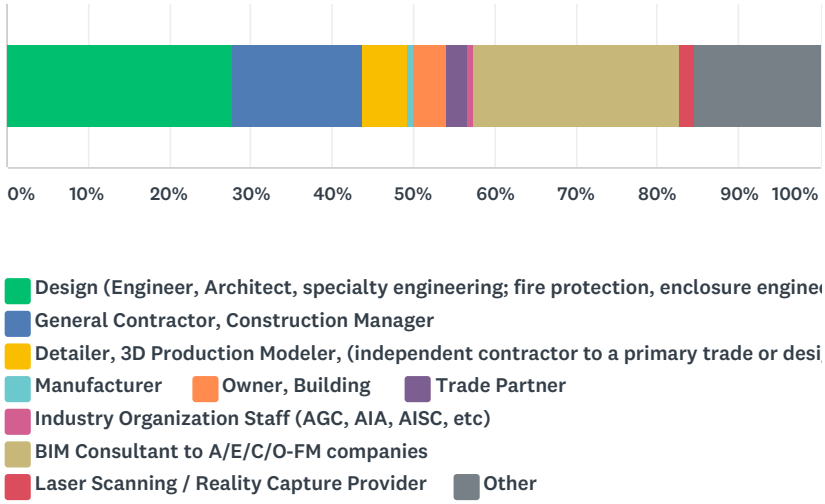
LOD Usage

A clear majority selected the BIMForum LOD Specification (around 62%), approximately 27% selected the AIA LOD Definitions, 22% said they utilized internally created standards, and roughly 8% said they didn't use LOD Specifications in their BIM process.

Appendix B2: Survey Data Responses

Q1 What best describes your role in your company on typical building projects?

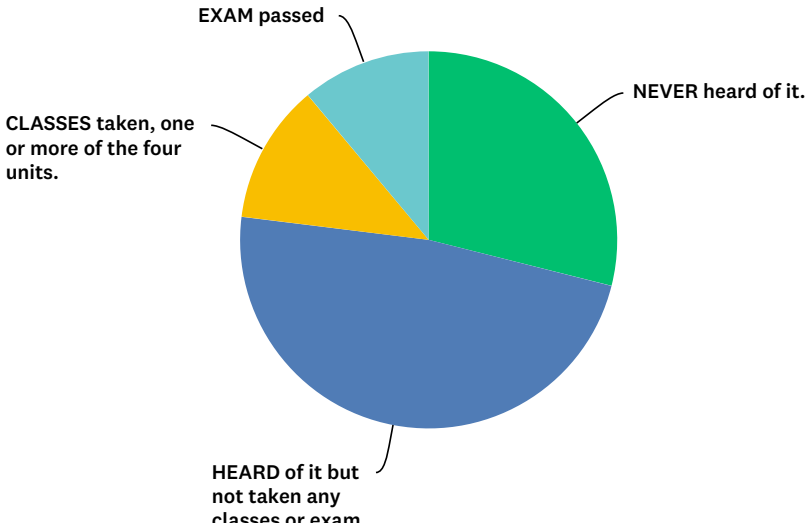
Answered: 565 Skipped: 0



ANSWER CHOICES	RESPONSES	
Design (Engineer, Architect, specialty engineering; fire protection, enclosure engineer, etc)	27.79%	157
General Contractor, Construction Manager	15.93%	90
Detailer, 3D Production Modeler, (independent contractor to a primary trade or designer)	5.49%	31
Manufacturer	0.88%	5
Owner, Building	3.89%	22
Trade Partner	2.65%	15
Industry Organization Staff (AGC, AIA, AISC, etc)	0.88%	5
BIM Consultant to A/E/C/O-FM companies	25.13%	142
Laser Scanning / Reality Capture Provider	1.95%	11
Other	15.40%	87
TOTAL		565

Q2 Select which best applies to your experience with the AGC's Certificate of Management in BIM (CM-BIM) Training and Exam

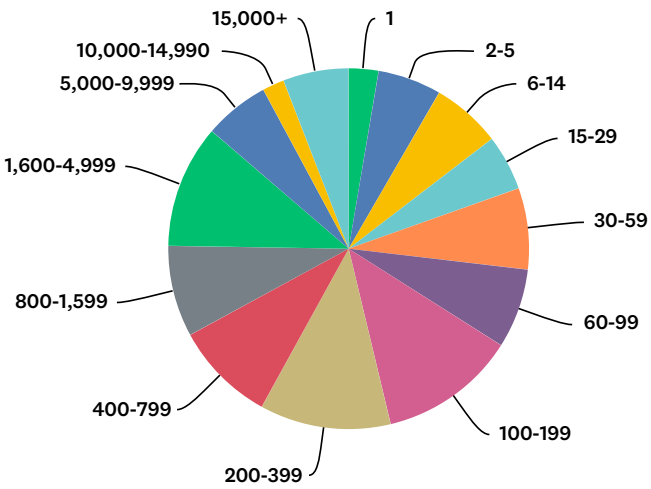
Answered: 560 Skipped: 5



ANSWER CHOICES	RESPONSES	
NEVER heard of it.	28.93%	162
HEARD of it but not taken any classes or exam.	48.04%	269
CLASSES taken, one or more of the four units.	11.96%	67
EXAM passed	11.07%	62
TOTAL		560

Q3 What is the size of your firm by number of employees?

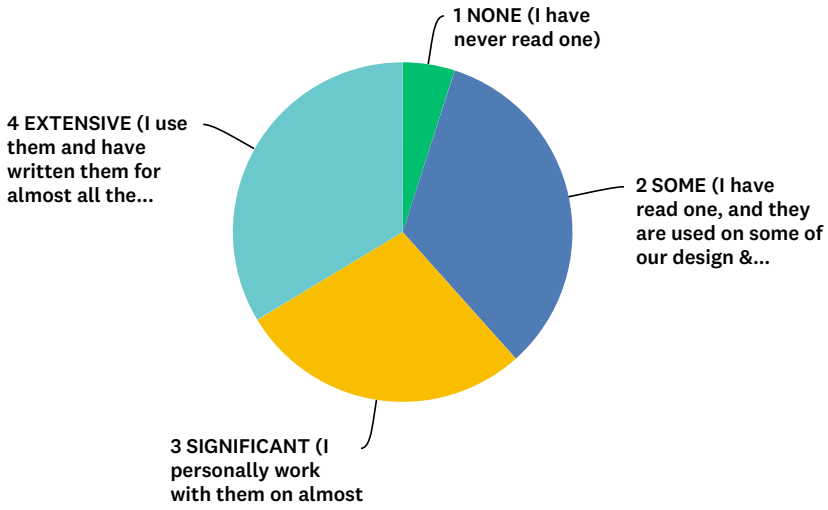
Answered: 562 Skipped: 3



ANSWER CHOICES	RESPONSES	
1	2.67%	15
2-5	5.69%	32
6-14	6.23%	35
15-29	4.98%	28
30-59	7.30%	41
60-99	7.12%	40
100-199	12.28%	69
200-399	11.74%	66
400-799	9.07%	51
800-1,599	8.19%	46
1,600-4,999	11.03%	62
5,000-9,999	5.87%	33
10,000-14,990	1.96%	11
15,000+	5.87%	33
TOTAL		562

Q4 How would you rate your knowledge of BIM Execution Plans?

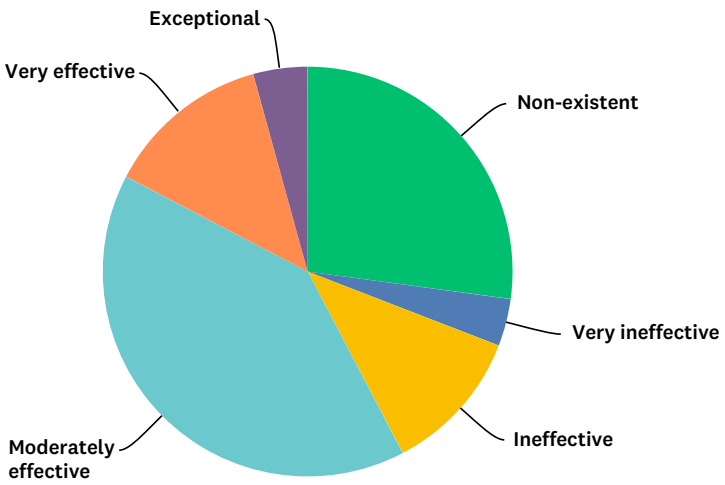
Answered: 565 Skipped: 0



ANSWER CHOICES	RESPONSES	
1 NONE (I have never read one)	4.96%	28
2 SOME (I have read one, and they are used on some of our design & construction projects)	33.45%	189
3 SIGNIFICANT (I personally work with them on almost all active projects)	27.96%	158
4 EXTENSIVE (I use them and have written them for almost all the projects I work on).	33.63%	190
TOTAL		565

Q5 How effective is your firm's BxP training?

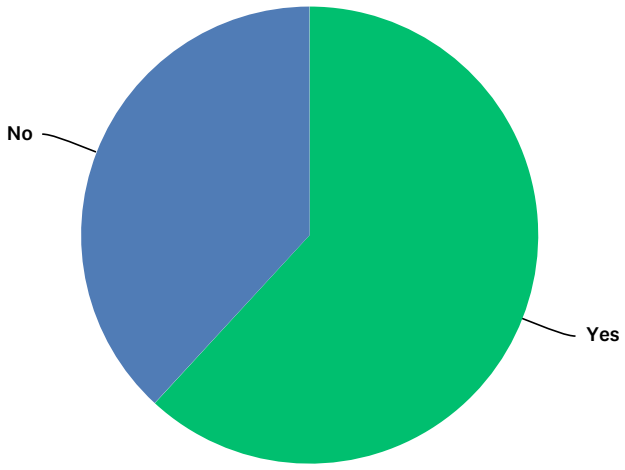
Answered: 560 Skipped: 5



ANSWER CHOICES	RESPONSES	
Non-existent	27.14%	152
Very ineffective	3.75%	21
Ineffective	11.43%	64
Moderately effective	40.36%	226
Very effective	13.04%	73
Exceptional	4.29%	24
TOTAL		560

Q6 Should a BxP have mandatory minimum requirements for BIM training and certification for those working with models on small to mid sized projects. Assume such a program exists and does not add significant cost or schedule impacts (less than $500 and a day of time per firm per year)?

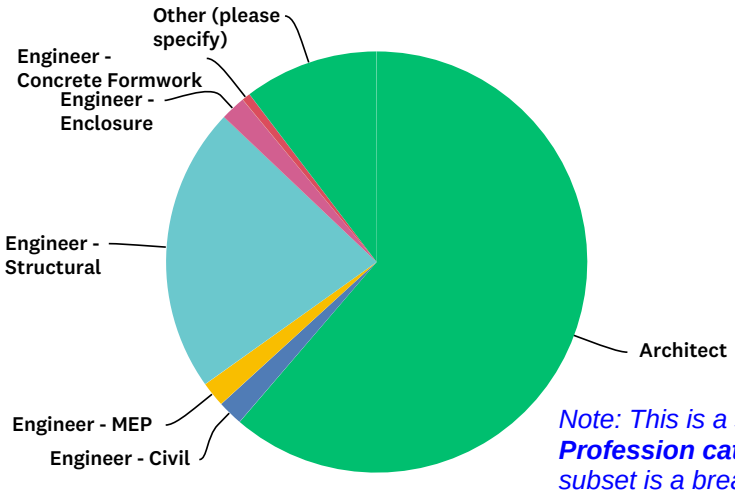
Answered: 561 Skipped: 4



ANSWER CHOICES	RESPONSES	
Yes	61.85%	347
No	38.15%	214
TOTAL		561

Q7 What is your profession?

nswered: 155 Skipped: 410

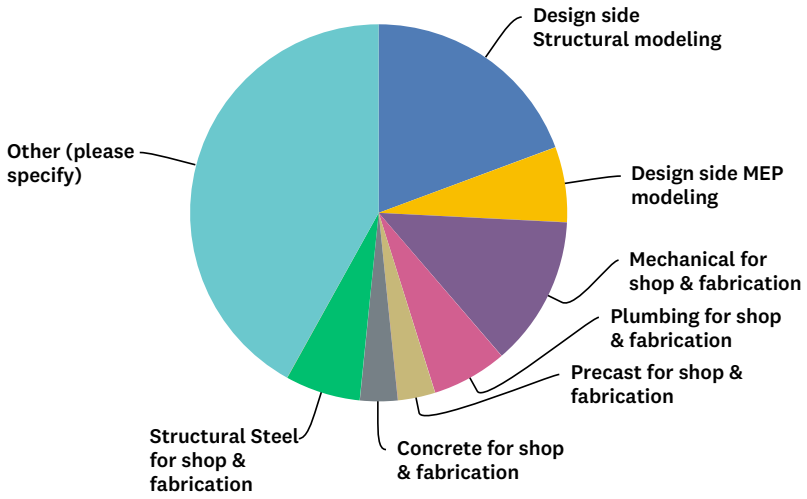


*Note: This is a subset of the **Question 1 Main Profession categories** from question 1. This subset is a breakdown of the "**Designers**" category.*

ANSWER CHOICES	RESPONSES	
Architect	61.29%	95
Engineer - Civil	1.94%	3
Engineer - MEP	1.94%	3
Engineer - Structural	21.94%	34
Urban Planner	0.00%	0
Engineer - Acoustical	0.00%	0
Engineer - Enclosure	1.94%	3
Engineer - Cold Formed Metal Framing	0.00%	0
Engineer - Concrete Formwork	0.65%	1
Engineer - Fire Protection	0.00%	0
Other (please specify)	10.32%	16
TOTAL		155

Q8 What is your primary focus of production modeling and/or detailing?

