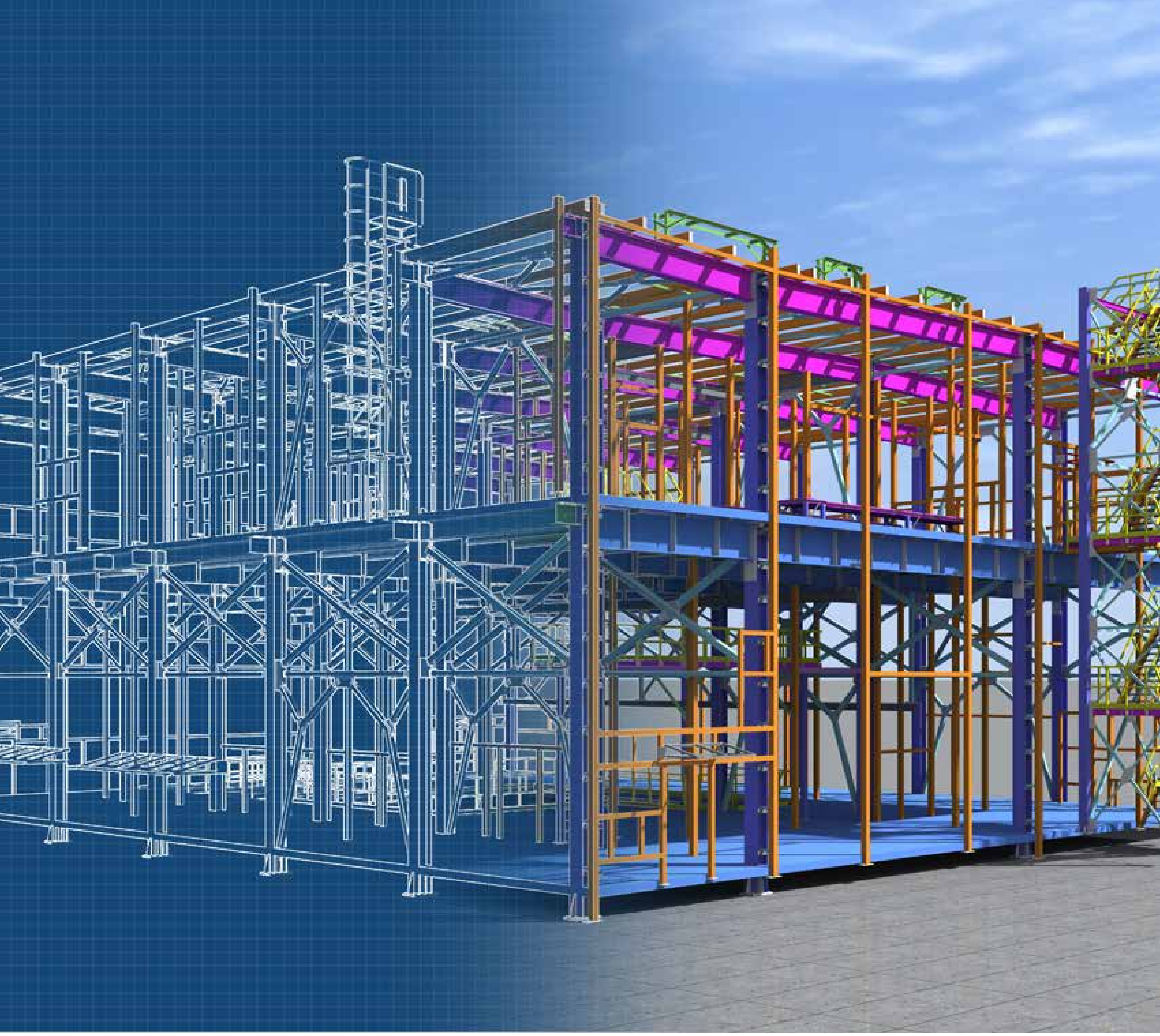

BIM & VDC
for Structural Steel

AMERICAN INSTITUTE OF STEEL CONSTRUCTION
FOUNDED 1921

Smarter.
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Printed in the United States of America

BIM & VDC for Structural Steel

Mission Statement

To provide an introduction and clarification to the steel industry in regards to Building Information Modeling (BIM) and Virtual Design and Construction (VDC). This document is not intended to provide a comprehensive or contractual outline for BIM practices. Rather, it is a guideline for what you may see in everyday practice within the building industry. BIM and VDC are tools and processes, for use within the steel industry and be used in conjunction with the AISC *Code of Standard Practice for Steel Buildings and Bridges*.

Be aware that this printed document may not contain the most recent information. Visit **aisc.org/bimguide** for the latest developments.

