BIM Comes of Age: The New ConsensusDocs BIM Addendum (2015) for Lifecycle Building Information Modeling

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A decade ago, building information modeling (BIM) software was becoming commercially available in the United States to create three dimensional (3D) images of structures. There were no best practices for how to develop and use 3D models, BIM was used primarily as a design tool ("CAD on steroids"), and reading model data generated on one vendor's BIM software with another vendor's BIM software was frustratingly unreliable. Yet technologically savvy contractors, designers, and owners saw the tremendous potential for BIM to improve project efficiency and actively began exploring ways to best harness its strengths. As a result, by 2008, the American Institute of Architects (AIA) and ConsensusDocs each had issued BIM contract forms. The AIA Document E202–2008, *Building Information Modeling (BIM) Protocol Exhibit*,[2] and the ConsensusDocs 301, *Building Information Modeling (BIM) Addendum (2008)*,[3] both endeavored to surmount then-perceived barriers in the use of this technology and began the process of articulating protocols for exchange of BIM design data.

Since then, BIM has matured into a powerful tool that can be used throughout the lifecycle of a structure, including initial project conceptualization, design development, construction, commissioning, operation and maintenance, and even decommissioning.[4] Preparation of a model to illustrate the design for a single design discipline (architectural, structural, mechanical, electrical, etc.) soon evolved by joining two or more models together electronically to undertake clash resolution—the virtual determination and elimination of physical (or *hard clash*) and spatial (*soft clash*) conflicts between architectural and engineering designs and trade shop models before construction commences. Moving beyond this intelligent[5] 3D depiction, a wide range of analysis tools are now available to virtually evaluate 3D models, including deriving 4D (scheduling) and 5D (cost/estimating) data, as well as a variety of sustainability, energy measurement, and systems performance evaluation processes.[6] It has become increasingly common for portfolio property owners—such as government, school, hospital, and mixed use developers—to use BIM model data at commissioning and afterward during operation and maintenance (O&M) to monitor mechanical, electrical, plumbing and other building systems for both energy efficiency and to troubleshoot operation failures.[7] Emerging O&M BIM uses include linking multiple models for campus- or community-wide fiscal and expansion planning, electronic smart-tagging (RFID) of moveable furniture, fixtures, and equipment for asset location management, and civil information modeling (CIM) to capture topography, building orientation, security, traffic flow, and site energy analysis.

With these expanded uses of BIM have come increasing needs to better document contractual obligations related to BIM processes and deliverables. In 2013, AIA updated and created several new forms of AIA Documents: the E203™–201 *Building Information Modeling (BIM) Protocol Exhibit*, and companion planning documents, the G201™–2013 *Project Digital Data Protocol Form*, and G202–2013™ *Project Building Information Modeling Protocol Form*.[8] These documents acknowledge BIM's migration away from traditional CAD design development sequence,[9] clarify authorized uses of model data, and expand description of the protocols needed for electronic exchange of model data. They aid in better documenting BIM execution planning through reference to expanded construction and O&M phase uses. The new AIA documents further presume that the Architect will be the lead in developing BIM protocols and end uses for a project,[10] which can be seen as part of the AIA's continued emphasis on protection of designer intellectual property rights, particularly in controlling access and ability of other parties to make modifications as a means of protecting design professionals from inadvertently taking on liability for design changes they do not author or otherwise expressly approve.[11]

As more interactive forms of project delivery, like design-build and integrated project delivery (IPD), have boosted the very early use of BIM from project conception planning stage onward, while undertaking 4D schedule and 5D cost analysis derived from BIM data have become more prevalent and important tools for design value engineering. Similarly, construction phase uses of BIM tools are on a significant upsurge. Project managers, site superintendents, designers, and construction workers are being equipped with mobile handheld computers that often depict 3D BIM project models, rather than 2D CAD designs. In short, both within the United States,[12] and around the world,[13] BIM is being mandated as the preferred means of creating and operating structures from project inception to the end of a structure's useful life. This very rapid development of BIM technology has, in turn, forced a re-evaluation of contract terms to better aid the project team tasked with expanded design, construction, and building operation modeling goals.

The 2015 ConsensusDocs BIM Addendum

In response to the need for articulating model rights and responsibilities on a lifecycle basis, ConsensusDocs has made very significant modifications to its BIM Addendum.[14] The new 2015 BIM Addendum covers the same six main topics but has completely overhauled and expanded each of those topic, which include the following: (1) impact of the 2015 BIM Addendum terms on related project contract documents; (2) definitions unique to the BIM process; (3) duties of the BIM Manager who coordinates all BIM operations; (4) development of a lifecycle BIM Execution Plan;[15] (5) insurance coverage and related risk allocation; and (6) intellectual property rights, including restrictions on Model data reuse.[16]

The 2015 BIM Addendum succinctly defines "Building Information Modeling" or "BIM" as follows:

> [T]he collaborative development of a three dimensional digital representation that is Intelligent and Parametric, depicting the physical and functional characteristics of a structure or site for use as a shared knowledge resource; it may also include generation of Geometric and non-graphic information, and related processes,

> analysis and deliverables for use over the lifecycle of the structure or site depicted.[17]

As this definition broadly signals, the entire focus of the BIM Addendum has been expanded to address BIM activities extending well beyond just the initial design of a structure.

Article 1: General Principles

When the BIM Addendum was initially issued in 2008, there were considerable fears that collaboration using BIM tools would modify longstanding construction industry liability apportionment as between the designer, contractor, and owner on design-bid-build projects under the *Spearin* doctrine.[18] A specific concern was that contractors, who traditionally had no ability to modify architectural or engineering designs, might cause design changes that violated code or structural requirements when contributing their trade expertise suggestions during model clash resolution activities during the design phase. Others worried that one designer would access another's Model and revise it, either intentionally or inadvertently, without consent of the original Model author. As a result, the first version of the ConsensusDocs BIM Addendum in 2008 went to great lengths to reassure parties that liability apportionment and responsibilities identified in their "Governing Contracts" (*i.e.*, the agreements between Owner and Architect, as well as Owner and Contractor) controlled over any BIM Addendum provisions. These sorts of provisions have been considerably streamlined in the 2015 edition of the BIM Addendum, if not outright eliminated. For example, a major change is new provision that expressly provides that the 2015 BIM Addendum takes precedence over other Governing Contracts.[19] Gone, too, are the limitations that Design Models are automatically presumed inadequate to determine material quantities and that contract documents other than the BIM Addendum will control building information modeling activities.

The new provisions of Article 1 also reinforce what is stated more explicitly later in the 2015 BIM Addendum, namely, that each Model "Contributor" (i.e., any party that contributes model data) is responsible for all the digital or other information they contribute. They confirm a Design Professional cannot be compelled to permit modifications to their designs inconsistent with their responsibility "to comply with applicable codes, regulations or laws."[20] Conversely, a Constructor's participation in clash resolution or other modeling activities "shall not constitute the performance of design services"[21] and the Owner's warranty of design sufficiency (*Spearin*) is not modified by virtue of following the BIM Addendum processes.[22]

Article 2: Definitions

The concept of a Federated Model has carried over from the original ConsensusDocs BIM Addendum and remains integral to the modeling process articulated in it. A "Federated Model" is one that "links distinct component Models, Drawings, analysis and other data sources that do not lose their identity or integrity by being so linked, so that a change to one component Model does not change another component Model" when they are joined together.[23] This definition reinforces the basic premise of the BIM Addendum that no one except the original Contributor of a model can modify another's contributions or model content without consent of that Contributor.