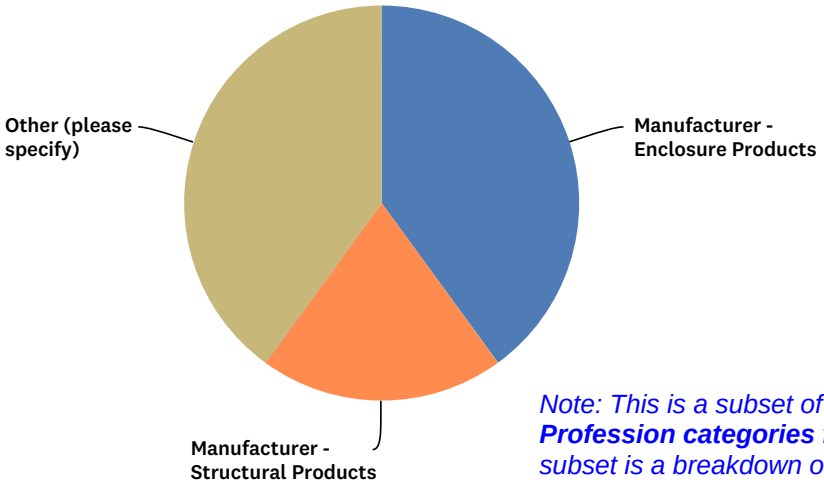
Answered: 31 Skipped: 534



ANSWER CHOICES	RESPONSES	
Design side Architectural modeling	0.00%	0
Design side Structural modeling	19.35%	6
Design side MEP modeling	6.45%	2
Curtain Wall for shop & fabrication	0.00%	0
Electrical for shop & fabrication	0.00%	0
Mechanical for shop & fabrication	12.90%	4
Plumbing for shop & fabrication	6.45%	2
Precast for shop & fabrication	3.23%	1
Reinforcing Steel for shop & fabrication	0.00%	0
Concrete for shop & fabrication	3.23%	1
Structural Steel for shop & fabrication	6.45%	2
Fire Protection for shop & fabrication	0.00%	0
Content for Manufactures for shop & fabrication	0.00%	0
Other (please specify)	41.94%	13
TOTAL		31

Q9 What is your profession?

Answered: 5 Skipped: 560

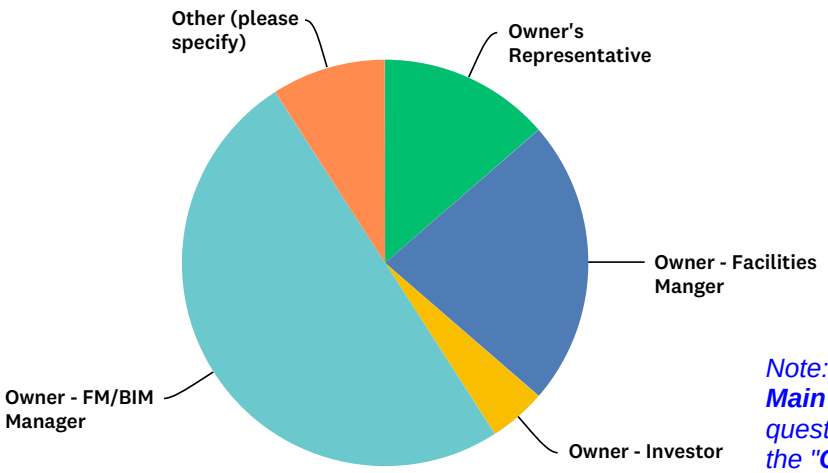


*Note: This is a subset of the **Question 1 Main Profession categories** from question 1. This subset is a breakdown of the "**Manufacturer**" category.*

ANSWER CHOICES	RESPONSES	
Manufacturer - Building Technology Proucts	0.00%	0
Manufacturer - Enclosure Products	40.00%	2
Manufacturer - Interior Products	0.00%	0
Manufacturer - MEP & FP Products	0.00%	0
Manufacturer - Structural Products	20.00%	1
Manufacturer - Subgrade Utility Products	0.00%	0
Manufacturer - Concrete Fromwork	0.00%	0
Other (please specify)	40.00%	2
TOTAL		5

Q10 What is your profession?

Answered: 22 Skipped: 543

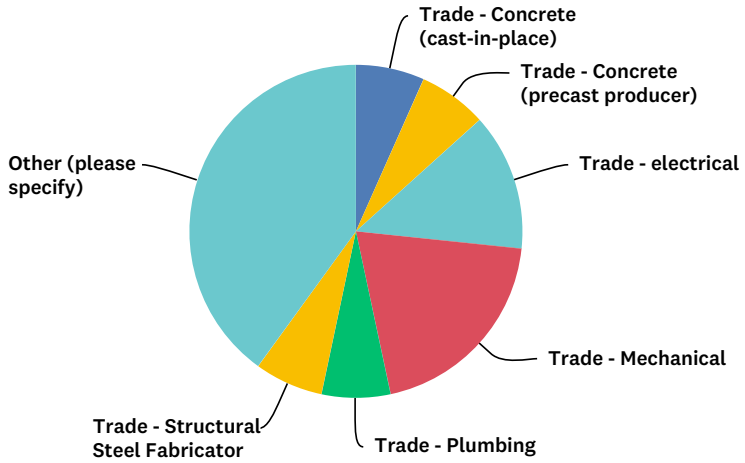


*Note: This is a subset of the **Question 1 Main Profession categories** from question 1. This subset is a breakdown of the "**Owner**" category.*

ANSWER CHOICES	RESPONSES	
Owner's Representative	13.64%	3
Owner - Facilities Manger	22.73%	5
Owner - Investor	4.55%	1
Owner - FM/BIM Manager	50.00%	11
Other (please specify)	9.09%	2
TOTAL		22

Q11 What is your profession?

Answered: 15 Skipped: 550

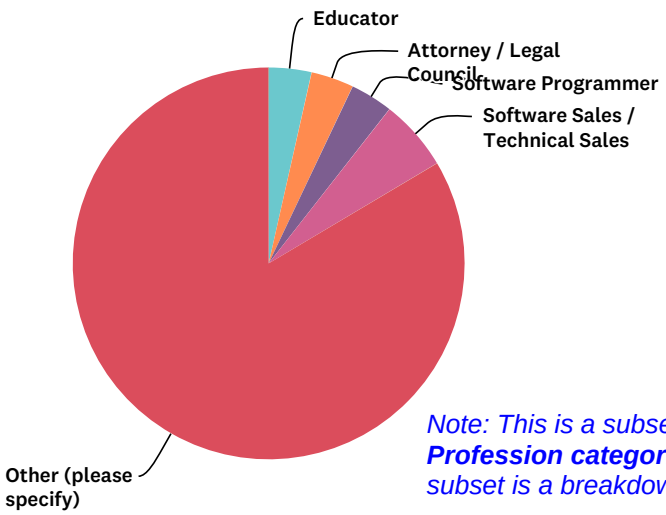


*Note: This is a subset of the **Question 1 Main Profession categories** from question 1. This subset is a breakdown of the "**Trade**" category.*

ANSWER CHOICES	RESPONSES	
Trade - Civil/Utilities	0.00%	0
Trade - Concrete (cast-in-place)	6.67%	1
Trade - Concrete (precast producer)	6.67%	1
Trade - electrical	13.33%	2
Trade - Exterior Metal Panel	0.00%	0
Trade - Exterior Waterproofing	0.00%	0
Trade - Fire Protection	0.00%	0
Trade - Glazier (Curtain Wall/Window)	0.00%	0
Trade - Mechanical	20.00%	3
Trade - Miscellaneous Metals/Stairs	0.00%	0
Trade - Plumbing	6.67%	1
Trade - Roofing	0.00%	0
Trade - Structural Steel Fabricator	6.67%	1
Other (please specify)	40.00%	6
TOTAL		15

Q12 What is your profession?

Answered: 85 Skipped: 480

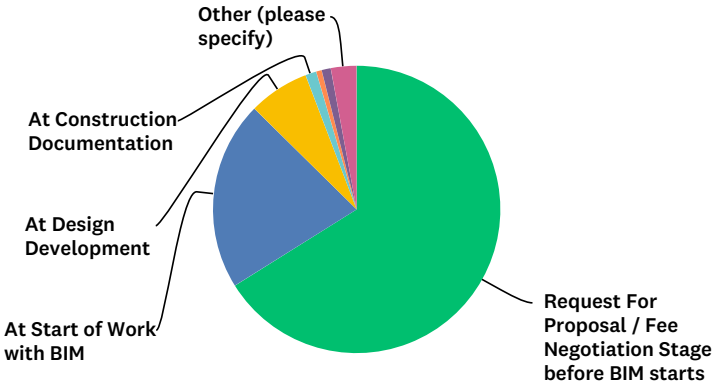


*Note: This is a subset of the **Question 1 Main Profession categories** from question 1. This subset is a breakdown of the "**Other**" category.*

ANSWER CHOICES	RESPONSES	
Banking - Commercial Lender	0.00%	0
Bonding Company	0.00%	0
Insurance Provider	0.00%	0
Educator	3.53%	3
Attorney / Legal Council	3.53%	3
Software Programmer	3.53%	3
Software Sales / Technical Sales	5.88%	5
Student	0.00%	0
Other (please specify)	83.53%	71
TOTAL		85

Q13 During DESIGN, at what stage of the process should the lead designers (normal the Architect) make their BxP available to their sub-consulting designers (normally engineers)?

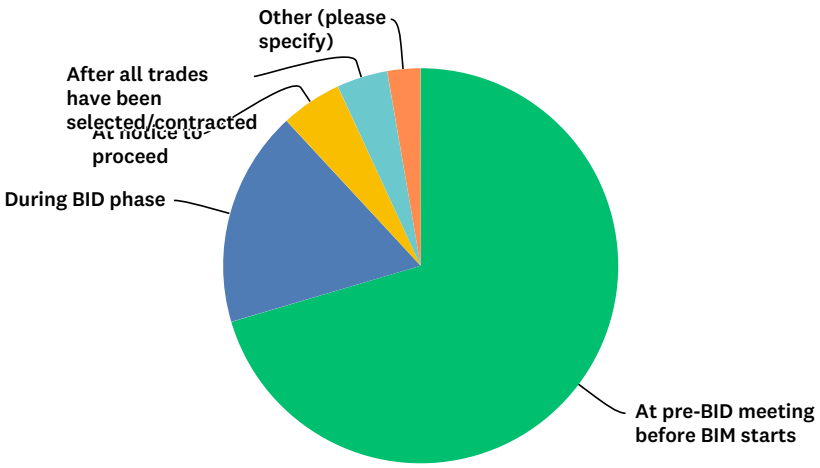
Answered: 484 Skipped: 81



ANSWER CHOICES	RESPONSES	
Request For Proposal / Fee Negotiation Stage before BIM starts	66.12%	320
At Start of Work with BIM	21.28%	103
At Design Development	6.82%	33
At Construction Documentation	1.24%	6
At Construction Administration	0.62%	3
Not Applicable (Designers don't use BxP's during design)	1.03%	5
Other (please specify)	2.89%	14
TOTAL		484

Q14 During CONSTRUCTION, at what stage of the process should the BxP be available to participating team member firms?

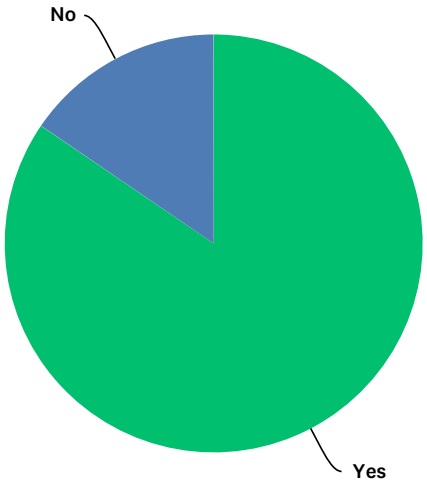
Answered: 480 Skipped: 85



ANSWER CHOICES	RESPONSES	
At pre-BID meeting before BIM starts	70.42%	338
During BID phase	17.71%	85
At notice to proceed	5.00%	24
After all trades have been selected/contracted	4.17%	20
Other (please specify)	2.71%	13
TOTAL		480

Q15 Do you view your BxP as a Quality Procedure document for the modeling process as part of an overall Quality Assurance/Quality Control (QA/QC) plan?