Acknowledgments

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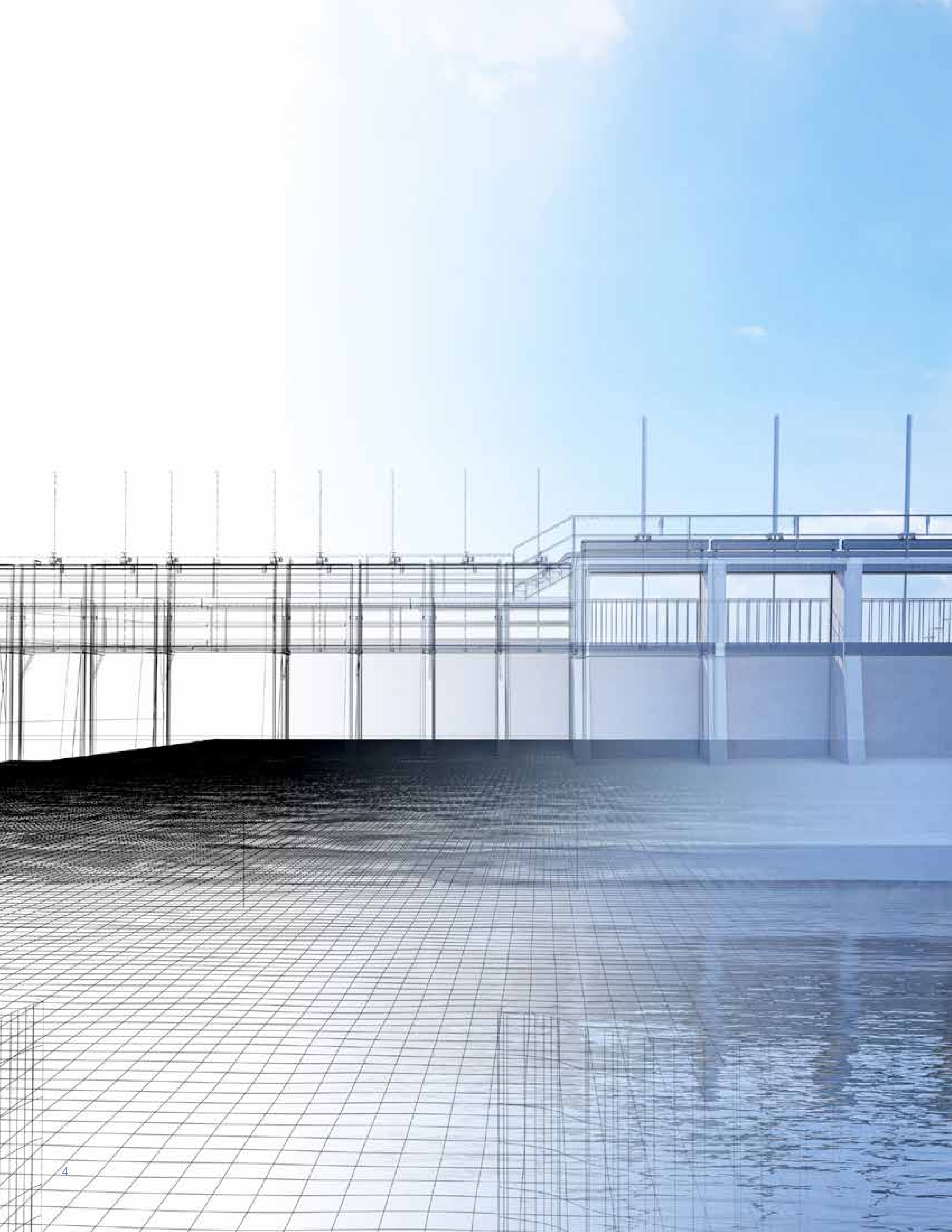


SECTION 1

Understanding BIM

Leaders in the structural steel industry have been using 3D modeling for decades now; however, 3D modeling and BIM are different processes.

BIM is often misappropriated to mean simply 3D modelling, but it goes far beyond that. The information in a Building Information Model can be more than just 3D geometry. For example, the model may include analytical, construction simulation data, scheduling data, cost data, facility management data, and even 2D drawings in some cases.

BIM can undoubtedly be a complicated concept, made more so by the fact that there is no universally agreed upon definition. BIM is often used as both a noun and verb—as a noun, the Building Information Model, and as a verb, Building Information Modeling, the process through which the model is produced, used, or coordinated. The most commonly agreed upon definition of BIM is from buildingSMART International:

> *Building Information Modeling (BIM) is a digital representation of physical and functional characteristics of a facility. A BIM is a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life-cycle; defined as existing from earliest conception to demolition.*