To address expanded lifecycle uses of Model data, additional new types of Models have also been added to the original definitions. A discipline-specific design prepared by an architect or engineer (*i.e.*, architectural, structural, mechanical, electrical, plumbing, fire protection, interior, landscape, and other specialty designs) is still called a "Design Model." When two or more are linked together to provide the equivalent of construction-ready 2D plans, it is still called a "Full Design Model."[24]

When a Constructor prepares the 3D BIM equivalent of a shop drawing, it is now called a "Shop Model," which is one type of a larger group of models developed by

Constructors called, generally, a “Construction Model” in the BIM Addendum.[25] The Construction Model concept includes a range of other model data prepared by Constructors, so, for example, an exploded detail prepared for constructability analysis, 4D scheduling or a 5D cost analysis derived from a Design Model would be additional examples of Construction Models. When the Full Design Model is joined with one or more Construction Models during design of the project to coordinate design information, undertake analysis of systems, or to resolve clashes, they are a “Project Model,” and when data in a Construction Model is modified as a result of the Project Model clash resolution process, it is reflected in a model deliverable called a “Coordinated Construction Model.”[26]

To help document emerging uses of modeling during construction phase, additional types of Models have been added in the definitions section. An “As-Built Construction Model,” for example, reflects changes to a Construction Model after construction commences, conforming the construction discipline’s Construction Model to the actual conditions of the work as it has been built.[27] A “Record Model” is a modified Design Model showing clarifications and changes to a single design discipline’s Model data in a way that does not lose any of the design data of the original Design Model.[28] This may be accomplished by highlighting design revisions and changes to the 3-D images themselves or by creating additional or modified non-graphic information in data fields or text balloons tied to modified design Elements or other component structures. A “Conformed Design Model” depicts “all final changes to physical conditions of the modeled structure and other as-built updates to the design that occurred throughout the construction phase” including non-graphic information intelligently embedded in the Design Model.[29] These special types of Models are used to develop design and construction information necessary for subsequent utilization of these Models during project turnover and commissioning and during operation and maintenance of the completed structure.

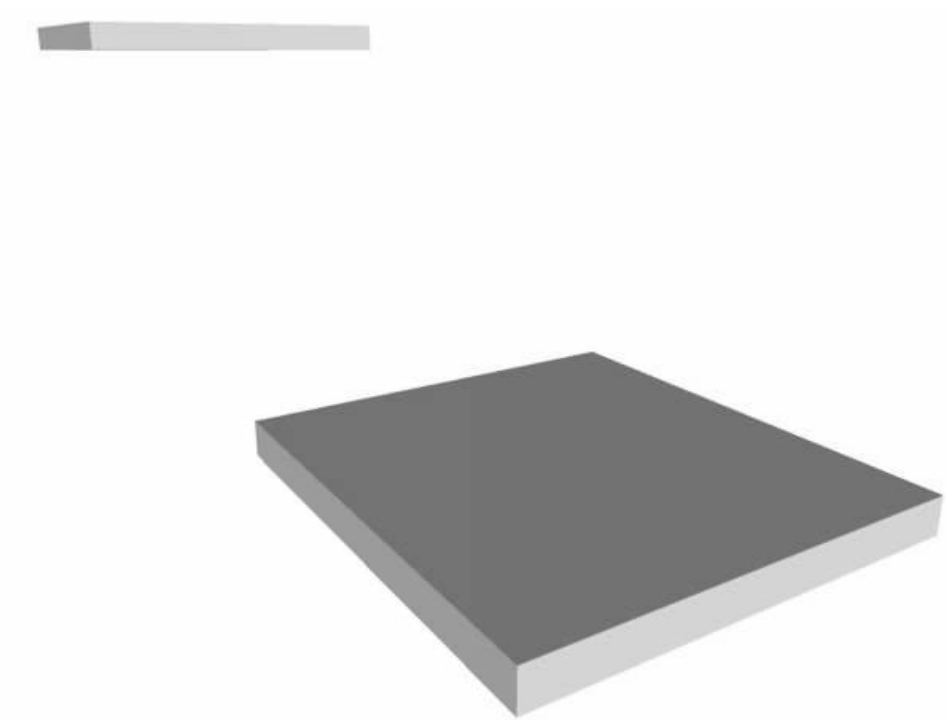
An additional set of new definitions deals with the quality and level of detail of Model data. There are four concepts added to the new version of the BIM Addendum. The first is a revised definition of “Dimensional Accuracy,” or how accurate to a fixed scale object dimensions are in the Model.[30] It may be perfectly fine for a marketing flythrough BIM used to pre-sell condominium units before a project breaks ground to have no Dimensional Accuracy, but an IPD team will need increasingly precise levels of Dimensional Accuracy to undertake reliable quantity and schedule take offs in their 4D and 5D analysis of a structure for value engineering purposes.

The next new term is “Granularity,” or the level of accuracy of Model geometric representations for an “Element”—an object that depicts a building component, system, or assembly.[31] A Model with a low level of Granularity might depict an unmarked rectangular box where an electrical panel will be housed. That same Model with a high level of Granularity will accurately depict all the circuit breakers in the panel box and name their connections via Intelligent data embedded in the Model.

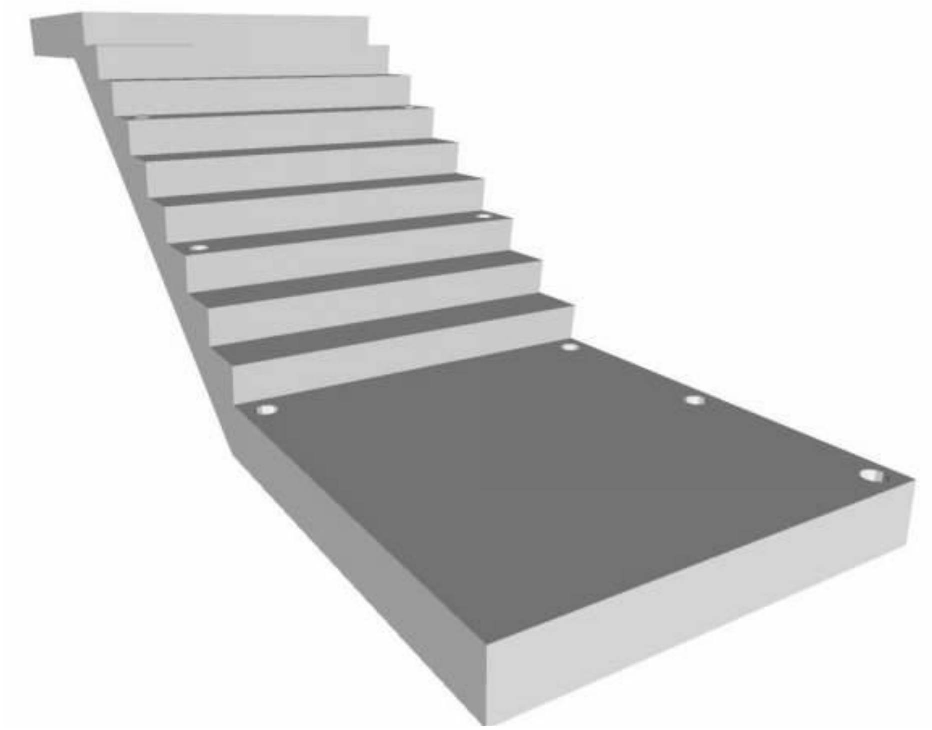
Dimensional Accuracy and Granularity, in turn, are used in conjunction with two additional concepts: “Level of Detail,” or the input detail, information maturity and richness of a Model Element,[32] and “Level of Development” (LOD), or the completeness and reliability of a Model Element.[33] The LOD concept in the BIM Addendum is based on visual depictions developed by BIM Forum in their Levels of Development Specification, a construction industry group illustration of design modeling at various phases of design development and completeness.[34] For example, depicting a pre-cast stair system in an early massing or LOD 200 schematic model may require establishing only the top and bottom landings to fix overall dimensions and orientation of the stair system. As an architectural Design Model becomes more fully developed to an LOD

300 level, the stair treads and risers would be added to the pre-cast stair. During clash resolution—an even higher, LOD 350 activity—the stair railing manufacturer would add their Shop Model depicting placement of embedded metal hardware that will be used to attach railings into the stair into the Full Design Model to confirm spacing and detailing. Each of these increasingly higher levels of LOD completeness and reliability would be specified in the BIM Execution Plan at discrete Phases of desired design development.[35]