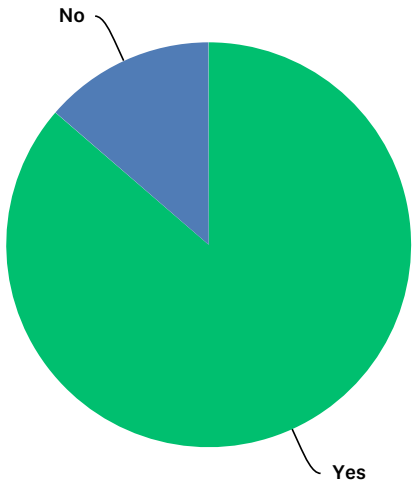
Answered: 478 Skipped: 87



ANSWER CHOICES	RESPONSES	
Yes	84.52%	404
No	15.48%	74
TOTAL		478

Q16 Does using a well written and implemented BxP reduce financial risk for YOUR FIRM?

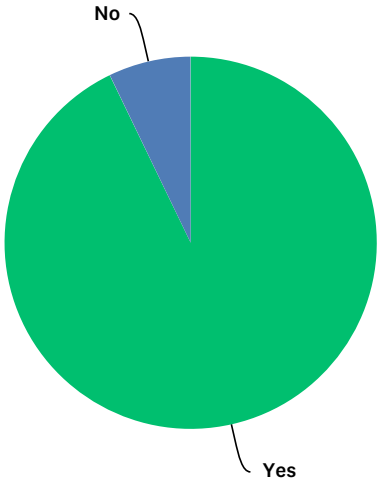
Answered: 476 Skipped: 89



ANSWER CHOICES	RESPONSES	
Yes	86.34%	411
No	13.66%	65
TOTAL		476

Q17 Does using a well written and implemented BxP reduce financial risk for the PROJECT OVERALL?

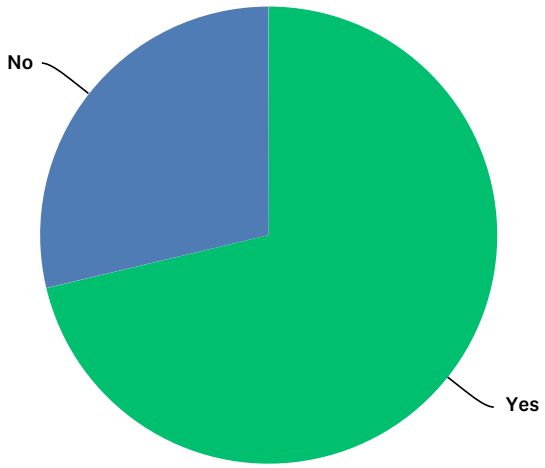
Answered: 475 Skipped: 90



ANSWER CHOICES	RESPONSES	
Yes	92.84%	441
No	7.16%	34
TOTAL		475

Q18 Does using a well written and implemented BxP during construction by the General Contractor / Construction Manager (GC/CM) improve physical construction safety as part of creating a well planned and organized job sites and lay-down areas?

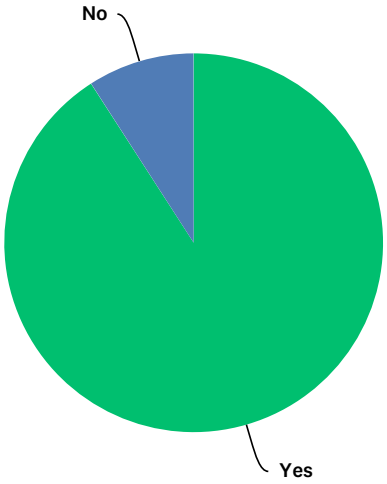
Answered: 470 Skipped: 95



ANSWER CHOICES	RESPONSES	
Yes	71.28%	335
No	28.72%	135
TOTAL		470

Q19 Does using a well written and implemented BxP during construction by the GC/CM improve the project quality of in place trade work?

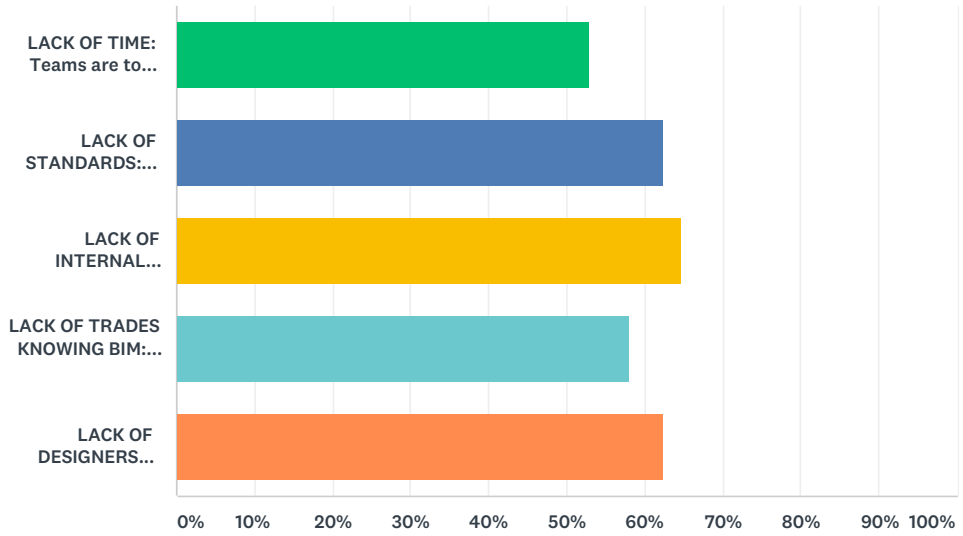
Answered: 472 Skipped: 93



ANSWER CHOICES	RESPONSES	
Yes	90.89%	429
No	9.11%	43
TOTAL		472

Q20 Why are teams not using more BIM and BxP(s) on small to mid-sized projects in the US? (Check all that apply)

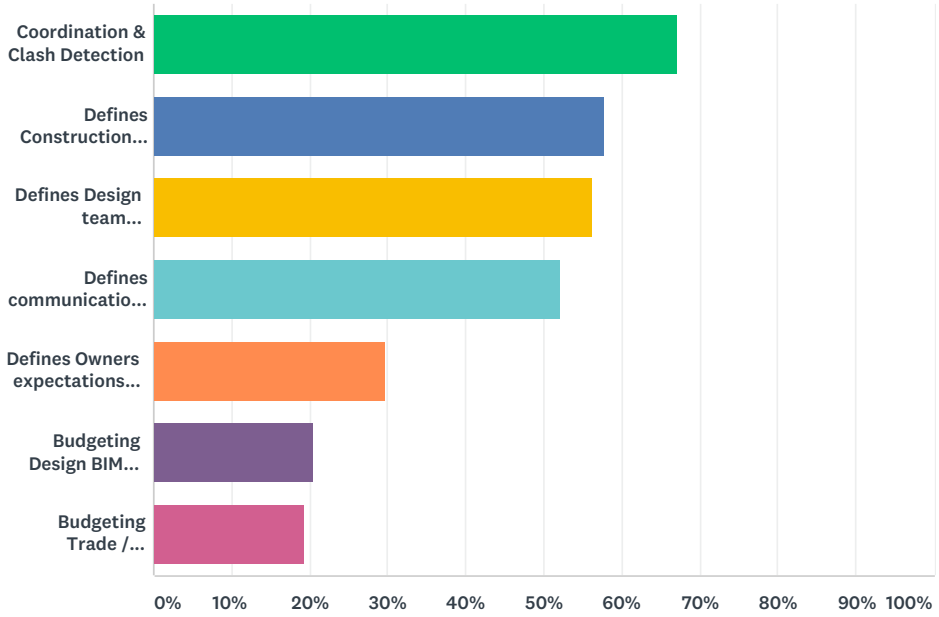
Answered: 463 Skipped: 102



ANSWER CHOICES	RESPONSES	
LACK OF TIME: Teams are too busy to implement BxPs on a given project.	52.92%	245
LACK OF STANDARDS: Firms do not have a standard for BxPs	62.42%	289
LACK OF INTERNAL KNOWLEDGE: Not enough training in how to use BIM for collaboration (ie, individuals use BIM internally but do not know how to collaborate in BIM).	64.58%	299
LACK OF TRADES KNOWING BIM: Too many team members are not in BIM at all.	57.88%	268
LACK OF DESIGNERS KNOWING BIM FOR COORDINATION: Too many designer models do not show realistic construction or geometry	62.42%	289
Total Respondents: 463		

Q21 What are the most important benefits you see from a well written BxP on current projects (Check your top 3 selections)?

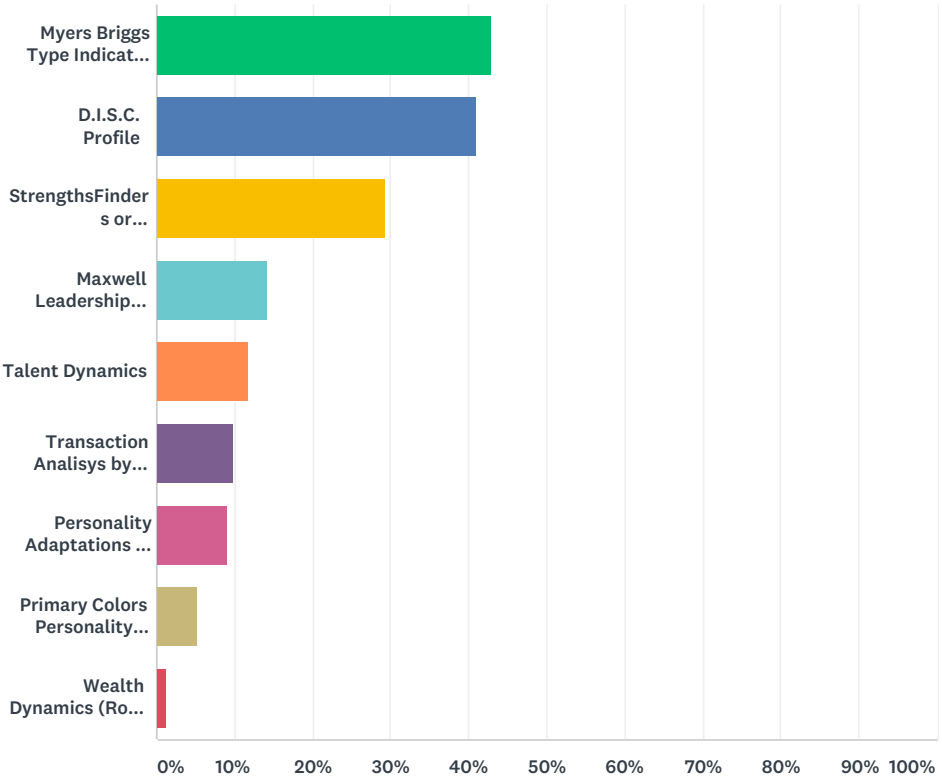
Answered: 487 Skipped: 78



ANSWER CHOICES	RESPONSES	
Coordination & Clash Detection	67.15%	327
Defines Construction team expectations, scope & process with BIM	57.70%	281
Defines Design team expectations, scope & process with BIM	56.26%	274
Defines communication plan for the BIM team.	52.16%	254
Defines Owners expectations with BIM for FM	29.77%	145
Budgeting Design BIM effort	20.53%	100
Budgeting Trade / Fabrication BIM effort	19.30%	94
Total Respondents: 487		

Q22 When assembling teams for BIM collaboration, have used any of the following personality assessments / organization development tools to improve team communication? (Select all that apply):

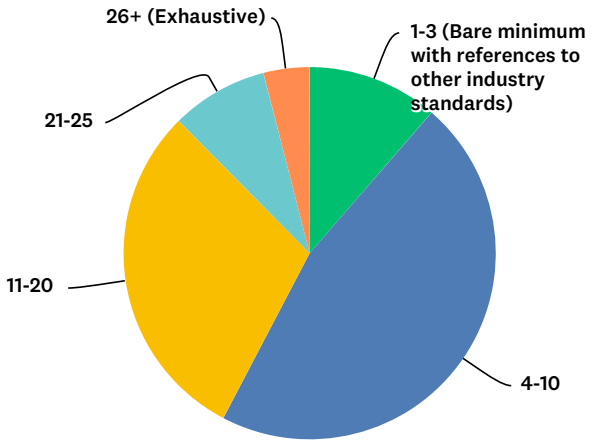
Answered: 154 Skipped: 411



ANSWER CHOICES	RESPONSES	
Myers Briggs Type Indicator (MBTI)	42.86%	66
D.I.S.C. Profile	40.91%	63
StrengthsFinders or StrengthsFinders 2.0	29.22%	45
Maxwell Leadership Assessment	14.29%	22
Talent Dynamics	11.69%	18
Transaction Analisys by Eric Berne	9.74%	15
Personality Adaptations by Jan Joines	9.09%	14
Primary Colors Personality Test (Dawn Billings Test)	5.19%	8
Wealth Dynamics (Roger Hamilton Test)	1.30%	2
Total Respondents: 154		

Q23 What is an appropriate length for a BxP (page count) on a small to mid sized building?