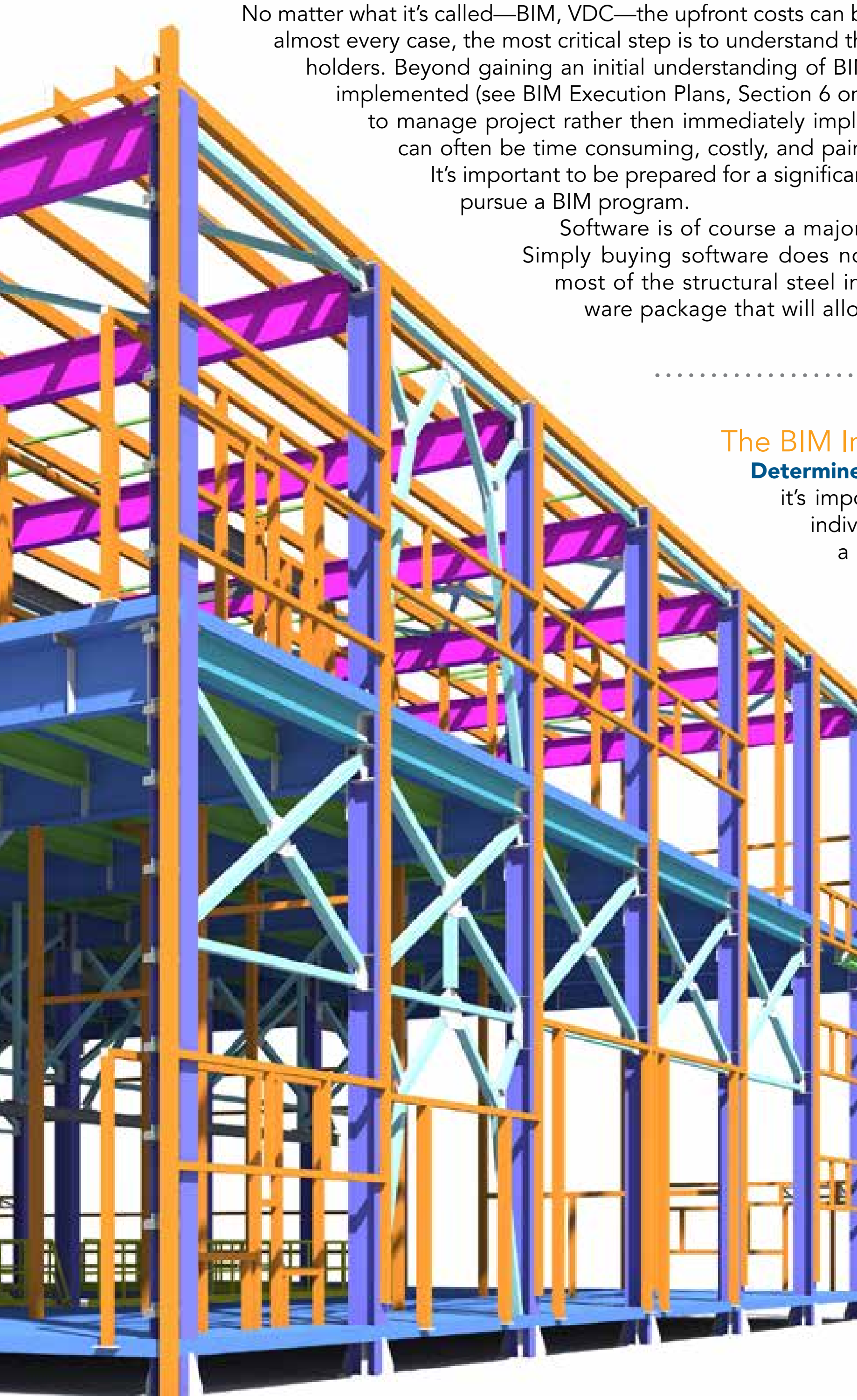
When describing the actual process of collaborating and creating models, Virtual Design and Construction (VDC) is a more appropriate term that is often used interchangeably with BIM(v). While it's easy and relatively common to conflate BIM, 3D modeling, and Virtual Design and Construction, for the purpose of this guide the terms will be defined specifically and independently.

> *VDC emphasizes collaboration and integrated working, and BIM is frequently a valuable part of VDC. BIM and VDC should not be considered analogous, however. Virtual design and construction need not necessarily involve building information modeling, and building information modeling can be undertaken without it being considered part of virtual design and construction. BIM is a much more specific process than VDC, but both are essentially methods of planning and managing a project collaboratively.*

For more information, please visit:
https://constructible.trimble.com/construction-industry/whats-the-difference-between-3d-cad-bim-and-vdc

SECTION 2

Getting Started with BIM



No matter what it's called—BIM, VDC—the upfront costs can be considerable and need to be taken into account. In almost every case, the most critical step is to understand the requirements for both you and other project stakeholders. Beyond gaining an initial understanding of BIM, it's important to decide on what scale BIM will be implemented (see BIM Execution Plans, Section 6 on page 14). Many choose to begin with a small, easier to manage project rather then immediately implement it company-wide. Establishing a BIM program can often be time consuming, costly, and painful, and ROI often takes a significant period of time. It's important to be prepared for a significant learning curve once the decision has been made to pursue a BIM program.

Software is of course a major consideration. BIM cannot be purchased in a box. Simply buying software does not automatically enable BIM compatibility. In 2019 most of the structural steel industry has already implemented some sort of software package that will allow participation in BIM-driven project.

The BIM Implementation Process

Determine how you're implementing: Top-down or bottom-up, it's important to understand how BIM is being driven at an individual company. Is it coming from management as a mandate (top down) or is it being driven by other employees (bottom up)?

In general, BIM is most successful when it's being driven by and comes with full buy-in from management. It is, however, not unheard of for the BIM adoption process to originate in mid or lower-level management. Successful BIM implementation typically requires careful planning, scheduling, and purchasing, which is why top-down BIM is generally regarded as having a better opportunity to succeed.

Develop a strategy and cost: There are multiple use-cases for BIM, ranging from relatively easy to complex. Part of the implementation process is deciding why you are using BIM. Are you, for example, using BIM to improve internal quality? Are you using it at the request (or demand) of a customer? Is it required in the bid documents of project that you've been awarded? In addition to these questions, your strategy should include additional purposes (or use cases) for the model with definable, achievable targets. You may identify as a target the use of a model for clash detection (relatively simple) or you may determine that a model should be used for all production planning, and erection sequencing (more complex)—or anywhere in between.

Software selection: In an ideal world, selecting software that best fits the company's planned BIM usage would be part of the implementation process. In reality, most fabricators, detailers, and engineers already own a variety of capable software packages and can begin the implementation process around software.

Identify key players: The most consistent factor in successful BIM implementation is that there must be a BIM champion who is empowered and enthusiastic. Having someone (or a group) tasked with leading the transformation is critical. It is too easy for a group to lose its way, lose momentum, and revert back to old methods at the first sign of trouble without a champion or cheerleader driving the effort.

Beyond a champion, it is also important to identify the "who" in the company in terms of users. Is the aim for company-wide implementation or will a specialized group be dedicated to BIM?