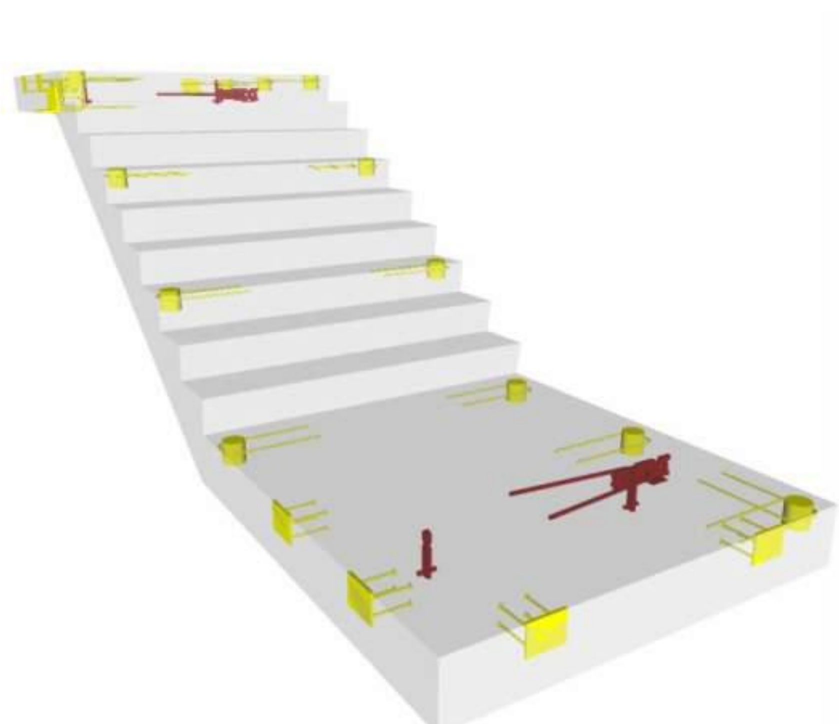
Figure 1: Illustrations from BIM Forum's Level of Development (LOD) Specifications – ©Ikerd Consulting, LLC, IKERD.com



LOD 200 Precast Structural Stairs – Architectural Design Model, schematic level

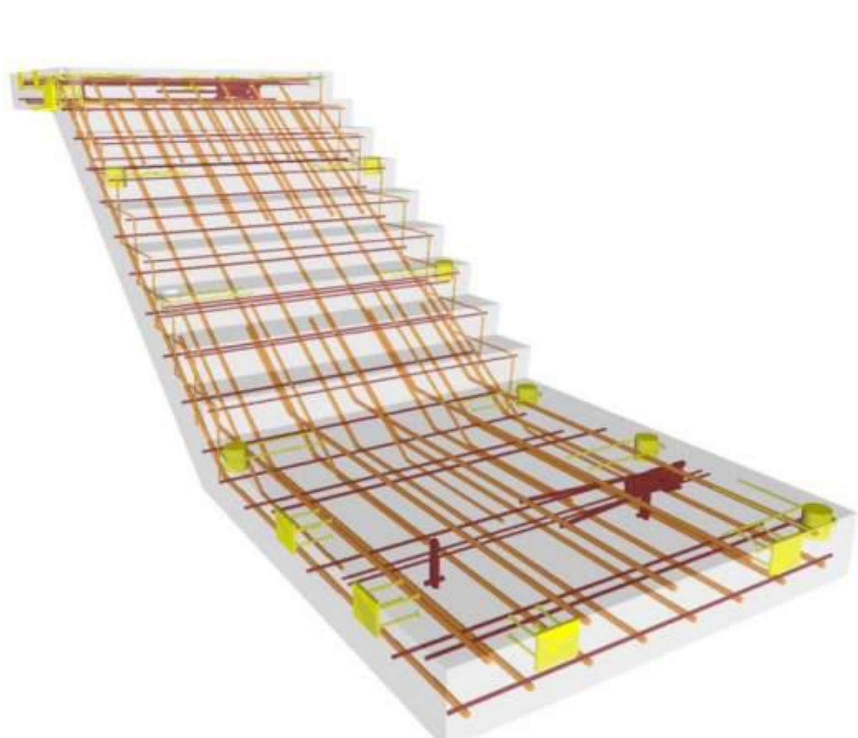


LOD 300 Precast Structural Stairs – Architectural Design Model with placeholders for railing connection by others



LOD 350 Precast Structural Stairs – Shop Model detailed, scalable placement

When particular needs for more detailed design information arise, the Level of Detail, or richness, of Model data can be increased at any stage of Level of Development. For example, a high Level of Detail might be needed to illustrate the location of custom rebar cages for purposes of steel rebar fabrication. A Shop Model that is based on data derived from an architectural Design Model can be generated as a separate fabrication Model with data that will not be added to the final Full Design Model because the rebar configuration is needed solely to support the steel fabricator and the installer of that product in the field. For all others, this information would be extraneous "noise" and so is omitted from the Models they review for clash resolution and construction purposes.



LOD 400 Precast Structural Stairs (High Level of Detail) – Scaled fabrication modeling.

Article 3: BIM Manager

In ConsensusDocs' 2008 version of the BIM Addendum, Article 3 described the duties of an "Information Manager," or person in charge of coordinating and general administration of the building information modeling activities during a project. This title has been changed in the 2015 version of the ConsensusDocs BIM Addendum to "BIM Manager," consistent with naming practices in the industry. The Owner, Designer, or Constructor can employ this BIM Manager, or one or more third party BIM experts can furnish the expanded list of services identified in Article 3, though the Project Owner is still responsible for the cost of the BIM Manager.[36]

The BIM Manager is primarily in charge of monitoring modeling process and maintaining quality control. Their role includes coordinating Contributors' access to Models, determining hardware configuration, software versioning and other technology needs and protocols, developing security measures to protect integrity of Model data, and reviewing completed Models for compliance with submittal requirements, including updating Model data that is changed during construction phase.[37]

One deceptively simple provision in Article 3 tasks the BIM Manager with determining "measures needed to achieve Interoperability of Model applications and resolve documented Model Interoperability issues."[38] "Interoperability**"** in the context of BIM is the "capability of different software programs to exchange data via a common set of exchange formats, to read and write in those formats, and to use the same protocols so that model data is not dropped, repurposed, or reformatted,"[39] and ensuring Interoperability currently remains a significant challenge of Model development. Though industry groups have pressed for better ability of one modeling software to read Model data on competitors' software sufficient to share Model designs from one to another without causing model data to be modified or lost, the proprietary nature of BIM software and the commercial desire of software companies to market and support use of their own proprietary licensed software products exclusively continue to hamper this goal.

Options for resolving this issue that are presently available to the BIM Manager are not ideal: First, the parties can require everyone involved with modeling for the project to use software programs created in a suite of programs by a single software vendor, who, ostensibly, has worked out data exchange amongst the various disciplines' software issued from that same company so data is not repurposed. Second, one or more Contributors can retain software programmers who custom-patch software code from one program to another so that all design data in a Model is fully expressed when it is read with a different software than the one that originated the data. This is labor-intensive but currently provides the most seamless solution for specific data exchange difficulties. Third, there is increasing use of Industry Foundation Classes (IFCs) developed by BIM industry group, buildingSMART®, a platform-neutral, object-based file format that facilitates Interoperability.[40] The process of developing IFCs has been slow and methodical, but for some applications (such as structural steel IFCs, which already have been particularly well developed), it can be a useful way of solving some Interoperability challenges. Contract drafters should be careful, however, to not simply make a sweeping requirement for use of IFCs or other exchange formats like gbXML or AgXML,[41] because the implementation process for them is more complex than merely requiring use of the file format tool. Nevertheless, they are increasingly seen as a desirable means of translating modeling data from one program to be read by another, and BIM modeling staff can supply additional detail about their intended use when needed during BIM Execution Plan development.

Article 4: BIM Execution Plan

The most significant changes to the ConsensusDocs BIM Addendum have been made to assist contracting parties to more thoroughly develop their "BIM Execution Plan," the roadmap for all BIM activities they will undertake on the project. These new Article 4 provisions contemplate that an initial Plan will be developed early in the life of the project, but as other parties who will contribute Models or analysis are hired, those parties can review and contribute refinements to the Plan with the mutual approval of the other Contributors that have already approved the BIM Execution Plan.[42]

Think of a BIM Execution Plan like a detailed index of a book, outlining the process and sequence of modeling activities that will be undertaken on a project, along with the Models that will be created as a result of those BIM activities. The BIM Addendum contemplates that anyone preparing contract terms for this Article should be generally familiar with "BIM Uses**,"** the end deliverables that can be produced using BIM software and analysis tools. For those new to modeling, an excellent set of resources for becoming more acquainted with this BIM Execution Plan process is Penn State's *BIM Project Execution Planning Guide* and *BIM Planning Guide for Facility Owners.*[43] These free resources were developed to explain BIM processes to those without BIM technical experience and help identify strategies for a project owner to make a cogent use case for better integration of BIM as a lifecycle tool for their organization.