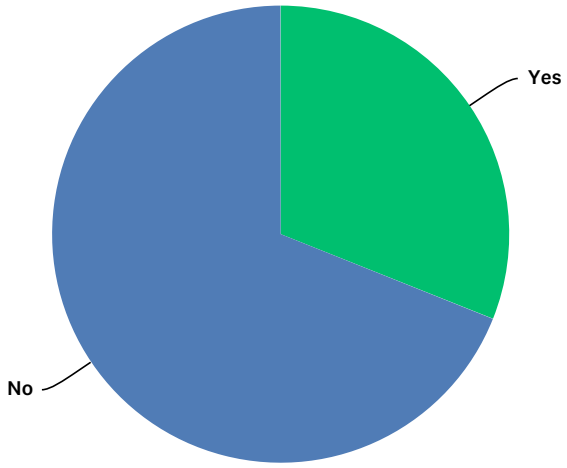
Answered: 475 Skipped: 90



ANSWER CHOICES	RESPONSES	
1-3 (Bare minimum with references to other industry standards)	11.37%	54
4-10	46.32%	220
11-20	29.89%	142
21-25	8.42%	40
26+ (Exhaustive)	4.00%	19
TOTAL		475

Q24 The AGC's Certificate of Management in BIM (CM-BIM) Training requires 32 hours of 'in-seat' time over 4 classes that may be offered at different times & cities throughout the country. AGC strongly recommends these classed be taken in order before the 4 hour in-person exam. Is it reasonable in a BxP make the AGC CM-BIM a mandatory requirement for all trade companies BIM Manager for projects under $100M in construction?

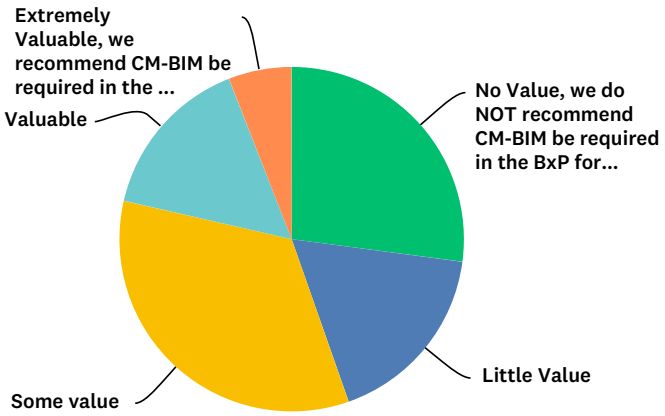
Answered: 438 Skipped: 127



ANSWER CHOICES	RESPONSES	
Yes	31.05%	136
No	68.95%	302
TOTAL		438

Q25 The AGC's Certificate of Management in BIM (CM-BIM) classes are reported to cost $1200-$1600 and the CM-BIM exam cost $575 for at total of up to $2175 and a week of time of from work. How VALUABLE would it be to make this certification a mandatory requirement for team members in the BxP on projects under $100M in construction.

Answered: 439 Skipped: 126



ANSWER CHOICES	RESPONSES	
No Value, we do NOT recommend CM-BIM be required in the BxP for trade PMs	27.11%	119
Little Value	17.54%	77
Some value	33.94%	149
Valuable	15.49%	68
Extremely Valuable, we recommend CM-BIM be required in the BxP for all trade PMs	5.92%	26
TOTAL		439

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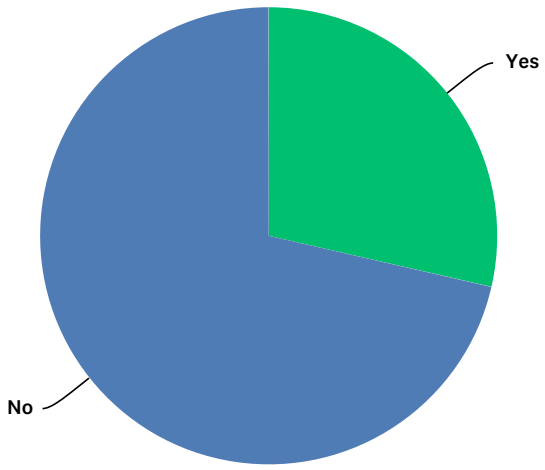
Q27 The Certificate of Development in BIM (CD-BIM.com) lead by NISD has a Certification which includes 4 hours of online/on-demand training and with a exam that takes less than 1 hr. The total cost is less than $400 for this online certification for basic BIM fundamental construction grade coordination. Are you familiar with this program?

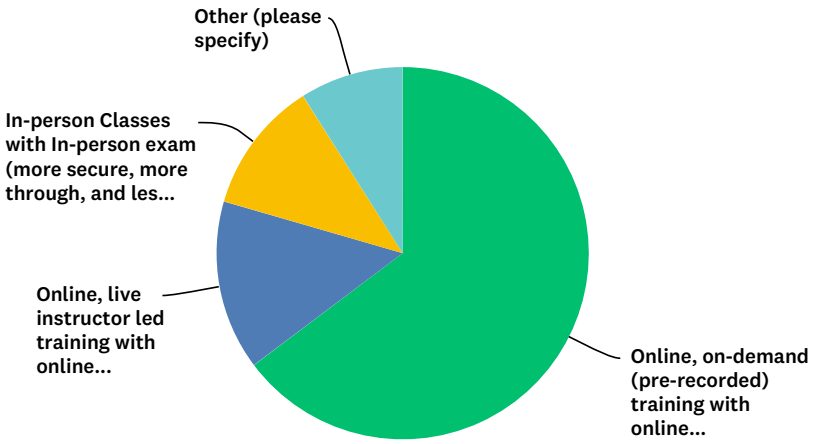
Answered: 437 Skipped: 128



ANSWER CHOICES	RESPONSES	
Yes	28.60%	125
No	71.40%	312
TOTAL		437

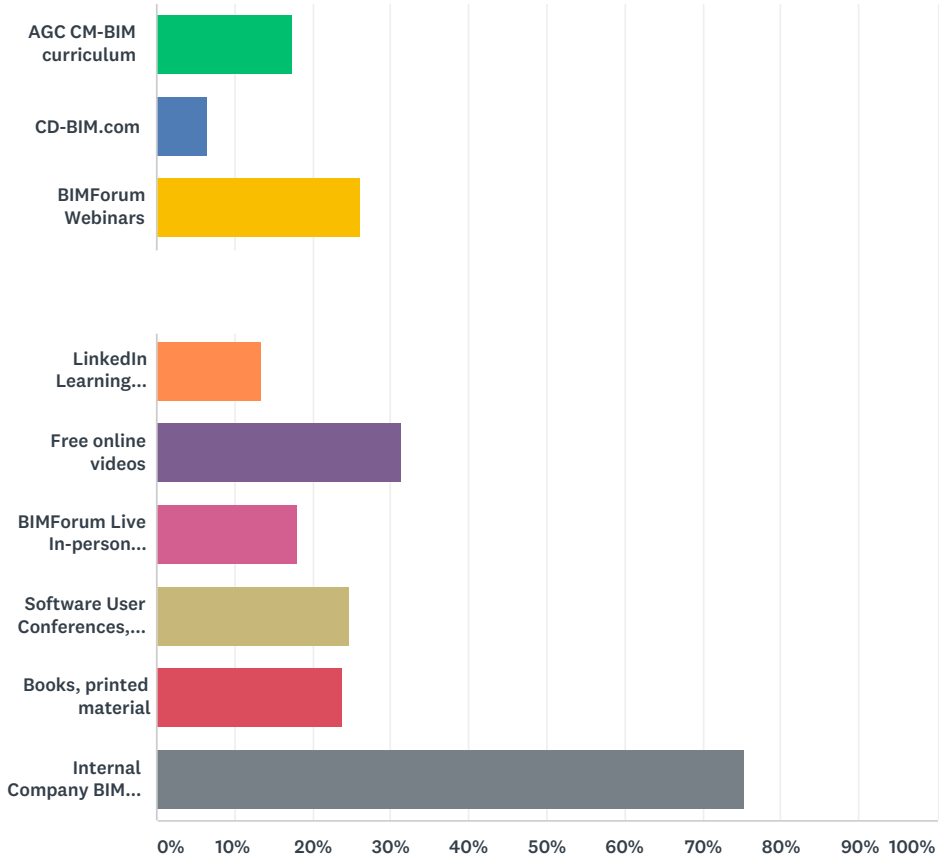
Q28 BIM training/certification that is a mandatory requirement for project team members in a BxP for a project less than $100M should be:

Answered: 434 Skipped: 131



ANSWER CHOICES	RESPONSES	
Online, on-demand (pre-recorded) training with online certification exam (easy, economical, fast verification of fundamentals)	64.75%	281
Online, live instructor led training with online certification exam (interactive training less easy to schedule)	14.75%	64
In-person Classes with In-person exam (more secure, more through, and less ecconomical process)	11.52%	50
Other (please specify)	8.99%	39
TOTAL		434

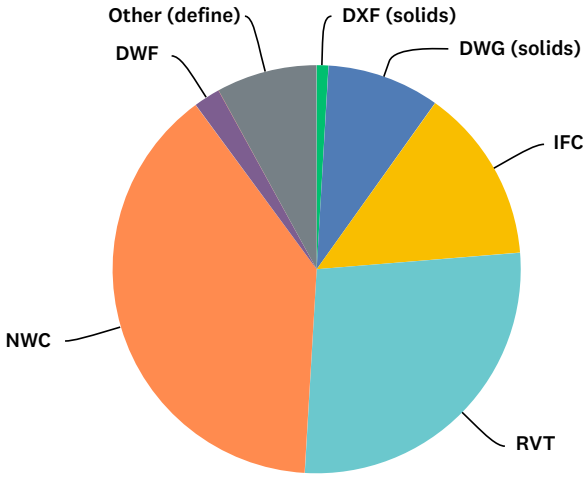
Q29 How do you train the teams on small to mid-sized projects in BxP fundamentals? (Check all that apply) :



ANSWER CHOICES	RESPONSES
AGC CM-BIM curriculum	17.28%
CD-BIM.com	6.54%
BIMForum Webinars	26.18%
LinkedIn Learning (formally Lynda.com)	13.35%
Free online videos	31.41%
BIMForum Live In-person Conferences	18.06%
Software User Conferences, Live In-person	24.61%
Books, printed material	23.82%
Internal Company BIM Curriculum	75.39%

Q30 What is your preferred base file type for BIM coordination\clash detection on a small to mid sized buildings ?

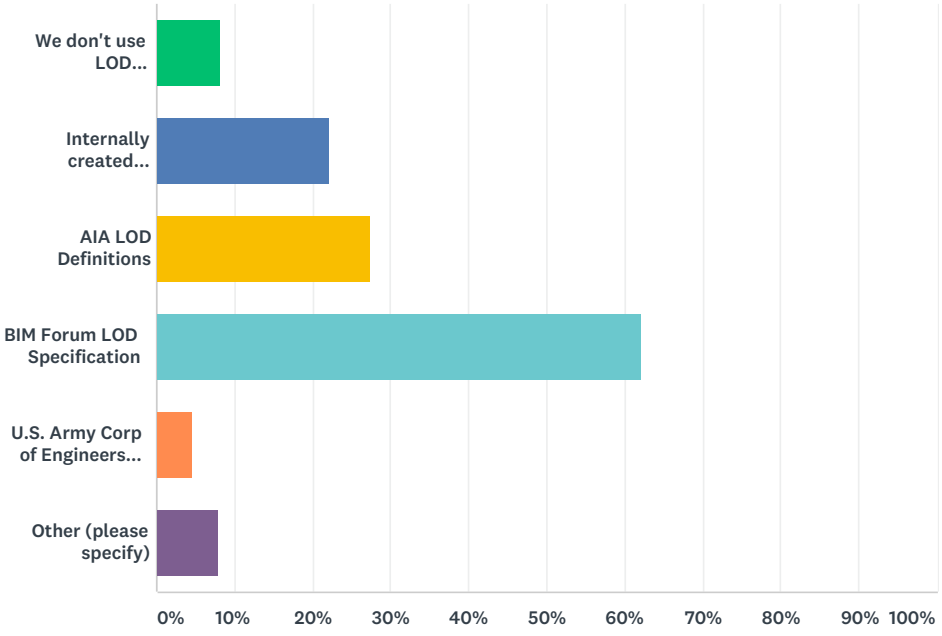
Answered: 426 Skipped: 139



ANSWER CHOICES	RESPONSES	
DXF (solids)	0.94%	4
DWG (solids)	8.92%	38
IFC	13.85%	59
RVT	27.23%	116
NWC	38.97%	166
DWF	2.11%	9
CIS/2	0.00%	0
SDNF	0.00%	0
VRML	0.00%	0
Other (define)	7.98%	34
TOTAL		426

Q31 What Model Element Level Of Development definition does your organization use in BxPs? (Check all that apply)

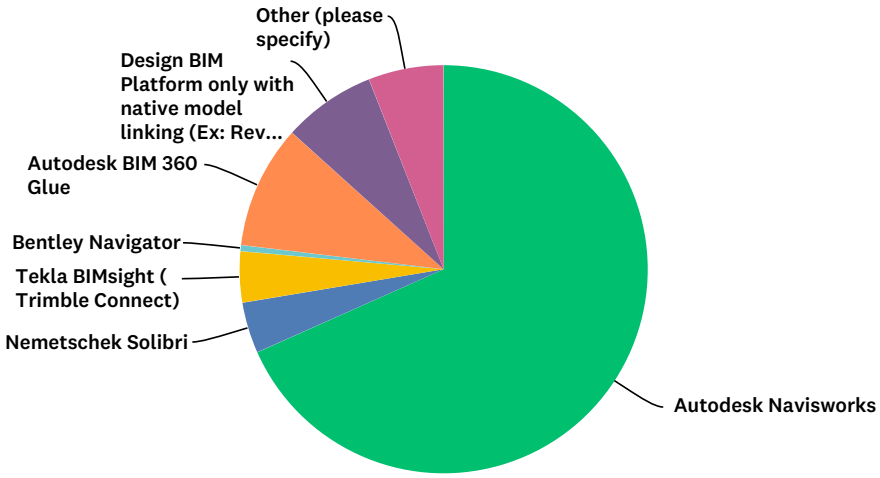
Answered: 420 Skipped: 145



ANSWER CHOICES	RESPONSES	
We don't use LOD Specifications in our BIM process	8.10%	34
Internally created standards	22.14%	93
AIA LOD Definitions	27.38%	115
BIM Forum LOD Specification	62.14%	261
U.S. Army Corp of Engineers Specification	4.52%	19
Other (please specify)	7.86%	33
Total Respondents: 420		

Q32 What is your preferred federation software for 3D coordination on a small to mid sized building?