Establish schedule: It is tempting to say "it'll take as long as it needs to," as a show of commitment to a new process, but setting and sticking to a realistic schedule will allow for a more controlled and better managed roll-out. Establishing a schedule helps create accountability with BIM implementation. You will almost certainly run into something unexpected. Having as few open-ended targets as possible will help mitigate the severity of unexpected, unpleasant surprises.

Other Critical Factors

Training: Once the "who" and the schedule have been identified training can begin. Work with your software vendor and explain your goals to help develop a realistic training timeline. Training can vary by position. Management, for example, may require fewer hours and less specific training than an everyday user will.

Hardware and IT: It's easy to overlook, but you must have hardware capable of running your system. Check with your software vendor to ensure that you have the right hardware. Requirements are constantly changing, and hardware performance is (mostly) constantly improving. Your vendor will be able to tell you both minimum and recommended hardware. Don't make any assumptions that your current hardware set-up is sufficient to support a new workflow.

An often-used rule of thumb for the cost of buying software, necessary hardware, and staff training is to take the price of the software alone and double it.

Connectivity can be particularly concerning for fabricators as their significant space requirements tend to push them further from urban centers and can leave limited choices in terms of available service.

Connectivity: Along with hardware and IT, you should review your connectivity options. Software and implementation can be a sizable investment, and the last thing you want to find out is that you're isolated by the inability to secure a good connection to move your data. Ensure that you have sufficient monthly data to move large projects and get a sense for how fast your upload/download speeds are.

Budget: When formulating a budget, at a minimum consider hardware recurring costs, replacement costs, software licensing costs, cloud and networking costs, connectivity costs (which may have implications for firewall performance and IT security), and costs for special licensing as needed on specific projects, and training costs (including courses, continuing education). Software vendors, resellers, and other service providers can help develop a cost estimate for these items.

Other considerations: While long-term storage may seem less urgent, it is no less important. Your process must consider audit trails, file storage, and document control. All issues of the model will need to be stored until the final completion of a project. Longevity and archival access should be considered as well. Will the authoring tool exist in ten years and will you be able to open the files in case of expansion or litigation?

Cloud-based technology has emerged as a solution to many of these issues. Software companies are continually working to improve this disparity between the development phase and construction phase to meet the communicative requirements.

Security: It will be important to work closely with an IT professional to ensure that a comprehensive set of security protocols are in place for all participants. With malware and ransomware on the rise, it will be critical to have a written set of security protocols for team members to follow.

It's equally important to consider a set of disaster recovery procedures in your budgeting process. Hardware can fail, and software can crash. A comprehensive set of backup procedures should be in place to insure a minimal loss of data. In a VDC environment, many can be adding to the BIM.

SECTION 3

Interoperability

Interoperability is a foundational component of BIM. It can be difficult to create a Building Information Model without at least some degree of interoperability, and, more likely than not, a high degree of interoperability is going to be required for successful execution.

Terms such as interoperability and round-tripping are often used in BIM conversations, but their meanings have been ill-defined and they are often used interchangeably. However, it is important for practitioners to draw a clear distinction between the two and to understand the specific requirements, challenges, and pitfalls of effective implementation of interoperability in your project.

The AGC BIM Education Program offers a clear definition of Interoperability:

> *The exchange of information among project participants throughout the lifecycle of a facility by direct communication between software applications. This is accomplished via a common set of exchange formats to read and write the same file formats and use the same protocols.*

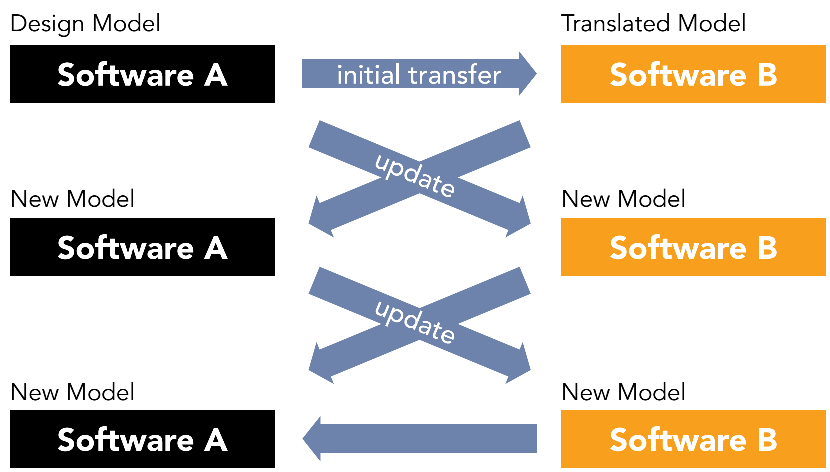
Defined more simply: Interoperability is the ability of a software platform to link or share information with another platform. Interoperability can be achieved through either a neutral file format, application programming interface (API), or other proprietary link.

This definition has evolved with the rise of cloud-based systems that allow the participants to forgo the writing of a common file transfer and push and pull data of an object from a common model to each discipline.