Article 4 causes Model Contributors to work backward from their desired Model BIM Uses to develop a specific, phased sequence of preparing and collaboratively sharing Models needed to achieve project-specific goals, including identifying parties responsible for each Model deliverable. To aid in this process, an extensive list of possible "Model Uses" are provided in Section 4.4 of the BIM Addendum that are decidedly lifecycle-oriented.

Specifically, the stages of the project are broken down in Article 4 by Model Phases that cover the entire useful life of a structure: Conceptual Planning, Design, Construction, Commissioning and Turnover, and Facility Operation & Maintenance (O&M) and Enterprise Management. For each Phase, extensive descriptions of typical modeling activities are described. It is up to the drafter to edit these lists by removing activities that will not be undertaken for the particular project and by expanding or adding to the description of activities to clarify the intended scope and purposes of remaining Model deliverables. For a party that wants to foster use of BIM, this list acts as a sort of smorgasbord of options, creating the opportunity for the contracting parties to meaningfully discuss which BIM deliverables will create best value for the specific project.

***Conceptual Planning Phase*.** Conceptual Planning is an entirely new section of Article 4 and was designed to support the very early use of BIM in the life of a project. This section includes BIM Use references for 4D budgeting and 5D schedule development, CIM surveying, site planning, existing conditions modeling (including 3D laser scanning of as-built conditions), and programming review[44]—all tools that significantly aid best value analysis on IPD, public-private partnership (P3), design/build and other interactive types of project delivery. Analyzing conceptual project data directly via 3D Model in this way is a powerful tool to help make informed decisions about early project design and foster thinking about the structure from the perspective of lifecycle, rather than simply initial construction, cost.

***Design Phase*.** The second Phase discussed in Article 4 is Design. This was the most well-developed phase in the 2008 version of the BIM Addendum, but additional refinements have been added to broaden the choice of modeling deliverables that can be required during the Design Phase. For example, the section that deals with design review, audit, and analysis,[45] now expressly includes a reference to "lean coordination," encouraging designers and contractors working together to deliver project designs using lean, just-in-time methodology.

Another new provision[46] has been expanded from simple clash resolution activities to include planning for digital fabrication "including any 3D printed objects or components to be derived from Model data."[47] Fabrication designs that are derived directly from 3D Design Model data, and using Model data to program 3D printers to print architectural details and building components, are areas of construction technology that are rapidly evolving.[48] As a result, if the parties know prefabrication, direct fabrication modeling, or 3D printing will be used on their project and want support these processes with adequate BIM development, the contract drafter adapting this BIM Addendum will want to gain a thorough understanding of Model data needs necessary to produce prefabricated building components or 3D printed objects. Then, this provision can be customized to add requirements for sufficient Granularity and LOD of the Model data to ensure seamless digital fabrication modeling without the need for significant remodeling of the Design Model data by the fabricator or printer.

Other new provisions for Design Phase cover use of Model data for "planning approval and regulatory permitting" of designs, as well as "life safety and other code analysis and validation."[49] These provisions reflect a growing trend, as state and local jurisdictions all over the United States experiment with accepting BIM modeling rather than 2D CAD drawings, for issuance of building permits. In addition, they foster use of BIM compliance software that allows a Model to be checked to meet fire protection and other national life safety codes.

One significantly expanded Design subsection addresses energy and sustainability analyses.[50] Sustainability modeling is an area of BIM that is growing swiftly in both frequency of use and number of programs available, largely because this type of study of a 3D virtual structure has the potential for generating very significant lifecycle cost savings. It is an area of BIM Execution Plan management, however, that typically requires more sophisticated contract terms than simply identifying which light, wind, air quality, thermal, acoustic, or other environmental testing will be performed during Design Phase. For example, a significant number of sustainability programs require simple massing of a building to perform an initial study of the 3D Model, and sustainability modelers will have to strip out design details like HVAC units depicted on a building roof or façade decoration to get the software to give them meaningful data for geo-positioning of a building to capture best wind load, daylighting, or other environmental conditions. For them, Model design development needs to be phased to include an early, pre-schematic massing depiction of the structure that looks like stacks of children's blocks. Similarly, during clash resolution of the mechanical, electrical, and plumbing Shop Models with architectural and structural Modeling, using sustainability analysis to value engineer and resolve space constraints can provide significant cost saving, but only if the BIM Execution Plan requires these sustainability analyses to be undertaken as part of the clash resolution process. Where a project owner wants to use BIM to operate and manage their completed facility, exploring available sustainability analyses and selecting those best able to give lifecycle return on investment should begin at or before the time the BIM Addendum is completed. Once sustainability analyses are selected, the LOD levels needed for various stages of analysis for each type of sustainability software should be identified, and then further detail added to the BIM Addendum (at section 4.2.7) to avoid the need for remodeling or retro-modeling of Design Models to be able to develop useful 3D depictions for sustainability analysis purposes.

A final new provision for Design Phase[51] focuses on developing as-built model data. This section is another that is critical if the completed Record Model or Conformed Design Models will be used to operate and maintain the completed building after construction is completed. To update Model designs with as-built data and create a Record Model, hand-annotated 2D plans, scaled field measurements, or laser point cloud of final field conditions can be selected to convert the Construction Models for the project.

Construction Phase. Significant additional provisions have been added to the BIM Addendum to describe the increasing uses of BIM during Construction Phase. For example, discrete details derived from Model data are being extracted from Design Models during Construction Phase to develop sequenced training simulations. These static detail Models can depict quality control requirements, break up work assignments by color coding Model Elements by trade, and then can be run through an animation scheduler to depict a virtual "build" of the detail, teaching trade contractors the preferred order of work activities.[52] Safety planning, including using BIM for site logistics, construction site waste management, and material RFID/smart tagging to permit just-in-time delivery of materials to work areas, is also being derived from 4D applications that break the Model design data into discrete work sequences.[53] Digital Fabrication requirements appear a second time in the BIM Addendum in Construction Phase, with an emphasis on construction-related Model needs, including "searchable and indexed pre-assembly, modularization and prefabrication processes."[54]

Where trade contractors will prepare Shop Models that will be used to operate and maintain completed systems (typically, mechanical, electrical, plumbing, fire protection, sustainability compliance metrics, and so on), the BIM Addendum can be expanded to detail specific As-Built Construction Model requirements and associated deliverables, such as reports that confirm energy consumption levels of the building at substantial completion for use in attaining LEED® and similar certifications.[55]

Commissioning and Turnover. Yet another completely new area of the BIM Addendum details modeling requirements related to commissioning of the completed structure, including using Model simulations for training users and operators at the time of building turnover on how to operate and maintain the structure and its mechanical systems.[56] A wide variety of performance level requirements can be included in the Intelligent data embedded in Model Elements to cross-check achievement of those levels during commissioning and to set the stage for ongoing operation and maintenance activities to achieve warranted performance. To facilitate this, an extensive checklist of As-Built and Record Model coordination was included as a separate spreadsheet in the BIM Addendum to provide an easy means of assigning responsibility for those aspects of the Models that must have updated Geometric Data, including any related written deliverables such as performance charts or sustainability analyses. This checklist can be used in commissioning the structure and thereafter to compare actual ongoing operations levels to original commissioning levels. In addition, there is a chart that allows the parties to specify whether access to the As-Built Construction Model or Record Model will have one-way or two-way dynamic information exchange and integration – a feature that must be included in very early Model phase development to be meaningfully useful during O&M Phase.[57]

Facility Operation & Maintenance (O&M) and Enterprise Management. For buildings today, Model-embedded Intelligent operation and maintenance data is replacing a storage room filled with shelves of three-ring binders containing O&M manuals and warranties. The Facility O&M Phase provisions of the BIM Addendum presume this embedded operations use of Model data as a baseline feature, but they also provide a wide range of additional provisions relating to smart building reporting and self-maintenance. Asset management, including Furniture, Fixture, and Equipment (FF&E) tracking, Installed Building Equipment (IBC) monitoring, Inventory control and Exterior Asset performance monitoring, for example, is an area of increasing post-construction use of Record Models featured in Article 4.[58] Ongoing sustainability analysis tools and building automation and management systems similarly use completed Record Models to track building performance and some have the ability to adjust it automatically to meet performance specifications.[59] Also included are provisions to allow the Record Models to be used for active O&M planning, such as ongoing access and security needs, as well as for disaster planning and finally, the eventual decommissioning and recycling of the structure at the end of its useful life.[60]