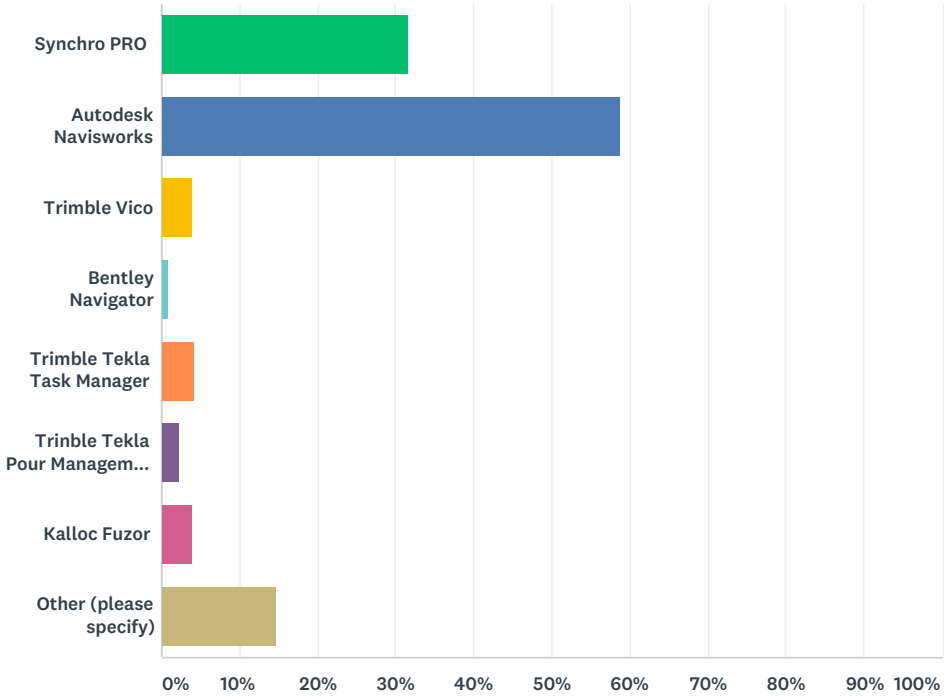
Answered: 420 Skipped: 145



ANSWER CHOICES	RESPONSES	
Autodesk Navisworks	68.33%	287
Nemetschek Solibri	4.05%	17
Tekla BIMsight (Trimble Connect)	4.05%	17
Bentley Navigator	0.48%	2
Autodesk BIM 360 Glue	9.76%	41
Design BIM Platform only with native model linking (Ex: Revit or Other)	7.38%	31
Other (please specify)	5.95%	25
TOTAL		420

Q33 What is/are your preferred platform for 4D modeling and BIM based Scheduling on small to mid-sized buildings? (Check all that apply)

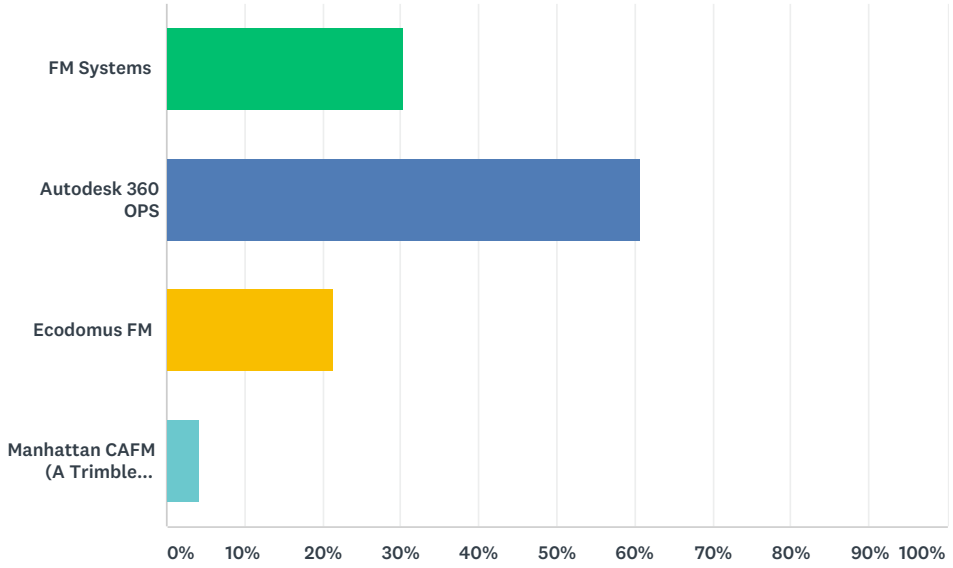
Answered: 360 Skipped: 205



ANSWER CHOICES	RESPONSES	
Synchro PRO	31.67%	114
Autodesk Navisworks	58.89%	212
Trimble Vico	3.89%	14
Bentley Navigator	0.83%	3
Trimble Tekla Task Manager	4.17%	15
Trinble Tekla Pour Management	2.22%	8
Kalloc Fuzor	3.89%	14
Other (please specify)	14.72%	53
Total Respondents: 360		

Q34 What is/are your preferred platform for Facility Management with BIM on small to mid-sized buildings? (Check all that apply)

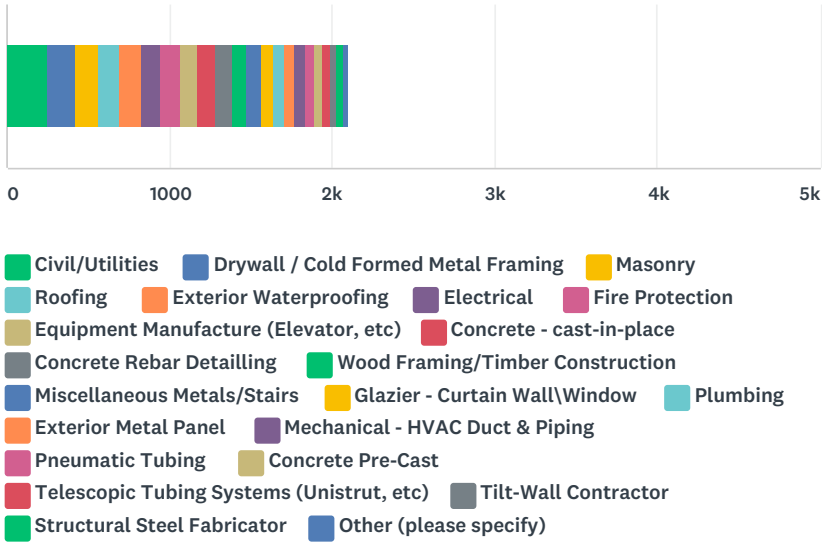
Answered: 145 Skipped: 420



ANSWER CHOICES	RESPONSES	
FM Systems	30.34%	44
Autodesk 360 OPS	60.69%	88
Ecodomus FM	21.38%	31
Manhattan CAFM (A Trimble Company)	4.14%	6
Total Respondents: 145		

Q35 Which TRADES who are NEEDED IN COORDINATION are the LEAST BIM ENABLED ? Select the 5 most non-BIM enabled trades (i.e. worst trades in BIM):

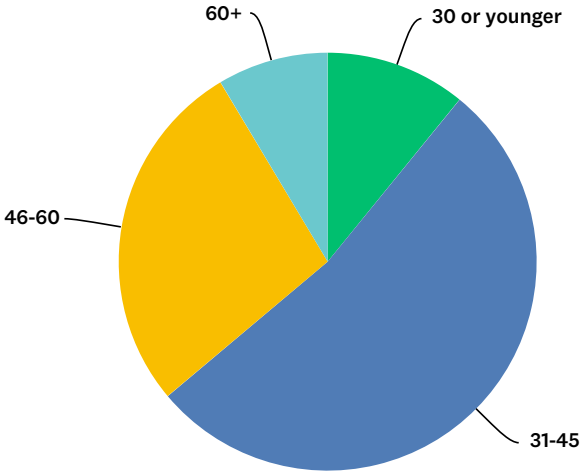
Answered: 440 Skipped: 125



ANSWER CHOICES	RESPONSES	
Civil/Utilities	56.82%	250
Drywall / Cold Formed Metal Framing	37.95%	167
Masonry	32.95%	145
Roofing	30.00%	132
Exterior Waterproofing	28.41%	125
Electrical	27.73%	122
Fire Protection	27.27%	120
Equipment Manufacture (Elevator, etc)	25.45%	112
Concrete - cast-in-place	25.00%	110
Concrete Rebar Detailling	23.41%	103
Wood Framing/Timber Construction	20.45%	90
Miscellaneous Metals/Stairs	20.23%	89
Glazier - Curtain Wall\Window	16.36%	72
Plumbing	15.91%	70
Exterior Metal Panel	14.77%	65
Mechanical - HVAC Duct & Piping	13.86%	61
Pneumatic Tubing	12.27%	54
Concrete Pre-Cast	11.82%	52
Telescopic Tubing Systems (Unistrut, etc)	11.14%	49
Tilt-Wall Contractor	9.32%	41
Structural Steel Fabricator	8.18%	36
Other (please specify)	7.73%	34
Total Respondents: 440		

Q36 What is your age?

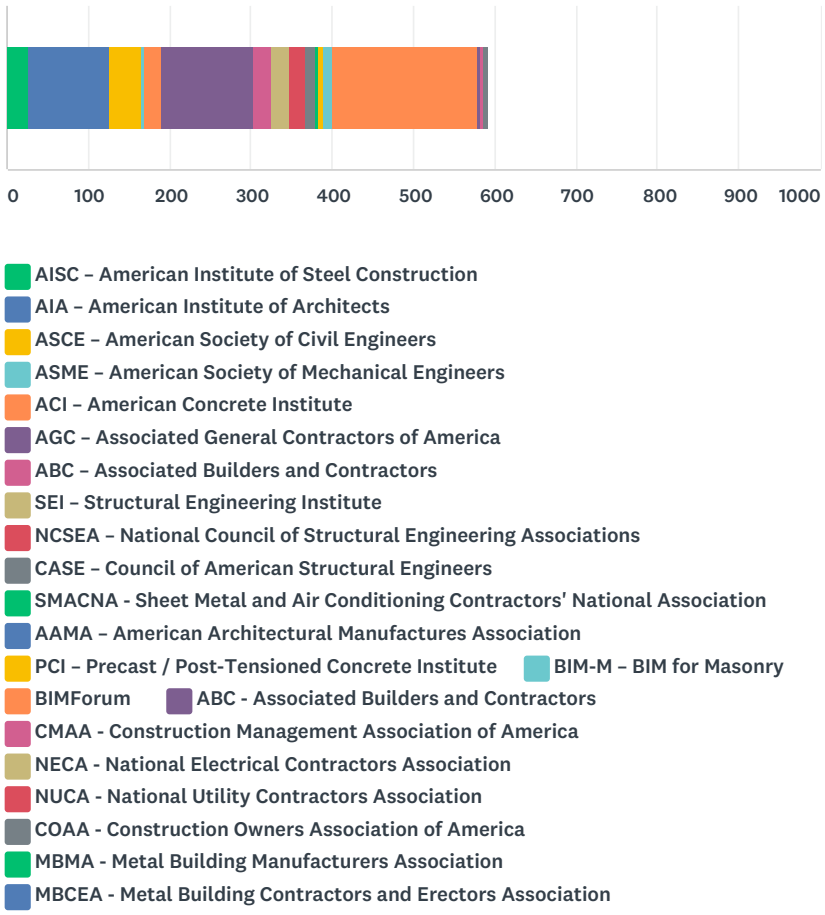
Answered: 432 Skipped: 133



ANSWER CHOICES	RESPONSES	
30 or younger	10.88%	47
31-45	53.01%	229
46-60	27.55%	119
60+	8.56%	37
TOTAL		432

Q37 What professional organizations are you a member of (check all that apply):

Answered: 300 Skipped: 265



ANSWER CHOICES	RESPONSES	
AISC – American Institute of Steel Construction	9.00%	27
AIA – American Institute of Architects	33.33%	100
ASCE – American Society of Civil Engineers	12.67%	38
ASME – American Society of Mechanical Engineers	1.00%	3
ACI – American Concrete Institute	7.67%	23
AGC – Associated General Contractors of America	37.33%	112
ABC – Associated Builders and Contractors	7.67%	23
SEI – Structural Engineering Institute	7.33%	22
NCSEA – National Council of Structural Engineering Associations	6.67%	20
CASE – Council of American Structural Engineers	4.00%	12

SMACNA - Sheet Metal and Air Conditioning Contractors' National Association	1.00%	3
AAMA – American Architectural Manufactures Association	0.00%	0
PCI – Precast / Post-Tensioned Concrete Institute	2.33%	7
BIM-M – BIM for Masonry	3.33%	10
BIMForum	59.67%	179
ABC - Associated Builders and Contractors	1.33%	4
CMAA - Construction Management Association of America	1.33%	4
NECA - National Electrical Contractors Association	0.00%	0
NUCA - National Utility Contractors Association	0.00%	0
COAA - Construction Owners Association of America	1.67%	5
MBMA - Metal Building Manufacturers Association	0.00%	0
MBCEA - Metal Building Contractors and Erectors Association	0.33%	1
Total Respondents: 300		

Appendix C: Sample BxP Content for Small Construction Coordination Project

The following example is provided with permission from the Certificate of Development in BIM (CD-BIM.org/BxP) curriculum as an example for educational purposes only. The BIMForum Taskforce is not recommending that this educational example be used on actual projects. It is intended to be provided as an example to illustrate the form and function of BxP content that might be seen on a small project such as a four-story Medical Office Building (MOB) with BIM uses of construction coordination.