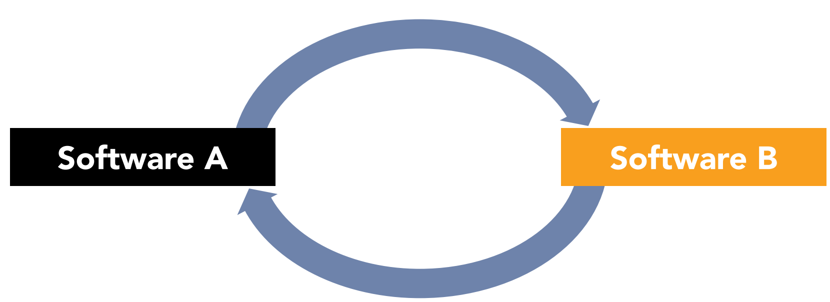
Round-tripping generally refers to exchanges between two (or more) separate disciplines that exchange a model. For example: A exports an engineer's analysis or structural model to the file format best suited to a project or task's needs. B imports that file into a structural fabrication software to create or update the fabrication model. The fabricator's structural detailer modifies and adds fabrication details to the model and then exports it to the same file format. That new file is then imported into the original engineering model, updating it with the new information.

Linear Interoperability—No Collaboration

Linear Interoperability—With Collaboration



"Round-trip" Interoperability



Interoperability Processes

When using a linear interoperability processes, each transfer from one platform to another results in a new model. This becomes a challenge in cases where collaboration requires accurate model information to be shared between trades. For example, if the detailer updates model geometry, the designers would need to manually update their models to see the same change.

Round-trip interoperability is usually facilitated by a program's API. This allows a plugin to be created—and many already exist—that will transfer geometry information, materials, BIM metadata, and more, all tracked by recording the Global Unique ID (GUID) of each object in its respective platform. But this kind of interoperability isn't a perfect process due to differences in vendor platforms.

When data is pushed from one platform to the next, and similar changes are made to the same elements in each platform, there may be difficulties reconciling those changes. When the data is updated, the receiving platform may lose information. While this is a big concern, it should not be a deterrent. There are many ways to incorporate element ownership into your process. What this means is that when portions of a project are released to another trade, a narrative describing the ownership should be incorporated, preferably using model parameters or attributes to tag each element that is released.

Challenges with Interoperability

Interoperability is not without challenges. One of the challenges is the transfer of data from the design or development phase of the process to the construction or fabrication phase. In situations where the design is communicated through a 3D model, expect to spend a significant amount of effort adding the fabrication information. Design models will typically contain only primary members, requiring a professional steel detailer to input items such as connections, stairs, rails, lintels, and pour stops. It is important that the design team is able to effectively communicate the information required for these secondary and miscellaneous items when traditional 2D contract drawings are not being used.

The fidelity of the data interpreted by the software can sometimes be an issue, too. It's important to validate information created from an imported model by checking it against the source model. Make sure the model elements are being imported to the correct origin, with the proper rotation and justification (center for columns and braces, below for beams, etc.). Many steel detailing software packages have ways to do this with built-in tools or reports.

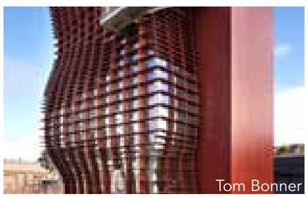
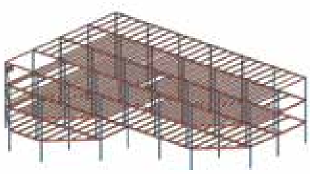
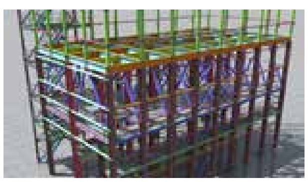
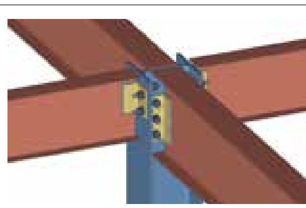
In many cases, revisions can cause transfer problems. For example, the design model may have had the sloped roof input as flat. The subsequent fabrication model corrected the roof slope. When a revision occurs in the design model, what happens to the fabrication model elements? This is where it becomes beneficial to establish a highly-collaborative round-tripping workflow, in which geometry changes from the fabrication model are pushed back to the design model. In the most collaborative processes, it becomes necessary for object ownership to shift from the design team to the fabricator as the objects are released for mill order. This is typically achieved by defining a set of parameters for elements to be tagged with an owner. The workflow for how revisions are communicated should be established in your BIM execution plan (see Section 6 on page 14).