Related Deliverables. While the construction industry is in the midst of a transition from 2D CAD to 3D BIM project documentation for permitting and field use, new revisions to the BIM Addendum require the parties to identify the non-Model deliverables that will be needed for the project.[61] These may include 2D drawings, 4D scheduling, 5D cost estimating, and supplementary written materials, like data collection protocols (such as COBie spreadsheets used by US government agencies to track physical assets).[62] Another particularly important provision of Article 4 sets precedence of dimensioning, making clear whether 2D data (ideally derived directly from the 3D Model data) or the 3D Model data itself controls if there is a conflict between the two mediums of depiction of the project designs.[63]

Technology Infrastructure and Information Exchange. Once the parties have determined what deliverables are needed by lifecycle phase, they then can make intelligent decisions about the hardware, software, physical and virtual workspaces, and the Model technology management and content formatting they will need to develop and share Model data. Section 4.6 of the BIM Addendum addresses these issues. While this information is typically the province of the technical staff that will actually create Models, it is important for those who prepare the BIM Addendum as a contract document to ensure that collaborative analysis actually occurs so that specific formatting and related technical parameters are developed. For example, if 4D or 5D activities are needed for the project, how a complex Model is partitioned into smaller, easier-to-modify subsections (for example, by floor, by zones on a particular floor, or otherwise) can either completely preclude or significantly enhance the ability to complete these 4D and 5D analyses.[64]

Another area of particular importance in managing BIM processes is determining obligations related to archiving of Model data at various Phases, including legacy integration (the need to migrate stored Model data from one storage medium to another, for example, much like the early computer transition from floppy to compact disc) and related Model reuse rights. Care should be taken to address these archiving needs during not only design and construction, but also the more elaborate needs during O&M Phase, including responsibility for updating Record Model data during O&M Phase as the as-built conditions of the site change with maintenance, remodeling, and expansion of the facility.[65]

BIM Staffing. The final provisions of the BIM Execution Plan provisions in Article 4 relate to establishing roles and responsibilities for the personnel who will actually implement the modeling process. Section 4.7 of the BIM Addendum helps to organize the project Contributors, establishes who among them is authorized to use Model data, sets training requirements, and, most importantly, causes the parties to develop decision hierarchies. Who gets access, and in what priority, to complex Models, and who has “go-no go” decision-making authority to determine if Model deliverables have been met, are critical to the success of BIM. The BIM Addendum includes a specific provision to cause the parties to give careful thought to this critical aspect of model management.[66] Additionally, to help document specific Contributor obligations, the BIM Addendum includes a second spreadsheet that summarizes principal deliverables by Phase, including responsible party, the authoring software they will use to create their Model deliverables, any Geometric requirements, the content of any Intelligent attributes of the particular Model and when it is due for exchange with the other Contributors.[67]

Article 5: Risk Allocation

The risk allocation provisions of the 2015 BIM Addendum flow from a simple concept—each Contributor is responsible for the Contributions they make or the data they develop as a result of their access to a Model.[68] In Article 5, each Contributor is required to use best efforts to minimize the risk of claims and each has a duty to report other parties' errors they discover. Everyone involved with Model development gets the right to use Model data only to the extent provided in the BIM Execution Plan, including having an ability to rely on the Dimensional Accuracy of Model data only to the extent the BIM Execution Plan has required it for any given Phase of the project.[69]

A very significant addition to Article 5 is a new section detailing BIM-related insurance coverage requirements. This is particularly important because the BIM Addendum establishes a waiver of many types of consequential damages,[70] and thus, insurance coverage will be the sole monetary remedy for certain types of problems arising from use of building information modeling technology (other than an extension of time granted for delays due to software defects as provided in Section 5.9 of the BIM Addendum). For example, all Contributors are required to obtain "technology or cyber liability insurance, including liability for exposures that include electronic security breaches, mistakes, and unauthorized employee acts, virus attacks, hacking, identity theft or private information loss, and infringing or disparaging content."[71] Those who provide website or other hosting services must provide "electronic data processing insurance, including coverage for electronic data processing (EDP), including media replacement cost coverage and EDP data coverage."[72] In addition, the BIM Manager, Constructors and Design Professionals all are required to get insurance that expressly includes "BIM model management" and "technical consulting" coverage.[73] Since the BIM Addendum can be prepared after some of the project contracts are already in place, care should be taken to cause

Designer and Constructor certificates of insurance to be updated to conform with these BIM-related coverage requirements when the BIM Addendum is adopted and executed.

Article 6: Model Intellectual Property Rights

The final section of the 2015 BIM Addendum provides parties with licensed intellectual property rights needed for Contributors to access, use, and develop project modeling. Echoing the Risk Allocation provisions of Article 5, Article 6 establishes a baseline obligation that each Contributor own or have a legal, licensed right sufficient to grant a license for sharing of their respective Contribution with other contracting parties who will work with BIM on the project.[74]

Several specific, broad use licenses are granted in Article 6. The first, and primary, license is a non-exclusive, project-specific license shared among the Contributors to permit all of them to undertake reproduction, distribution, display and derivative work development of the project Models.[75] A second license, arising after final completion of construction, is granted so each Contributor may keep archival copies of their project-related Contributions.[76] A final optional license can also be granted to the Owner to continue to use the Record Models on those projects where BIM will be used during O&M Phase.[77] This Owner's O&M license can be suspended if the Owner fails to make timely payments as determined by a formal adjudication and resumes upon satisfaction of judgment of the amount owed by the Owner.[78] In addition, to help eliminate concerns about taking on inadvertent liability for changes made by others, Article 6 makes clear that collaborative work related to a specific Model does not automatically result in the creation of a joint work (with its related joint rights of ownership) unless the parties expressly designate it to occur.[79]

BIM is becoming the fulcrum for developing, organizing, delivering and operating structures. Its parametric and intelligent features are supplanting CAD as a design tool entirely, creating results that virtually guarantee it to become the tool of choice for evaluating early design data to undertake lifecycle value analysis. The expanded BIM Uses and delivery process in the ConsensusDocs 2015 BIM Addendum are an excellent way to help parties determine the BIM activities that will add best value to their specific project. The next few years of industry use of the BIM Addendum should help to generate a whole series of new life-cycle related best practices as buildings become more connected in the Internet of Things.

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[2] AM. INST. OF ARCHITECTS, AIA DOCUMENT E202–2008*,* Building Information Modeling Protocol Exhibit (2008).

[3] CONSENSUSDOCS 301, Building Information Modeling (BIM) Addendum (2008) [hereinafter CONSENSUSDOCS 2008 BIM ADDENDUM].

[4] For example, The National Institute of Building Sciences (NBIMs), an organization created to foster meaningful use of BIM in the United States, has expanded its definition of BIM to expressly focus on its lifecycle benefits, defining BIM as having "three separate but linked functions," including the following:

> [A] BUSINESS PROCESS for generating and leveraging building data to design, construct and operate the building during its lifecycle. BIM allows all stakeholders to have access to the same information at the same time through interoperability between technology platforms.
>
> [T]he DIGITAL REPRESENTATION of physical and functional characteristics of a facility. As such it serves as a shared knowledge resource for information about a facility, forming a reliable basis for decisions during its life cycle from inception onwards.
>
> [T]he ORGANIZATION & CONTROL of the business process by utilizing the information in the digital prototype to effect the sharing of information over the entire lifecycle of an asset. The benefits include centralized and visual communication, early exploration of options, sustainability, efficient design, integration of disciplines, site control, as built documentation, etc. – effectively developing an asset lifecycle process and model from conception to final retirement.

National Institute of Building Sciences buildingSMART Alliance, *National BIM Standard, United States*, Version 3, § 3.4.1 (2015), http://www.buildingsmart.org/resources/terms-and-definitions.

[5] Unlike CAD, BIM models are "intelligent**,**" *i.e.*, they have data linked to each object that is a component of a structure, providing further specifications and other information about the object via text balloons that appear when a cursor is tracked over an object image, further specifications included on drop-down lists, and hyperlinks to outside sources of data, such as related RFI and change order lists, schedule and cost analysis spreadsheets. *See* ACCOC. GEN. CONTRACTORS OF AM., BUILDING INFORMATION MODELING EDUCATION PROGRAM, UNIT 3, BIM

CONTRACT NEGOTIATION AND RISK MANAGEMENT PARTICIPANT MANUAL, 1:2–1:4 (2010) [hereafter AGC BIM PROGRAM UNIT 2 MANUAL].