The example shown is based on the CD-BIM.com LOD Sample Model for a medical office building. This sample has been developed in collaboration with the BIMForum's LOD Taskforce and illustrates a four-story medical office building at different design stages. Visit **CD-BIM.com/LOD** to learn more about the sample building this BxP content is based on.

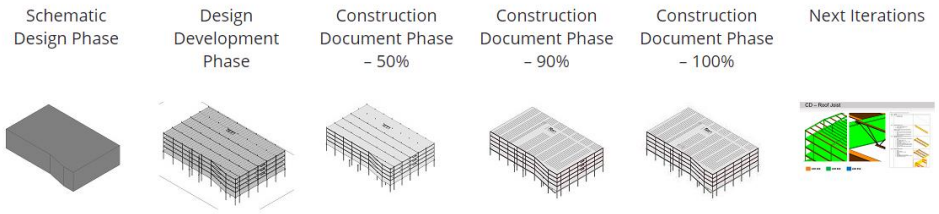


Figure 14: Stages of The Sample LOD Model that is part of the CD-BIM.com curriculum. This model was developed in collaboration with the BIMForum LOD Taskforce, NISD and SEI. The model may be freely download at CD-BIM.com/LOD. Image courtesy Ascend Building Knowledge Foundation (AscendBKF.org, CD-BIM.com), 2019. https://creativecommons.org/licenses/by-nc/4.0/

Note to the Readers:

This is a sample BIM Project Execution Plan (BxP) developed as part of Ascend Building Knowledge Foundation's Certificate of Development in BIM educational program. The curriculum began in collaboration with the National Institute of Steel Detailing (NISD). This document is for educational purposes to represent common industry trends in BxP provisions gathered from hundreds of different projects led from the very top design and construction teams from across the country. At the time of publishing, it also includes the latest developments from some of the leading international BIM organizations such as BIMForum, BIMForum Level Of Acceptance (LOA), Building Information Modeling for Masonry Initiative (BIM-M), The Steel Joist Institute (SJI) and many others. The sample BxP has also undergone peer review from some of the leading practitioners in the area of BIM. There are multiple parts to the CD-BIM BxP Sample. This one is 300 which is focused on construction. The other BxP parts are the 100 series for Owners and the 200 series for Designers.

To learn more about the organizations referenced in this document, please visit their websites:

1) ***BIMForum, BIMForum.org***
2) ***BIMForum Reality Capturer Level Of Acceptance (LOA), BIMForum.org/Reality***
3) ***National Institute of Steel Detailing (NISD), NISD.org***
4) ***Building Information Modeling for Masonry Initiative (BIM-M), bimformasonry.org***
5) ***Steel Joist Institute, SJI.org***

This document is for educational purposes only as part of the CD-BIM training curriculum and certification program. The intended audience is potential CM-BIM candidates who are existing modelers in BIM or students considering a career in creating and developing BIM in the building industry. This document is free to distribute. Any portions of it that are copied should cite the source.

Setting:

The participant of the CD-BIM program shall read and study this document with the following assumptions. Imagine these circumstances as you read this document:


CD-BIM National Institute of Steel Detailing
Certificate of Development
in Building Information Modeling
CD-BIM Part 2 : Structural Steel
John Doe Detailer
Has met the requirements of the CD-BIM program for part 2 Discipline Specific Structural Steel.
Dec. 1, 2015 | Rxxxxxx

1. Your job entails modeling in BIM for design, construction or facility management.
2. The company you model for could be an architecture, engineering, discipline-specific focused company or independent modeling and detailing firm.
3. This BxP is issued by a project stakeholder who will lead BIM coordination on a project the firm is proposing on. You have been told that you need to estimate the BIM requirements as part of preparing a budget for your time.
4. The project requires that all modelers involved have a current CD-BIM certificate.

Sample Specification XX-XX-XX: BIM Project Execution Plan

1. SECTION 1 – GENERAL COMPANY BIM REQUIREMNTS

1.0. SUMMARY

The Project Team intends to improve the design, construction and facility management processes, create efficiencies in the product delivery, and enhance the quality of the construction project through Virtual Design and Construction (VDC) techniques. VDC utilizes 3D models to construct the project in a virtual environment. This allows designers and construction trades the opportunity to identify and resolve potential conflicts at early stages. VDC utilizes the principles of Integrated Project Delivery (IPD) to create a line of communication and coordination between members of the construction team in order to make the construction process more coordinated and predictable. This can reduce the risk and provide a profitable and positive experience for all project participants.

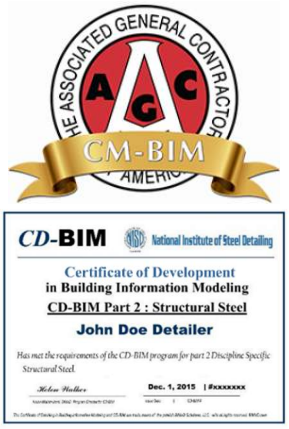
1.1. GOALS

1. One of the goals of this process is to perform clash detection between the construction disciplines and to verify constructability from design to construction. For the purpose of field installation, the trade partners shall consider the final coordinated models as a contract for space. It is their responsibility to notify the general contractor and the potentially impacted trade if they wish to make any changes to the models they have agreed upon. The subcontractors reserve space by modeling or directing a third party modeler with the components included in their scope of work, including access space, etc. If a conflict arises in the field during installation, the subcontractor who did not reserve space for their components is responsible for moving their components for the subcontractor who did reserve space at no additional cost. It is discouraged for any contractor to install components that have not already been submitted and approved through the coordination process.

2. The frequent sharing of models during development allows subcontractors to familiarize themselves with the constraints of the project early and clearly communicate concerns before other disciplines in the coordination effort finalize their work. This also allows each discipline to use other disciplines' models as 3D backgrounds during their modeling process. This practice should promote proactive modeling leading to clash avoidance. The Spatial Coordination Process serves as a supplement to the existing coordination process. Subcontractors are ultimately responsible for coordination with other disciplines. Therefore, all disciplines need to be proactive in uploading revised and up-to-date files so that others can utilize models and/or backgrounds of other team members when planning and modeling their respective scope of work.

1.2 BIM MANAGER & MODELER REQUIREMENTS

The following will be required by each project stakeholder's manager or designated modeler. The requirements are:



1. Show the minimum qualifications for BIM. The main BIM manager for the project shall complete the 4 day AGC Certificate of Management in BIM (CM-BIM) curriculum and pass the AGC CM-BIM credential. All modelers on the project shall complete the Certificate of Development in BIM (CD-BIM) Part 1 General Curriculum. This is a half day of online content and a 1-hr exam for a nominal fee.

2. **Attend a BIM kickoff meeting for the project.** The location and time will be determined by the Project Team. The training may include the basics of how to use the free BIM Federation Model review and digital plan review tools.

3. **Have a laptop computer that meets the minimum system requirements for the applications shown at the kickoff meeting.** It is the modeler's responsibility to validate the tools that the lead BIM Coordinators will use prior to working on the project.

4. **Remain on the project for the duration of the coordination effort through field implementation with the role of communicating layouts defined in the model to the field personnel who are installing their content.** If a discipline changes its project manager who passed through initial training (item 1 above) they must notify the lead BIM manager for the project and the Project Team in writing with at least two weeks' notice prior to changing that discipline's project manager. At the Project Team's discretion, the discipline's replacement project manager may be required to attend a half-day orientation meeting at the Project Team's office, at a cost to be stated by the main BIM Manager at bid time to be back-charged to that discipline's contract.

5. **Upload information and signoff on models punctually per the instruction in this BIM execution plan**. If a discipline's project manager is delayed in uploading information for model creation, that discipline will be back-charged for late model information uploads at a rate to be set by the main BIM Manager at bid time. Uploaded model information may include but is not limited to 2D sketches of proposed installation paths, routing of a discipline's systems, or any requested PDF's of submittal data.

6. **The subcontractors shall use the free model viewers and tools shown in the training (item 1 above). They are responsible for directing the modeling of and signing off on the 3D models for spatial validation as the basis of their installation and development of their 2D shop drawings.** The models on this project do not replace the formal 2D shop drawing process required by the construction documents as the official submittal process.

7. The trades shall submit their sub-BIM Execution Plan (sub-BxP) that outlines their specific scope of work, schedule, budget and model element LOD.

2.4 FILE SHARING REQUIREMENTS

1. The main BIM manager shall establish an FTP site for the project with their 3D BIM consultant.

2. Instructions on where to upload files will be distributed to the team at the kick-off meeting.

3. Questions regarding the file sharing site should be directed to the Project Team's BIM manager.

4. The subcontractor's information for modeling (2D PDF, CAD, etc.) must be uploaded no later than two (2) business days prior to a scheduled meeting unless noted otherwise by the Project Team. This will allow time to coordinate the files, information, models and perform clash detection. A pre-meeting report will be uploaded 24 hours prior to a meeting for all team members to review and have potential clash solutions ready to expedite the meetings. **Files will NOT be accepted that do not follow the file naming convention or are not oriented per the instructions outlined in this plan.**

2.5 BIM FILE REQUIREMENTS

1. The required submittal format for files are outlined in the software table shown in Exhibit Table 6 with components of the trade partners scope represented as 3D solids (not polymesh).

2. Model files are to be free of unnecessary data, including any x-refs (except for grid lines), text or marks that are not used in the Spatial Coordination Process.

3. The layer names of the submitted model files shall be intuitive for construction practitioners, with clearance/access zones on separate layers for distinguishing from solid model objects.

4. The models for each subcontracting discipline will be developed in zones that are defined by each level of the building. Each model for a given level will contain objects above that level's finish floor elevation and below the next level's finish floor elevation. There shall be no overlap or gap between the components represented in different model files with the exception of riser drawings, should a discipline choose to model their respective risers through the building in one model file.

1.5 FILE NAMING CONVENTION

1. Names of submitted model files shall follow the schema outlined below:

PROJ	4 letter acronyms for the job name:
ARCH	4 letter acronym for the discipline: ARCH: Architecture STRL: Structural MECH: Mechanical Only ELEC: Electrical Only ELTS: Light Fixtures EPWR: Electrical Power PLUM: Plumbing Only GPIP: Gravity Piping PPIP: Pressure Piping TELE: Telephone / Data (Cable Tray) FIRE: Fire Protection MASN: Masonry PNEU: Pneumatic Tubing MTPN: Metal Panels CFMF: Cold Form Metal Framing & Sheathing WTPR: Waterproofing STLM: Structural Steel DWAC: Drywall / Acoustical MFCL: Metal Framing Channel MDEQ: Medical Equipment KTEQ: Kitchen Equipment FEDM: Federated Model - Composite of 2+ BIMs
ACMEC	5 letter acronym for the firm. (ACME Company)
P0A	Phase of the model
L01	Zone of the model
030	The model is approximately 30% complete for that level
YYYY-MM-DD	Date of export & upload of that zone of the model.

2. If a coordination team member needs to use a different system for breaking down and submitting model files, and thus needs to alter the aforementioned file naming convention, the method of breakdown and file naming needs to be submitted and approved by the Coordination Manager. File names and model breakdowns need to be adhered to, once submitted, for the duration of the project with no exception. The functionality of federation model software depends on consistent file names. Files not adhering to these requirements will be returned to the sender for correction.

SECTION 2 – Project Specific

The following sections of the BxP are specific to The Project.

2.0 Project Information (Reference Exhibit Table 0)

This table provides key project information and milestone dates. It is normally updated at the BIM kick-off meeting. This is attached at the end of this specification as Exhibit Table 0.