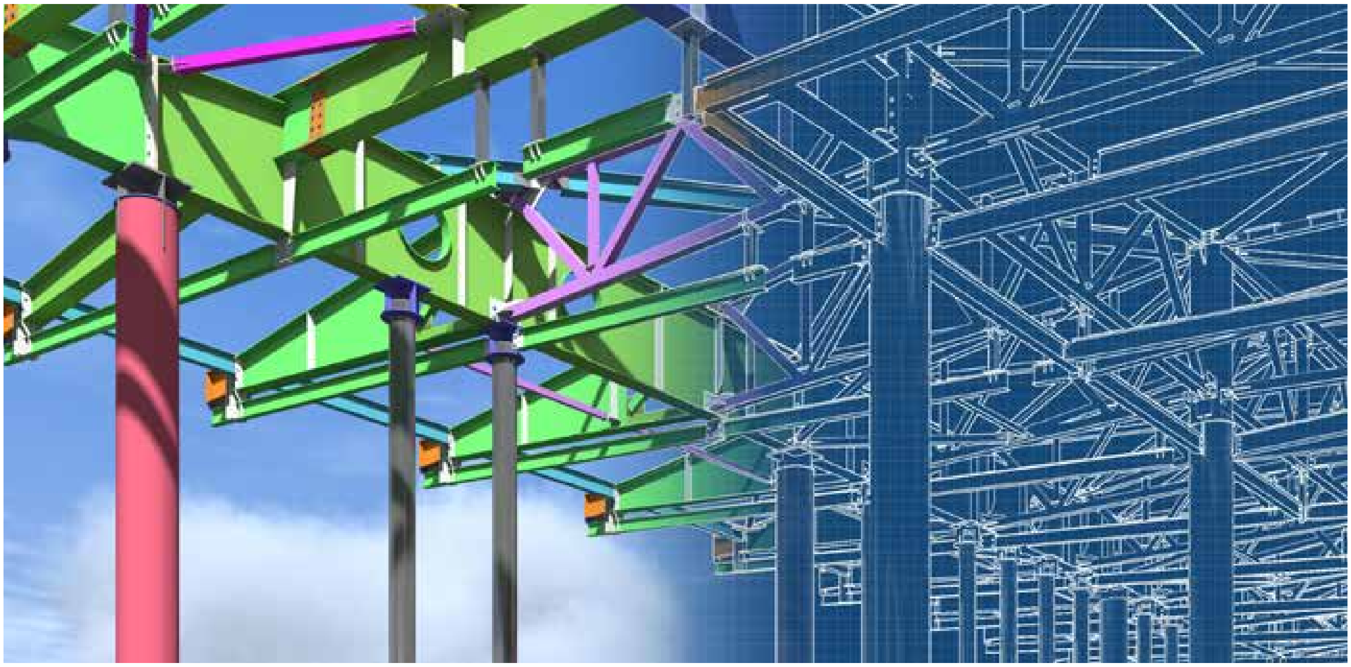
Models are now being used at the site and for facility management, and not all companies have all the required software. When planning the project workflow, it is beneficial to identify the needs of the project stakeholders and the lifecycle of the model. Not all information will need to be transferred for everyone's work. A federated model that brings all trades together for field planning is the ultimate goal, as that facilitates important pre-construction tasks such as clash detection and site planning.

At times it is not the interoperability of the software but the availability of the software that creates a challenge. Each of the widely used fabrication software has a different approach to their models and software architecture. This will affect interoperability. Some feel that only one software suite can be used but due to the diversity of structures and their requirements, you will be hard-pressed to find a software suite that completely satisfies the industry from conception to facilities management. Reliable interoperability is an absolute necessity.

Model Views and Uses

A critical part of BIM or VDC is determining not only which software packages you are communicating with but also what type of model you are using, sending, or receiving. The model may be a documentation model (e.g., REVIT/BENTLEY), structural design analysis model (e.g., RAM/RISA), or fabrication model (e.g.,TEKLA Structures/SDS/2/Advance Steel). You know what type of model you are working with, and define what type of model to expect as part of your BIM process.

Model Type	Image	Example Software Packages*	Description [Key Items Defined]
Architectural Design and Analysis		ArchiCAD, Revit, MicroStation, Rhino, SketchUp	Architectural model used to define building components and used for quantity take offs, area planning, code analysis, and to create architectural drawings. [Floor-to-floor heights; may also include slab edges, misc. steel, stairs]
Structural Analysis		RISA, ETABS, Robot, SCIA, RAM, Tekla Structural Designer	Structural engineers build several analysis models for different building components (lateral, gravity) which may be created before a documentation model. [Simple line representation of structural steel (centerline, top of steel, etc.); may include sizes, splice locations]
Structural Documentation Model		Revit, Tekla Structures, MicroStation	Structural model that is used for geometric coordination with other disciplines and to create structural design drawings. [Includes structural steel member sizes]
Coordination Models		ArchiCAD, BIM 360 Glue, Navisworks, Trimble Connect, Solibri	Coordination models typically created by general contractors to detect conflicts between the models from different disciplines.
Mill Order Model		Tekla Structures, SDS/2, Advance Steel, Bocad	A model created by the fabricator (or sometimes the general contractor) that contains key structural steel elements to facilitate early costing and ordering of structural steel.
Fabrication Model		Tekla Structures, SDS/2, Advance Steel, Bocad	A model created by the steel detailer in order to create shop drawings for the fabricator and/or CNC files.



Expanded Explanations of Models

Highlighted sections indicate definitions from the AISC *Code of Standard Practice for Steel Buildings and Bridges (Code)*. Definitions from the *Code* should always take precedence over any other definition. Beyond definitions from the *Code,* this guide offers further clarification on model types. This is for clarification only and should not be expected to supersede definitions from the *Code*.

Structural Analysis Model

The structural analysis model(s) is used to evaluate the structural behavior of the structural design model. Based on the results, the Structural Design Model maybe be refined multiple times in an effort to create the most optimal structural system.

Design Model (Structural Design Model)

A dimensionally accurate 3D digital model of the structure that conveys the structural steel requirements given in *Code* Section 3.1 for the building.

Coordination Model

This model is typically created/managed by the GC/CM but may also be managed by a separate BIM Manager. The model is typically used for purposes of clash detection between trades but may also be used to schedule and sequence a project.

Mill Order/Early Detailing Model

This is a preliminary model that is imported into a fabrication authoring tool to be used for estimation purposes. The quality of this model depends on the original authoring tool and the group of people that builds it. These models may need some considerable clean-up before use. Some will contain connection information while others may not or contain only partial connection information.

Fabrication (Detailer's) Model

A dimensionally accurate 3D digital model produced to convey the information necessary to fabricate the structural steel. This may be the same digital model as the erection model, but is not required to be.

This model is closest to what is fabricated. All the primary and secondary members are included. Note that some buy-out items may not be included in the model. It is important that the missing items are communicated.

Erector Model (Per the AISC *Code*)

A dimensionally accurate 3D model produced to convey the information necessary to erect the structural steel. This may be the same digital model as the fabrication model, but is not required to be.