[6] For an excellent listing of BIM analysis tools by discipline, see AGC BIM PROGRAM UNIT 2 MANUAL 3:1–3:30.

[7] *See generally* Penn State Univ. Computer Integrated Constr. Research Program, *BIM Planning Guide for Facility Owners, Version 2.0*, (2013), http://bim.psu.edu/resources/owner/bim_planning_guide_for_facility_owners-version_2.0.pdf. This free planning tool assists project owners with developing a business case for use of BIM on renovation and new construction, and provides extremely helpful explanations of a wide range of BIM lifecycle uses.

[8] For an excellent discussion of the specific changes from the 2008 to 2013 versions of AIA's BIM documents, see Krista Hallberg Kapp, *The What, When and How of the 2013 AIA Digital Practice Documents*, *Construction Law Corner*, Fall 2013 eNewsletter, http://www.lauriebrennan.com/article-The-What-When-and-How-of-the-2013-AIA-Digital-Practice-Documents.html. Of the principal changes to AIA's BIM documents, one of the most helpful is the expanded Model Element Table, permitting designation of specific parties to complete modeling by CSI work division on a phased basis more consistent with the method that BIM design is currently undertaken.

[9] AIA's classic "design-bid-build" sequence of design document preparation (*i.e.*, programming, schematic design, design development, construction documents, and construction phases, as depicted in the AM. INST. OF ARCHITECTS, AIA DOCUMENT B103–2007, Standard Form of Agreement between Owner and Architect for a Large or Complex Project, Art. 3) is giving way to model-specific design sequences that include new BIM-related design phases like massing, clash resolution and federated model analysis stages of design development.

[10] *See, e.g.*, AM. INST. OF ARCHITECTS, AIA DOCUMENT E203–2008, §§ 4.5.2, 4.8 and 4.8.4. It is equally as likely that the contractor or a third party BIM consultant may be the BIM champion, leading model planning and implementation for the project, in which case modification of these forms may be necessary.

[11] The concern that a party other than the author of a particular model might make a surreptitious change to it without knowledge of the author, thereby exposing the author to liability if the change is defective or inadequate, has been largely eliminated by tracking processes that are standard for many BIM software programs today. Virtually every change made to a model can be identified including specifying the party creating it, the date of revision, and the nature and extent of the change—often with additional discretionary, intelligent narrative to explain or document the change that can be embedded in the model. As this documentation is significantly greater than what is possible with traditional CAD, early fears of liability exposure related to unauthorized modification of a BIM design have turned out to be largely unwarranted. *See* Dwight A. Larson & Kate A. Golden, *Entering the Brave, New World: An Introduction to Contracting for Building Information Modeling*, 34 WM. MITCHELL L. REV. 8–26 (2007).

[12] The number of public and private entities in the United States who mandate use of BIM for their projects is growing very rapidly. A sampling of some of the more well-developed government and institutional BIM users' modeling requirements includes the following.

Alabama: Univ. of Ala., *Building Information Modeling (B.I.M)* (2012), http://bis.ua.Edu/Building%20Information%Modeling.pdf. **California:** Univ. of S. Cal., *Building Information Modeling (BIM) Guidelines Version 1.6* (2012), http://facilities. usc.edu/uploads/documents/cas/ BIMGuidelines_VS1_6_2012.pdf; Los Angeles Cmty. Coll. Dist., *LACCD Building Information Modeling Standards (LACCD BIM) Version 3.0* (2010), http://az776130.vo. msecnd. net/media/ docs/default-source/contractors-and- bidders-library/standards-guidelines/bim-design-build- standards.pdf?sfvrsn=2; Los Angeles Cmty. Coll. Dist., *LACCD Building Information Modeling Standards (LACCD BIM) Version 4.0 Lease Lease-Back and Design-Bid-Build* (2015), http://az776130.vo.msecnd.net/media/docs/default-source/contractors-and-bidders-library/standards-guidelines/bim/bim-design-bid-build-standards.pdf?sfvrsn=2; San Diego Cmty. Coll.Dist., *BIM Standards for Architects, Engineers and Contractors Version 2.0* (2012), ttp://public.sdccdpropsn.com/CR/Forms/SDCCD%20%20Building%20Design%20Standards/02.%20BIM%20Standards/SDCCD%20BIM%20Standards%20Version%202.pdf. **Colorado:** Colo. St. Univ., https://www.fm.colostate.edu/construction/constr_standards.cfm, (last visited February 14, 2014); Denver Int'l Airport*, Design Standards Manual 12: Chapter 1 – Electronic Data Collection & Interchange Procedures Manual* (Rev. 2015), http:// business.flydenver.com/bizops/documents/bim-dsm12.pdf. **Connecticut:** Conn. St. Dept. of Educ. (SDE) Bureau of Sch. Facilities (BSF) (2015), http://www.ct.gov/dcs/lib/dcs/bsf/guidelines/guidelines_for_school_districts_and_ design_professionals.pdf; Conn. Constr. Guidelines Coalition, *The Manual for Successful Building Projects* (2nd ed. 2011), http://www.aiact. Org/userfiles/file/PPRT/Guidelines_2011_low.pdf. **Florida**: Univ. of Fla., *Bim Execution Plan, Version 1.1* (2011), http://www. facilities.ufl.edu/announce/BIMExecutionPlan.pdf; Univ. of S. Fla., *BIM Guideline and Standards for Architects, Engineers and Contractors* (2015), http://www.usf.edu/administrative-services/facilities-planning/documents/guide- bim-standards.pdf. **Georgia**: Ga. St. Fin. and Inv. Comm'n, *GSFIC BIM Guide Series 01: Model Analysis and Validation* (2013), https://gsfic.georgia.gov/sites/gsfic.georgia.gov/files/related_files/document/GSFIC%20BIM%20Guide%205.pdf; Ga. Inst. of Tech., *Georgia Tech BIM Requirements & Guidelines for Architects, Engineers and Contractors* (2011), http://www.facilities.gatech.edu/files/DC/2011_0815_GT_BIM_Requirements_v1.0.pdf. **Illinois:** Ill. St. Univ., http://facilities.illinoisstate.edu/facilities_planning/vendor/bim_standards.shtml (follow hyperlink to 13.11.01 BIM Project Execution and Standards Guide V.1); Ill. St. Univ. Facilities Planning and Constr., *BIM Project Execution and Standards Guide V.1* (2013); Univ. of Ill., *Building Information Modeling (BIM) Requirements for Professional Services Consultants* (2012), http://www.fs.illinois.edu/docs/default-source/facility-standards/bim-requirements.pdf?Status=Temp&sfvrsn=4. **Indiana:** Ind. Univ., *BIM Guidelines & Standards for Architects, Engineers and Contractors* (2009), http://www.indiana.edu/~uao/docs/ standards/IU% 20BIM%20Guidelines%20and%20Standards.pdf. **Maryland:** Md./D.C. Assoc. of Sch. Bus. Officials, *BIM Resource Guide* (2013), http://asbo.org/images/downloads/Resources/bim_resource_guide.pdf. **Massachusetts:** Mass. Divis. of Capital Asset Mgmt. and Maint., *BIM Guidelines for Design and Construction* (2015), http://www.mass.gov/anf//docs/dcam/ pubbldgconstr/15-5-28-bim-guide.pdf; Mass. Inst. of Tech., *CAD & BIM Guidelines* (2012), http://web..mit.edu/facilities/maps/MIT_CAD_BIM_guidelines.pdf. **Michigan:** West. Mich. Univ., *BIM Project Execution and Standards Guide for Western Michigan University Facility Management* (2014), http://www.fm.wmich.edu/ap/sg/guidelines/Admin_GUIDELINEs_WMU%20BIM%20Execution%20Plan_V14_current.pdf. **Minnesota:** St. of Minn., *BIM Guideline* (2014), http://www.mn.gov/admin/ images/RECS-CS-BIM-Guideline.pdf. **Missouri:** Assoc. of Gen.