1. Project Name:	[redacted]
2. Project Address:	[redacted]
3. Contract Type/Delivery Method:	[redacted]
4. Brief Project Description:	[redacted]
5. General Contractor Project Number:	[redacted]
6. BxP Author:	[redacted]

Project Phase / Milestone	Estimated Start Date	Estimated Completion Date	Stakeholders Involved
Notice to Proceed	[redacted]	[redacted]	All BIM Stakeholders
A/E GIM Kickoff Meeting	[redacted]	[redacted]	GC, A/E
100% CDs Complete (Building)	[redacted]	[redacted]	GC, A/E
Permit Issued	[redacted]	[redacted]	GC, A/E
Construction BIM Kickoff Meeting	[redacted]	[redacted]	Electrical, Underground Utilities
Construction BIM Coordination Start	[redacted]	[redacted]	Electrical, Underground Utilities
Construction BIM Kickoff Meeting	[redacted]	[redacted]	Above ground trades
Construction BIM Coordination Start	[redacted]	[redacted]	Above ground trades
Construction BIM Coordination Complete	[redacted]	[redacted]	All Coordination Team Members
GC Site Mobilization	[redacted]	[redacted]	All BIM Stakeholders
GC Construction Complete	[redacted]	[redacted]	All

2.1 Project Contacts (Reference Exhibit Table 1)

This sheet will be updated at each team meeting for attendance and included in meeting minutes. This is attached at the end of this specification as Exhibit Table 1.

							Job Name		dd/mm/yyyy	dd/mm/yyyy	dd/mm/yyyy	
First Name	Last Name	Company	Disapline	Title	Stakeholder	Coord. Attendance Required (1-required /0-not-required	Email Address	Phone	Kick-off	Name	Name	Name
[redacted]									x			
[redacted]									x			
[redacted]												
[redacted]									x			
[redacted]									x			
[redacted]									x	x		
[redacted]									x			
[redacted]									x			
[redacted]									x			
[redacted]												
[redacted]												
[redacted]												

2.2 Model Delivery Schedule, Reference Exhibit Table 2D, 2C & 2L

The project review process will follow the Model Delivery Schedule. The models will be reviewed by zone as defined in the zone and level sections of this BIM PEP guide.

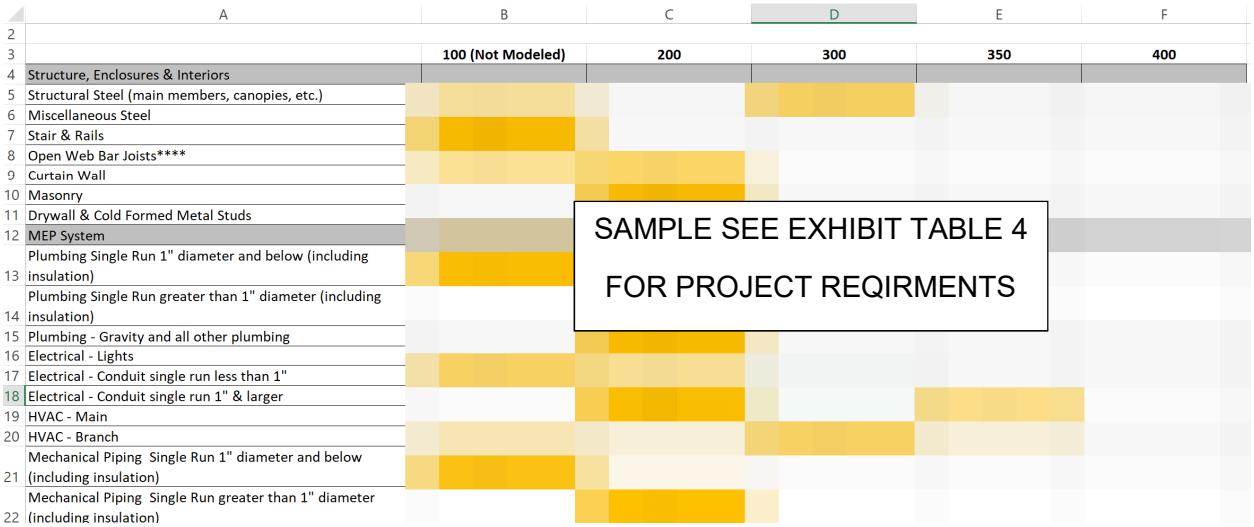
Reference Exhibit Table 2 for the Project's Model Delivery Schedule

BIM Model Delivery Schedule

Area	Level	Due Date	Due Date	Due Date	Due Date	Due Date	Due Date	Due Date	Due Date	Due Date	Due Da
Kick		First Clash	First Clash	First Clash							
LO A		First Clash	Coord.	Fully Coord.							
L0 B		First Clash	Coord.	Coord.	Fully Coord.						
L1 A				Coord.	Coord.	Fully Coord.					
L1 B		First Clash	Fully Coord.	Fully Coord.	Fully Coord.						
L2 A					First Clash	Fully Coord.	Fully Coord.	Fully Coord.			
L2 B						First Clash	Coord.	Coord.	First Clash		
L3 A							First Clash	Fully Coord.			
								First		Fully	

2.3 LEVEL OF DEVELOPMENT (LOD), Reference Exhibit Table 4 LOD

All reference to LOD shall be per the **BIMForum Level Of Development Specification 2019**. The LOD requirement for this project shall be document in the BIM PEP LOD table Exhibit 4. The following image is a sample LOD table. Key building elements are show in the left side column with their corresponding required LOD requirement identified. **SEE EXHIBIT TABLE 4 FOR PROJECT REQUIREMENTS**



	A	B	C	D	E	F
2						
3		100 (Not Modeled)	200	300	350	400
4	Structure, Enclosures & Interiors					
5	Structural Steel (main members, canopies, etc.)					
6	Miscellaneous Steel					
7	Stair & Rails					
8	Open Web Bar Joists****					
9	Curtain Wall					
10	Masonry					
11	Drywall & Cold Formed Metal Studs					
12	MEP System					
13	Plumbing Single Run 1" diameter and below (including insulation)					
14	Plumbing Single Run greater than 1" diameter (including insulation)					
15	Plumbing - Gravity and all other plumbing					
16	Electrical - Lights					
17	Electrical - Conduit single run less than 1"					
18	Electrical - Conduit single run 1" & larger					
19	HVAC - Main					
20	HVAC - Branch					
21	Mechanical Piping Single Run 1" diameter and below (including insulation)					
22	Mechanical Piping Single Run greater than 1" diameter (including insulation)					

SAMPLE SEE EXHIBIT TABLE 4

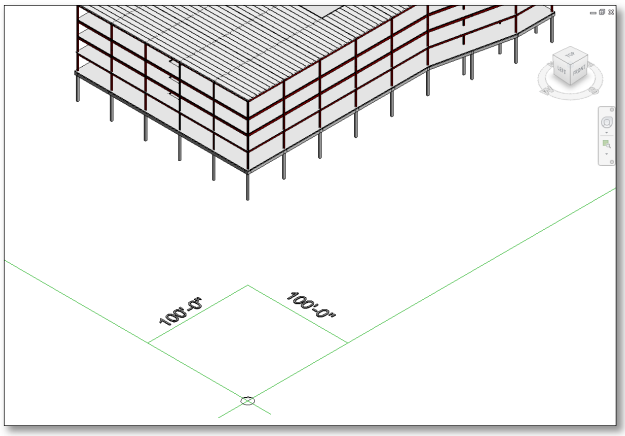
FOR PROJECT REQIRMENTS

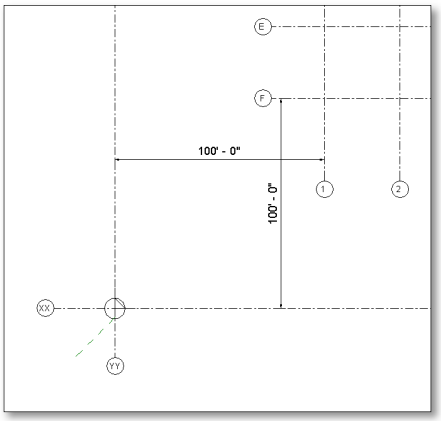
2.4 ORIGIN LOCATION, Reference Exhibit Table 7 Origin XYZ

1. Load the project coordinate location file into your BIM software by inserting it at the origin of your application (Global X, Y, Z COORDINATE = 0,0,0). This file shall be located on the project's file share site.

2. Orient the model to the following information that is in the XYZ Origin file:
   X-Axis = **100'-0" West of Grid 1**
   Y-Axis = **100'-0" South of Grid F**
   Z-Axis = **100'-0" Below FF**

   See below for example:

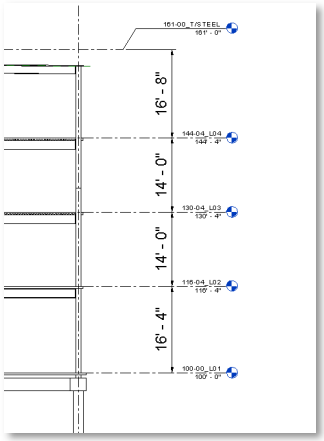




2.5 PROJECT ZONES, Reference Table 7 Origin XYZ

The model should be broken up and submitted by Level. Each Level is defined from finish floor to finish floor as follows:

Zone L00: Below 100'-0"
Zone L01: EL= 100'-0" to 116'-4"
Zone L02: EL= 116'-4" to 130'-4"
Zone L03: EL= 130'-4" to 144'-4"
Zone L04: EL= 144'-4" to 161'-0"



1. Project Name:	CD-BIM LOD Sample MOB
2. Project Address:	1234 Example Street, City, State, 98765
3. Contract Type/Delivery Method:	Design-Bid-Build
4. Brief Project Description:	The scope of work for this project will include, but not be limited to, the construction of the CD-BIM LOD
5. General Contractor Project Number:	Sample Medical Office Building at the Project Address.
6. BxP Author:	Mitchell Manager, BIM Manager
7. Project Number:	2019-xxx-xx

Project Phase / Milestone	Estimated Start Date	Estimated Completion Date	Stakeholders Involved
Notice to Proceed	January 2019	January 2019	All BIM Stakeholders
A/E GIM Kickoff Meeting	May 2019	May 2019	GC, A/E
100% CDs Complete (Building)	June 2019	June 2019	GC, A/E
Permit Issued	May 2019	July 2019	GC, A/E
Construction BIM Kickoff Meeting	July 2019	July 2019	Electrical, Underground Utilities
Construction BIM Coordination Start	September 2019	September 2019	Electrical, Underground Utilities
Construction BIM Kickoff Meeting	October 2019	October 2019	Above ground trades
Construction BIM Coordination Start	October 2019	October 2019	Above ground trades
Construction BIM Coordination Complete	February 2020	February 2020	All Coordination Team Members
GC Site Mobilization	December 2019	March 2020	All BIM Stakeholders
GC Construction Complete	#N/A	July 2021	All

NOTES:
1)

BIM Model Delivery Schedule

Area	Level	Due Date	Due Date	Due Date	Due Date	Due Date	Due Date	Due Date	Due Date
			SD	**DD**	**50% CD**	**75% CD**	**90% CD**	**100% CD - PERMIT/PRICING**	**100% CD - Issued For Construction**
Kick									
LO A									
L0 B									
L1 A									
L1 B									
L2 A									
L2 B									
L3 A									
L3 B									
L4 A									
L4 B									
L5 A									
L5 B									

NOTES:
1) Design side model reviews are typically conducted a few weeks before each of the given Construction Document (CD) submissions.

CD-BIM.com | Certificate of Development in Building Information Modeling

BIM Model Delivery Schedule

Count = 15

Area	Level	Due Date 12/1/2019	Due Date 12/8/2019	Due Date 12/15/2019	Due Date 12/22/2019	Due Date 12/29/2019	Due Date 1/5/2020	Due Date 1/12/2020	Due Date 1/19/2020	Due Date 1/26/2020	Due Date 2/2/2020	Due Date 2/9/2020	Due Date 2/16/2020	Due Date 2/23/2020	3/1/2020	3/8/2020
Kick		First Clash	First Clash	First Clash												
LO A		First Clash	Coord.	Fully Coord.												
L0 B		First Clash	Coord.	Coord.	Fully Coord.											
L1 A				Coord.	Coord.	Fully Coord.										
L1 B		First Clash	Fully Coord.	Fully Coord.	Fully Coord.											
L2 A					First Clash	Fully Coord.	Fully Coord.	Fully Coord.								
L2 B						First Clash	Coord.	Coord.	First Clash							
L3 A							First Clash	Fully Coord.								
L3 B								First Clash	Coord.	Fully Coord.						
L4 A									First Clash	Coord.	Fully Coord.					
L4 B										First Clash	Coord.	Fully Coord.				
L5 A											First Clash	Coord.	Fully Coord.			
L5 B												First Clash	Fully Coord.			