For the purposes of final planning, the fabrication model is typically used due to its higher accuracy and LOD (see next section). In some cases, a structural design model may be used for preliminary planning to determine phasing and sequencing.

Approval Model

This model is used for the approval process by the engineer in lieu of the traditional shop drawing review. Typically, the review model is the same as the fabrication model. When using this process it is strongly advised that the engineer use the same software in which the model was authored for the review process.

SECTION 5

Level of Development

Level of Development

The Level of Development (LOD) *Specification* is a reference tool intended to improve the quality of communication among users of BIMs about the characteristics of elements in models. The LOD *Specification* expands upon the LOD schema developed by the American Institute of Architects (AIA) for its E202-2009 BIM and Digital Data Exhibit and updated for the AIA's G202-2013 Project BIM Protocol Form by providing definitions and illustrations of BIM elements of different building systems at different stages of their development and use in the design and construction process. Building information modeling presents information about a construction project or structure in the form of 3D graphical representations of elements (e.g., doors, beams, etc.) that 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 brief narrative definitions left too much room for interpretation. Discussions within the BIMForum led to the creation of the LOD *Specification* by a multi-disciplinary task force. The LOD *Specification* is an organized collection of interpretations of the AIA's LOD definitions describing input and information requirements and providing graphical examples of the different levels of development of a broad variety of building element classes. The LOD *Specification* does not prescribe the necessary levels of development for different steps in the construction process. That determination is left to each project team. It is believed, however, that the availability of more precise definitions 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, through 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 (and in a few cases to Level 5) to provide detail and clarity to the element definitions. The LOD *Specification* addresses only LOD 100 through LOD 400 of the AIA's LOD Schema, along with a new level—LOD 350—which was added between LOD 300 and LOD 400 to better address the information levels required for effective trade coordination. The LOD *Specification* does not address LOD 500 since that LOD relates to field verification and is not an indication of progression to a higher level of geometry or information.

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, the document does provide a concise schematic means through the spreadsheet in Part II for a project team to identify model element authors, again in the interest of improving communication among model users. In addition, the LOD *Specification* task force has been working with software developers to provide a means within the software of tagging individual elements within a model with their current LOD level. The LOD *Specification* is intended as a reference standard, but is also intended to evolve as the use of BIM develops. The *Specification* is updated annually, and previous versions are maintained on the BIMForum website (**www.bimforum.org/lod**). Users are invited to provide comments and recommendations for consideration in future editions.

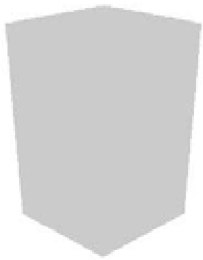
Level of Development vs. Level of Detail?

These terms are often used interchangeably, but there are important fundamental differences. The primary function of Level of Development is to communicate the amount of thought or development that has gone into a model element. Level of Detail explains how much detail has been included in an element. BIMforum's LOD guide explains it as follows:

> *In essence, Level of Detail can be thought of as input to the element, while Level of Development is reliable output.*

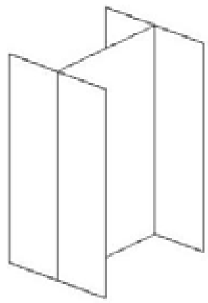
LOD is intended to be used in conjunction with a BIM Execution Plan (BxP/BEP in the following section).

It is highly recommended that readers download the complete LOD *Specification* from BIMForum and thoroughly review it to get a more complete and in depth understanding of this concept. A sample of LOD as it relates to structural steel can be found to the right.



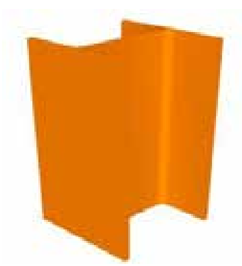
100: Conceptual. The Model Element may be graphically represented in the model with a symbol or other generic representation but does not satisfy the requirements for LOD 200. Information related to the Model Element (e.g., cost per square foot, tonnage of HVAC, etc.) can be derived from other Model Elements.

Explanation (from BIMForum): 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.



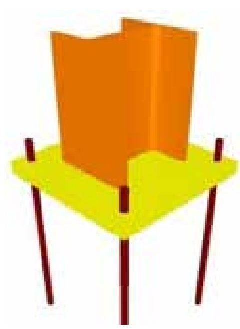
200: Generic Placeholders. The Model Element is graphically represented within the model as a generic system, object, or assembly with approximate quantities, size, shape, location, and orientation. Non-graphic information may also be attached to the Model Element.

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.



300: Specific Assemblies. 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.

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.



350: Detailed Assemblies. 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.

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.

400: Detailed Assemblies. 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.

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.

SECTION 6

BIM Execution Plans

One of the tools considered most critical to a successfully executed BIM projects is a BIM Execution and Planning Guide (BEP or BxP). A BxP will help identify and define successful tactics and strategies to effectively and successfully carry out a BIM project. **BIM Execution Plans are meant to establish the framework for many different key aspects of a project such as:**

- Who will serve as BIM Manager for the project?
- What are the various project milestones?
- Where and how often will project coordination meetings take place?
- Who is the responsible party for each project stake-holder?
- Model discipline: How often will the model be updated? And who has rights to update the model?
- What exchange formats will be used on the project for model/data exchange?
- Who ultimately owns the model? (Usually it's the project owner.)

It's important to understand that this is not an all-inclusive list, nor can the BxP answer these questions or fill in blanks. It will not serve as a substitute for project experience or knowledge. It can, however, go a long way to helping establish project guidelines and expectations.