Contractors of Mo., *Construction Guidelines for the Metropolitan St. Louis Construction Industry* (2001), https://higherlogicdownload.s3.amazonaws.com/AGCSTL/e419dcad-6550-44b5-acb5-0bfb0378a44d/ UploadedImages/5.24.12. Construction%20Guidelines%20Complete%20Manual.pdf. **New Jersey:** Port Auth. of N.Y. and N.J., *Building Information Model (BIM) Standard Manual* (2015), http://www.panynj-cadstandards.com/Content/ EAD_BIM/PA- EAD_BIM_Standard_Manual.pdf; Port Auth. of N.Y. and N.J., *E/A Design Division BIM Standard Manual* (2012), http://www.panynj.gov/business-opportunities /pdf/ engineering--consultants-ead-bim-standard-manua-september-2012.pdf; http://www.panynj-cadstandards.com/, (Last updated December, 2015); N.J. Turnpike Auth., *CADD/BIM Manual* (2013), http://www.state.nj.us/turnpike/documents/NJTA_BIM_CAD_032213.pdf; **New Mexico**: N.M. Dept. of Transp., *Autodesk, Guide to BIM* (2012), available at http://www.modlar.com/blog/new-mexico-department-of-transportation-use-bim/. **New York:** N.Y. City Dept. Design and Constr., *BIM Guidelines* (2012), http://www.nyc.gov/html/ddc/downloads/pdf/DDC_BIM_Guidelines.pdf; N.Y. City Sch. Constr. Auth., *Building Information Modeling Guidelines and Standards for Architects and Engineers* (2013), http://www.nycsca.org/Business/WorkingWithTheSCA/Design/Manuals/SCA_BIM_Standards_Manual.pdf; Dormitory Auth. St. of NY, *Building Information Model (BIM) Standards Manual* (2013), http://www.dasny.org/Libraries/Documents_- Construction/DASNY_BIM_Manual.pdf. **North Carolina**: Mecklenburg County N.C., *Plan Submittal Guidelines for the Hybrid Collaborative Delivery Team* (2013), http://charmeck.org/mecklenburg/ county/LUESA/CodeEnforcement/permitting/ Documents/HCDT-Plan%20 Submittal%20Guidelines%201-5-15.pdf. **Ohio**: Ohio Dept. of Admin. Serv., *State of Ohio Building Information Modeling Protocol* (2011), http://das.ohio.gov/Portals /0/DASDivisions/GeneralServices/SAO/pdf/SAO-BIMProtocol.pdf; Ohio St. Univ., *Building Information Modeling (BIM) Project Delivery Standards* (2015), https://fod.osu.edu/bim/ohio-state_bim_pds.pdf. **Pennsylvania:** Penn. St. Univ., *Project Execution Planning Guide Version 2.0* (July 2010), http://bim.psu.edu/; Penn. St. Univ., *Planning Guide for Facility Owners Version 2.0* (June 2013), http://bim.psu.edu/; Penn. St. Univ., *Penn State Office of Physical Plant Building Information Modeling (BIM) Contract Addendum Version 2.0* (2012), http://www.opp.psu.edu/planning_construction/design_and_construction_standards/documents/OPP%20BIM%20Contract%20Addendum. **South Dakota**: S.D. St. Univ., *Computer Aided Design and Drafting (CADD) Standards* (2012), https://www.sdstate.edu/facserv/about/divisions/fac- engineering/ upload/CaddStandards.pdf. **Tennessee:** St. of Tenn. Office of the St. Architect (TN OSA), *Building Information Modeling Standards (BIMs) Version 1.1* (2015), https://www.tn.gov/ finance/article/fa-osa-bim-standards. **Texas:** Tex. Facilities Comm'n, *Architectural Engineering Guidelines* (2012), http://www.tfc.state.tx.us/divisions/facilities/prog/construct/formsindex/01%20-%202012%20AE%20GUIDELINES.pdf; City of San Antonio, *Building Information Modeling (BIM) Development Criteria and Standards for Design & Construction Projects* (2011), https://webapps. Sanantonio.gov/ RFPListings/uploads%5 CRFQ_1223_201103030427040.pdf. **Virginia:** Va. Commonwealth Univ., *Building Information Modeling (BIM) Guidelines and Standards for Architects, Engineers, and Contractors* (2013), http://wp.vcu. Edu/basketballpractice/wp-content/uploads/sites/4053/2014/02/VCU-BIM- Guidelines-09202013.pdf. **Washington:** Univ. of Wash., *CAD and BIM Standards, PDF Requirements and CAD Compliance Review Submittals* (2012), https://cpo.uw.edu/cpo/sites/default/files/consult-opp/Attachment%20G%20-%20%20UW%20CAD%%20Standards%20 and%20Compliance%20BIM%20REV%2004-12_0.pdf; **Wisconsin:** Wis. Dept. of Admin., *Building Information Modeling Announcement and Standards* (2012), http://www.doa.state.wi.us/Default.aspx?Page=b1b89cc2-4688-4669-8e2a-47c2234a8179. **U.S. General Services Administration:** *GSA BIM Guide Overview* (2007), http://www.gsa.gov/portal/content/105075. **U.S. Army Corps. Of Engineers**: *BIM/CIM Contract*

Requirements (2016) and *USACE BIM ROADMAP* (2016), https://cadbimcenter.erdc.dren.mil. **U.S. Air Force:** Air Force Center for Engineering and the Environment, *Building Information Modeling in the Air Force* (2011), https://www.wbdg.org/pdfs//afit_ satellite_course.pdf; **U.S. Dept. of Transp.:** U.S. Depart. of Transp., Fed. Highway Admin., 3D Engineered Models, https://www.fhwa.dot.gov/construction/3d/design.cfm; **U.S. Dept. of Veteran Affairs**: Department of Veterans Affairs, *The VA BIM Guide* (2010), http://www.cfm.va.gov/til/bim/BIMguide/lifecycle.htm.

[13] Outside the United States, there are multiple jurisdictions assertively exploring mandated BIM use, including the following.

Australia and New Zealand: Austl. and N.Z. Revit Standards, *ANZRS blog*, http://www.anzrs.org/blog/; Australian Construction Industry Forum, https://www.acif.com.au/documents/item/724; CRC for Construction Innovation, National Guidelines for Digital Modeling (2009), http://www.construction-innovation.info/images/pdfs/BIM_Guidelines_Book_191109_lores.pdf; *NATSPEC Building Information Modeling Portal, National BIM Guide* (2013), http://bim.natspec.org/index.php/natspec-bim-documents/national-bim-guide; Building Performance, *Building Information Modeling (BIM) in New Zealand* (2014), http://www.building.govt.nz/bim-in-nz. **Canada:** AEC (CAN) BIM Protocol, *Implementing Canadian BIM Standards for the Architectural, Engineering and Construction Industry Based on International Collaboration 1.0* (2012), http://s3.amazonaws.com/canbim-production/vol/www/apps/canbim_ production/ releases/20121021065404/en/public/documents/documents/original_63.pdf?1352735902; AEC (CAN) BIM Protocol, *Implementing Canadian BIM Standards for the Architectural, Engineering and Construction Industry Based on International Collaboration 2* (2014), http://s3.amazonaws.com/canbim-production/var/www/apps/canbim_production/releases/20140529051000/en/public/documents/documents/original_140.pdf?1412121991. **Hong Kong**: Hong Kong Institute of Building Information Modeling, *The HKIBIM BIM Standards* (2013), http://www.hkibim.org/?page_id=1378. **France:** Elaine Knutt, *France and Germany Move Forward on BIM Adoption*, BIM+ (Feb. 12, 2015), http://www.bimplus.co.uk/news/france-and-germany-move-forward-bim-adoption/; Geoff Zeiss, *France Moving Toward Mandating BIM for Public Procurement in 2017*, Between the Poles (Dec. 2, 2014), http://geospatial.blogs.com/geospatial/2014/12/france-moving-toward-mandating-bim-for-public-procurement-in-2017.html. **Germany:** Willkommen Bei AEC3, *BIM-Guide for Germany* (2013), http://www.aec3.com/de/downloads/BIM-Guide-Germany.pdf. **Norway:** Statsbygg, *Statsbygg BIM Manual 1.2.1* (Dec. 17, 2013), http://www.statsbygg.no/Files/publikasjoner/manualer/StatsbyggBIM-manual-ver1-2-1eng-2013-12-17.pdf. **Singapore:** Building and Construction Authority, *Singapore BIM Guide 2* (Aug. 2013), https://www.corenet.gov.sg/media/586132/Singapore-BIM-Guide_V2.pdf. **Spain:** Elaine Knutt, *Spain Launches BIM Strategy with Penciled-in 2018 Mandate*, BIM+ (July 16, 2015), http://www.bimplus.co.uk/news/spain-launches-bim-strategy-pencilled-2018-mandate/. **United Kingdom:** Construction Industry Council, publications available at http://cic.org.uk/publications/; NBS National BIM Library, *NBS BIM Object Standard v1.2* (2014), http://www.nationalbimlibrary.com/nbs-bim-object-standard; HM Government, *Building Information Modeling* (2012), https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/34710/12-1327-building-information-modelling.pdf.