NOTES:
1)

CD-BIM.com | Certificate of Development in Building Information Modeling

BIM Model Delivery Schedule

		Due Date	Due Date	Due Date	Due Date	Due Date	Due Date	Due Date	Due Date	Due Date	Due Date	Due Date	Due Date	Due Date	Due Date
Area	Level	7/29/2020	8/5/2020	8/8/2020	8/11/2020	8/14/2020	8/17/2020	8/20/2020	8/23/2020	8/26/2020	8/29/2020	9/1/2020	9/4/2020	9/7/2020	9/10/2020
Kick		PRE-MOBILIZATION PLANNING PHASE													
LO A				FIELD SCAN ZONE L0 A & B			REGISTATION			MODELING (SCAN TO BIM)					
L0 B															
L1 A							FIELD SCAN ZONE L1 & L2								
L1 B															
L2 A															
L2 B															
L3 A															
L3 B															
L4 A															
L4 B															
L5 A															
L5 B															

NOTES:

1) THERE ARE FOUR (4) DISTINCT PHASES FOR MODEL DELIVERY OF A "SCAN-TO-BIM" PROJECT. THESE ARE

1.1) PRE-MOBILIZATION PLANNING

1.2) FIELD SCANNING. THIS WORK IS COMMONLY DIVIDED INTO INTERIOR, EXTERIOR VERTICAL AND EXTERIOR ROOF AREAS. OTHER SUB-DIVISIONS OF SCANNING COULD BE ABOVE CEILING SCANNING FOR EXAMPLE.

1.3) REGISTRATION : THIS IS THE PHASE WHEN THE SCANNING WORK IS REGISTERED AND THE POINT CLOUDS ARE PLACES IN A FEDERATED MODEL.

1.4) MODELING (SCAN TO BIM): THIS IS THE PHASE WHEN A BIM IS DEVELOPED FROM THE POINT CLOUDS CREATED IN THE PREVIOUS REGISTRATION PHASE.

2) THESE DATES WILL VARY GREATLY FOR A GIVE PROJECT. HOWEVER, IT IS RECOMMENDED TO HAVE A MODEL DELIVERY SCHEDULE ATTACHED TO ANY PROPOSED LASER SCANNING WORK.

3) This seciton could include the BIMForum LOA Specification Table after the Model Delivery Table.

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Project Requirement: BIMForum 2019 Level Of Development Specification

	000	100	200	300	350	400	MEA	Notes
Project Dimentional Controls								
Grids, Levels, and Origins / Bench Marks (State Plane)				x				
Grids, Levels, and Origins (Local)				x				
Structure, Enclosures & Interiors								
Structural Steel (main members, canopies, etc.)				x				
Concrete Structure				x				
Wood Structure				x				
Miscellaneous Steel					x			
Stair & Rails					x			
Open Web Bar Joists****					x			
Curtain Wall				x				
Masonry					x			
Drywall & Cold Formed Metal Studs					x			
MEP System								
Plumbing Single Run 3/4" diameter and below	x							
Plumbing Single Run greater than 3/4" diameter				x				
Plumbing - Gravity and all other plumbing				x				
Electrical - Lights				x				
Electrical - Conduit single run less than 1"	x							
Electrical - Conduit single run 1" & larger				x				
Electrical - Conduit, groups of more than 1 conduite (all sizes)				x				
HVAC - Main					x			
HVAC - Branch				x				
Mechanical Piping Single Run 3/4" diameter and below				x				
Mechanical Piping Single Run greater than 3/4" diameter				x				
Pneumatic Tubing	x							
Telescopic Tubing (Unistrut, etc.)	x							
Fire Protection				x				
Clearance for MEP-F content above. Code and Maitence Clearances.					x			
Civil / Site Model								
Surface				x				
Water				x				
Sanitary				x				
Storm				x				
Franchise utilities								

NOTE:
1) Hangers are not included at LOD 300.
2) LOD 300 does require insulation being modeled where specified on the given model elements.
3) LOD 000 (Not Modeled): this level is for elements that are not modeled.

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USES			
3D Coordination	X		
Design Reviews	X		
Design Authoring			
Design Communications			
Construction System Design			
Existing Conditions Modeling			
3D Control and Planning	X		
4D Scheduling			
5D Estimating			
6D Owner Information			
Programming			
Phase Planning (4D Modeling)			
Record Modeling			
Site Utilization Planning			
Site Analysis			
Structural Analysis			
Energy Analysis			
Cost Estimation			
Sustainability LEED Evaluation			
Building System Analysis			
Space Management / Tracking			
Mechanical Analysis			
Code Validation			
Lighting Analysis			
Other Eng. Analysis			
Digital Fabrication			
Asset Management			
Building Maint. Scheduling			
Disaster Planning			

This table of BIM Uses is adapted from Kreider, John Messner, and Craig Dubler's Twenty-Five Uses of BIM.

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Instructions:

Document Control Software							
	All						
		BIM Process	**Discipline**	**Software**	**Version**	**Primary Coordaintion File Format**	**Secondary Coordaintion File Format**
		Document Control (Final documents only)	All	[SOFTWARE NAME]	Most Current		
		Document Control (Commissioning)	GC, Subs	[SOFTWARE NAME]	Most Current		
		Document Control (All 3D model files)	All	[SOFTWARE NAME]	Most Current		
		Document Control (Native Design Models)	All	[SOFTWARE NAME]	Most Current		
		PDF Viewer/Editor (All 2D PDF)	GC, Subs	[SOFTWARE NAME]	Most Current		
Authoring and Collaboration Software							
	Design						
		BIM Process	**Discipline**	**Software**	**Version**		
		3D Authoring Models	Architect	[SOFTWARE NAME]	2018		
		3D Authoring Models	Structural	[SOFTWARE NAME]	2018		
		3D Authoring Models	Mechanical	[SOFTWARE NAME]	2018		
		3D Authoring Models	Plumbing	[SOFTWARE NAME]	2018		
		3D Authoring Models	Electrical	[SOFTWARE NAME]	2018		
		3D Authoring Models	Technology	[SOFTWARE NAME]	2018		
		3D Authoring Models	Special Equipment	[SOFTWARE NAME]	2018		
		3D Authoring Models	Sitework & Utilities	[SOFTWARE NAME]	2018		
		3D Model Coordination	All	[SOFTWARE NAME]	Most Current		
	Construction						
		BIM Process	**Discipline**	**Software**	**Version**		
		3D Authoring Models	Mechanical and Plumbing	[SOFTWARE NAME]	2018	3D CAD - Solid	
		3D Authoring Models	Electrical	[SOFTWARE NAME]	2018	3D CAD - Solid	
		3D Authoring Models	Structural Steel	[SOFTWARE NAME]	2018	3D CAD - Solid	
		3D Authoring Models	Fire Protection	[SOFTWARE NAME]	2018	3D CAD - Solid	
		3D Viewing Only	All	[SOFTWARE NAME]	2018	Free Federated Model File	
		3D Model Coordination	GC, Subs	[SOFTWARE NAME]	2018		
		3D Field Validation	GC, Subs	[SOFTWARE NAME]	2018		
		3D Model As-Builts	GC, Subs	[SOFTWARE NAME]	2018		
		3D Record Model	GC, Subs	[SOFTWARE NAME]	2018		
		4D Simulation	GC	[SOFTWARE NAME]	2018		
		5D Simulation + Cost	GC	[SOFTWARE NAME]	2018		
		Point Coordinates	All	[SOFTWARE NAME]	2018	CAD	TXT
		6D Facilites Management	All	[SOFTWARE NAME]	2018		

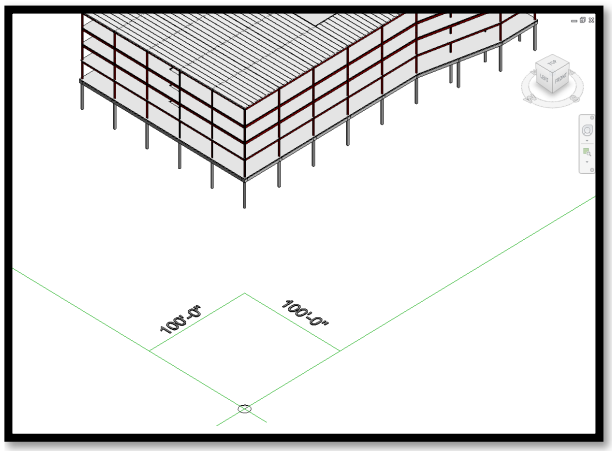
NOTES:
1) 3D CAD - Solid, This coudl be Autodesk AutoCAD 3D solids for example. If using a CAD package with object enablers on top of AutoCAD, export out a *.DWG file that has all model geometry fully expressed in the single file so that the enablers are not required for viewing.
2) Free Federated Model File, eg Tekla BIMsite, Autodesk Navisworks

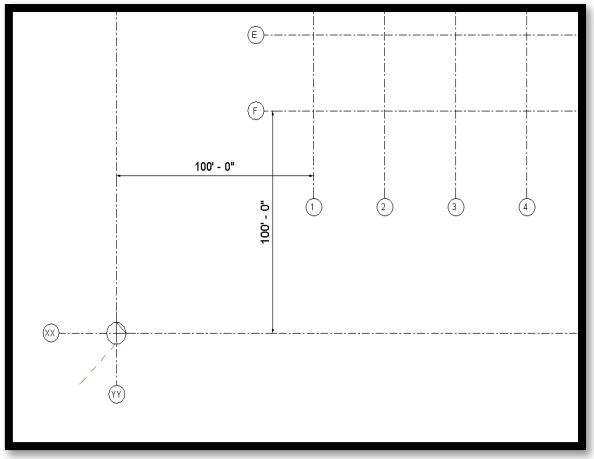
BUILDING ORIGIN

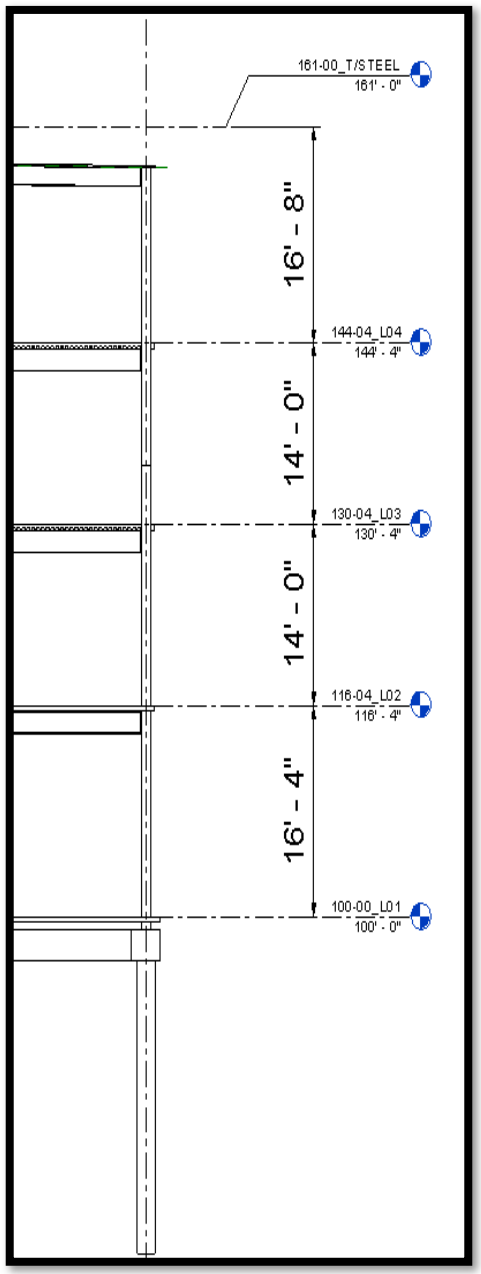
Load the project XYZ.DXF coordinate location file (**TBD**) into your BIM software by inserting it at the origin of your application (Global X, Y, Z COORDINATE = 0,0,0). This file shall be located on the project's FTP site. Orient the model to the following information that is in the DXF file:

Plan North:	Y	Axis	
	FT		Grid
X-Axis =	**-50.0000**	**West of Grid**	**1**
Y-Axis =	**-50.0000**	**South of Grid**	**F**
Z-Axis =	**100.0000**	**Below FF**	

Zone	Low	High	Note	Delta
	(FT)	(FT)		(FT)
L00	N/A	100.0000	Subgrade	
L01	100.0000	116.3333		16.3333
L02	116.3333	130.3333		14.0000
L03	130.3333	144.3333		14.0000
L04	144.3333	161.0000		16.6667
L05 (ROOF)	161.0000	N/A	Above Roof	







Typical Weekly Coordination Schedule - For BIM Coordinator

EST	Sun	Mon	Tue	Wed	Thur	Fri	Sat
6:00 AM							
6:30 AM							
7:00 AM							
7:30 AM			Late BIM Assessment to PM				
8:00 AM			Coord Analysis				
8:30 AM			Coord Analysis				
9:00 AM			Coord Analysis				
9:30 AM			Coord Analysis				
10:00 AM			Receive Agenda Topics				
10:30 AM			Coord Analysis				
11:00 AM			Coord Analysis				
11:30 AM			Coord Analysis				
12:00 PM							
12:30 PM				Meeting Prep			
1:00 PM			Coord Analysis	Coord Meeting			
1:30 PM			Coord Analysis	Coord Meeting			
2:00 PM			Post Agenda	Coord Meeting			
2:30 PM			Coord Analysis	Coord Meeting			
3:00 PM			Coord Analysis	Meeting Minutes			
3:30 PM			Coord Analysis	Meeting Minutes			
4:00 PM			Coord Analysis	Meeting Minutes			
4:30 PM		Receive Models	Coord Analysis	Post MM & FBIM			
5:00 PM							
5:30 PM							
6:00 PM							

	Items lead by BIM Coordinator
	Items that trades need to respond to.
	Items where information is posted to the trades.

NOTES:
1)