[14] CONSENSUSDOCS 301, Building Information Modeling (BIM) Addendum (2015) [hereinafter CONSENSUSDOCS 2015 BIM ADDENDUM].

[15] A **BIM Execution Plan** is a process developed by contracting parties to identify the purposes for which BIM will be used, who will be responsible for creating project models, developing protocols for model data exchange and identifying model deliverables, including analyses of the 3D model at various points in the design, construction and operation of a structure. *See* CONSENSUSDOCS 2015 BIM ADDENDUM § 2.6.

[16] *Id.* art. 1-6.

[17] *Id.* § 2.6. Article 2 further defines the related concepts used in this definition. "'**Parametric**' means that attributes of construction materials, equipment and assemblies are linked and consistently coordinated and maintained in all Model views and schedules such that a change to a Model Element or other data in any view or schedule is automatically similarly modified in all views and schedules where it appears in the model." *Id.* § 2.36. "'**Intelligent**' means the imbedded specifications, sizes, material definitions, characteristics, manufacturer properties, identification numbers, and other data describing the attributes and configuration of an Element that are readable directly within the model." *Id.* § 2.27. "'**Geometric**' means rectilinear or curvilinear points, lines and surfaces developed using BIM." *Id.* § 2.23.

[18] In the landmark decision, *United States v. Spearin*, 248 U.S. 132 (1918), the United States Supreme Court created an implied warranty for design defects in project plans from the project owner, such that contractors were entitled to rely on the sufficiency of plan and specifications prepared by the architect hired by the owner for design-bid-build projects, even though the contractor lacked contractual privity with the architect. Since contractors are given earlier and more extensive access to Design Model data, and have input on its development, with BIM, questions arose as to whether the *Spearin* doctrine had been eroded or vitiated.

[19] CONSENSUSDOCS 2015 BIM ADDENDUM § 1.7 (modifying former § 1.8 from CONSENSUSDOCS 2008 BIM ADDENDUM).

[20] CONSENSUSDOCS 2015 BIM ADDENDUM § 1.3.

[21] *Id.* § 1.5.

[22] *Id.* § 1.4.

[23] *Id.* § 2.23.

[24] *Id.* §§ 2.17, 2.24.

[25] *Id.* §§ 2.11, 2.42.

[26] *Id.* § 2.16.

[27] *Id.* § 2.5.

[28] *Id.* § 2.41.

[29] *Id.* § 2.10.

[30] *Id.* § 2.18. See also *id.* § 4.6.9, which establishes whether Model data will be required to be dimensionally accurate and/or dimensions will be derived from 2D Drawings instead of the project Models. There are some uses of BIM, particularly during early conceptual activities, when Models are for illustrative or conceptualizing purposes, much like a schematic-level 2D drawing could not be used to develop accurate quantity estimates or be used for actual construction. This provision helps to establish whether the Model(s) needed for the particular project must be prepared to a level that permits reliable scaled measurements to be taken from Model data.

[31] CONSENSUSDOCS 2015 BIM ADDENDUM § 2.26.

[32] *Id.* § 2.29.

[33] *Id.* § 2.30.

[34] *See id.* § 2.31.

[35] For an interesting discussion about potential pitfalls of LOD use, see Brian Renehan, *Pushing LOD off the BIM Cliff* (January 24, 2016), *http://bimfix.blogspot.com.au/2016/01/LOD-FalsePremis.html.*

[36] *Id.* § 3.1.

[37] *Id.* §§ 3.2.1–3.2.17.

[38] *Id.* § 3.2.11.

[39] *Id.* § 2.30.

[40] *See* buildingSmart, *IFC Overview Summary*, http://www.buildingsmart-tech.org/specifications/ifc-overview. The IFC model specification is registered by ISO and is an official International Standard ISO 16739:2013f.

[41] The Green Building XML (gbXML) open format platform helps facilitate the transfer of building properties stored in 3D building information models (BIM) to undertake engineering and sustainability analysis. *See* gbXML, *Background*, *http://gbxml.org/aboutgbxml.php.* AgXML is a royalty-free open standards file format to facilitate real time communications when running 3D architectural modeling software. *See* Web 3D Consortium, *Open Standards for Real-Time 3D Communication*, http://www.web3d.org*.*

[42] CONSENSUSDOCS 2015 BIM ADDENDUM § 4.1.

[43] Penn State Univ. Computer Integrated Constr. Research Program, BIM Project Execution Planning Guide and Templates: Version 2.0, http://www.bim.psu.edu/, and *BIM Planning Guide for Facility Owners, Version 2.0*, (2013), http://bim.psu.edu/resources/owner/bim_planning_guide_for_facility_owners-version_2.0.pdf.

[44] CONSENSUSDOCS 2015 BIM ADDENDUM § 4.4.1.

[45] *Id.* § 4.4.2.2.

[46] *Id.* § 4.4.2.4.

[47] *Id.* § 2.19. Digital Fabrication is defined as "the process by which machine technology is used to prefabricate Elements used in construction directly from Model data, including spooling into appropriate sections and inputting into fabrication equipment for production of system assemblies to be used in construction of the Project." *Id.*

[48] For more information on emerging practices related to construction industry prefabrication, see Kevin T. Colby and Lee C. Davis, *The Rise of Modular Construction: A Changing Legal Landscape*, J. AM. COLL. OF CONSTR. LAW., Vol. 9, No. 1, 123–177 (Winter 2015). For more information about construction industry uses of 3D printing, see Vince Anewenter, Kimberly A. Hurtado, Josh M. Leavitt, and Timothy D. Tonyan, *Brave New Extruded World: Legal Issues Arising in the Construction Industry from Using Additive 3D Printing Technology,* J. AM. COLL. OF CONSTR. LAW., Vol. 9, No. 2, 2–53 (Sumer 2015).

[49] CONSENSUSDOCS 2015 BIM ADDENDUM §§ 4.4.2.4, 4.4.2.9.

[50] *Id.* § 4.4.2.7.

[51] *Id.* § 4.4.2.10.

[52] *Id.* §§ 4.4.3.2–4.4.3.4.

[53] *Id.* §§ 4.4.3.5, 4.4.3.6, 4.4.3.8 and 4.4.2.9.

[54] *Id.* § 4.4.3.7.

[55] *Id.* §§ 4.4.3.11 and 4.4.2.12.

[56] *Id.* § 4.4.

[57] *Id.* § 4.4.4.4 and Chart A, "O&M Deliverables."

[58] *Id.* § 4.4.5.3(a)–(d).

[59] *Id.* §§ 4.4.5.5 and 4.4.5.6.

[60] *Id.* §§ 4.4.5.8, 4.4.5.7 and 4.4.5.12.

[61] *Id.* § 4.5.

[62] For a description of the Construction-Operations Building Information Exchange (or COBie) process for creating electronic data base asset management lists, visit http://www.wbdg.org/resources/cobie.php.

[63] CONSENSUSDOCS 2015 BIM ADDENDUM § 4.5.1.2.

[64] Using a zone that cuts through the center of a floor, if that is where the mechanical runs will be, for example, precludes the mechanical contractor from undertaking meaningful 5D cost analysis derived from the Model because each zone must be manually added to the others, along with connections from zone to zone.

[65] CONSENSUSDOCS BIM ADDENDUM § 4.6.13.

[66] *Id.* § 4.7.4.

[67] *See id.*, Chart B, "Modeling Requirements."

[68] *Id.* § 5.1.

[69] *Id.* §§ 5.4–5.5.

[70] *Id.* § 5.2.

[71] *Id.* § 5.8.4.

[72] *Id.* § 5.8.5.

[73] *Id.* §§ 5.8.1–5.8.3.

[74] *Id.* § 6.3

[75] *Id.* § 6.1

[76] *Id.* § 6.2.1

[77] *Id.* § 6.6

[78] *Id.* § 6.6.1.2

[79] *Id.* § 6.4.3