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. Penalties clearly stated in the BxP discourage contributors 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 trade's 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" on **www.bimforum.org**.

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 SMART (Specific, Measurable, Attainable, Reasonable, and Time-bound) schedules provide accountability and direction. 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.

Incorporating the BxP into project documents

The BxP and other BIM requirements should always be included in bid documents and should not be introduced later. It is vitally important that any added project requirements are known prior to bidding. Different BIM requirements can represent significant expenses and can vary widely.

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.

Implementing a BIM Execution Plan

According to AGC BIM 101 guide, there are four methods of implementing a BEP:

Top-down: In this approach, the company's upper management makes a decision to use BIM on current and upcoming projects. Management provides support to reach the technology objectives and articulates strategy to the entire company.

Bottom-up: Individual employees who want to learn the new tools start the process of implementing BIM within the organization. This action frequently takes place with little or no management support.

Parallel: The company selects one construction project as a pilot study of BIM implementation, while following traditional methods on other projects. Afterward, the results are used to evaluate the potential of BIM.

Organic: A mixture of the above.

Examples of BxPs

There are numerous BxP templates available for users to take advantage of, with subtle differences between many of them.

BIMForum BIM Execution and Planning Guide

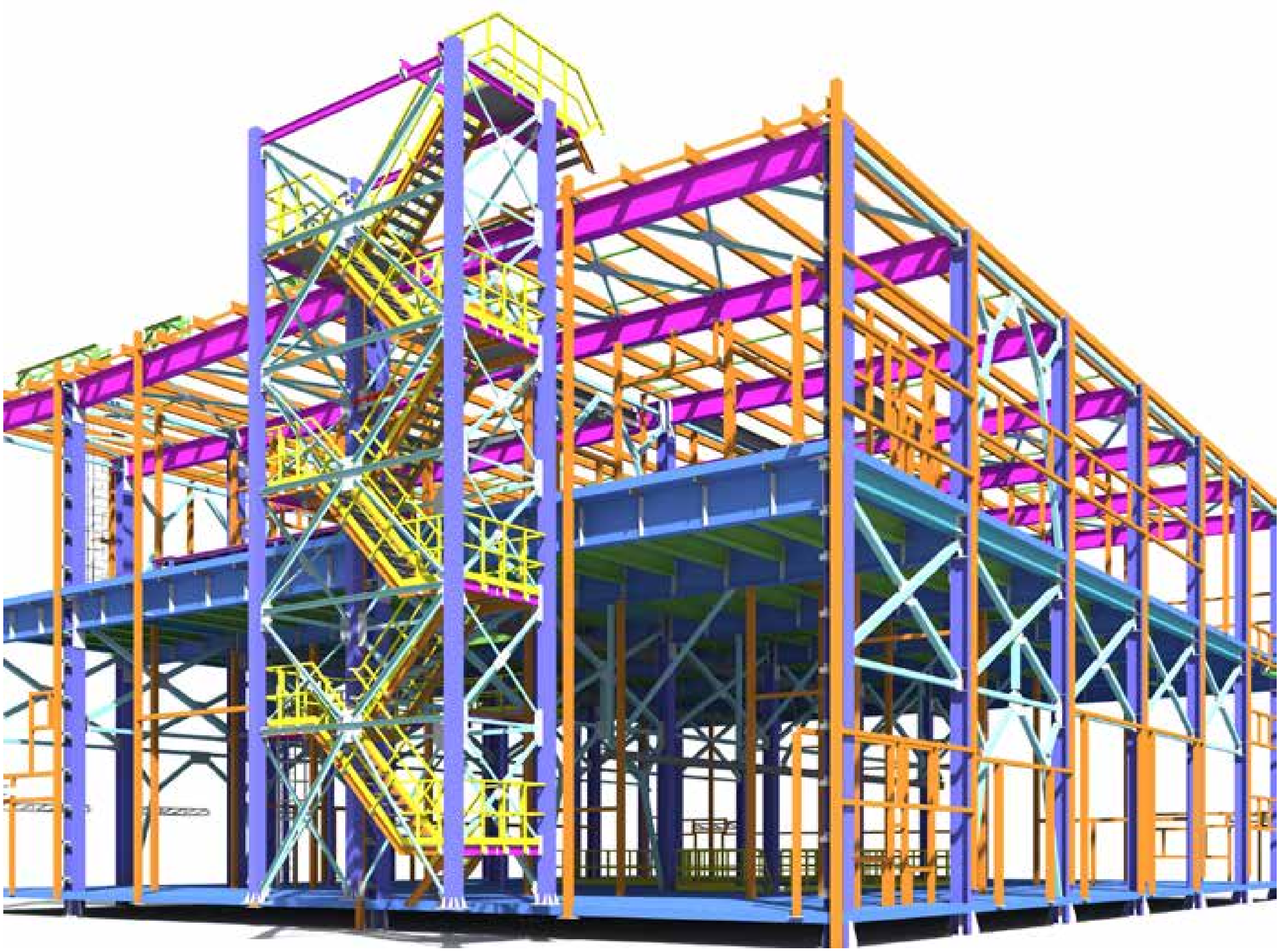
Generally intended for projects under $150 million and under five stories. Intended to introduce BxP concepts to any project stakeholder.

Penn State Project Execution Planning Guide

Aimed primarily at owners and institutions, the Penn State guide has been incorporated into the National BIM Standards. Penn State also offers guides on Uses of BIM, Models in Construction, and BIM Planning for Facility Owners.

GSA

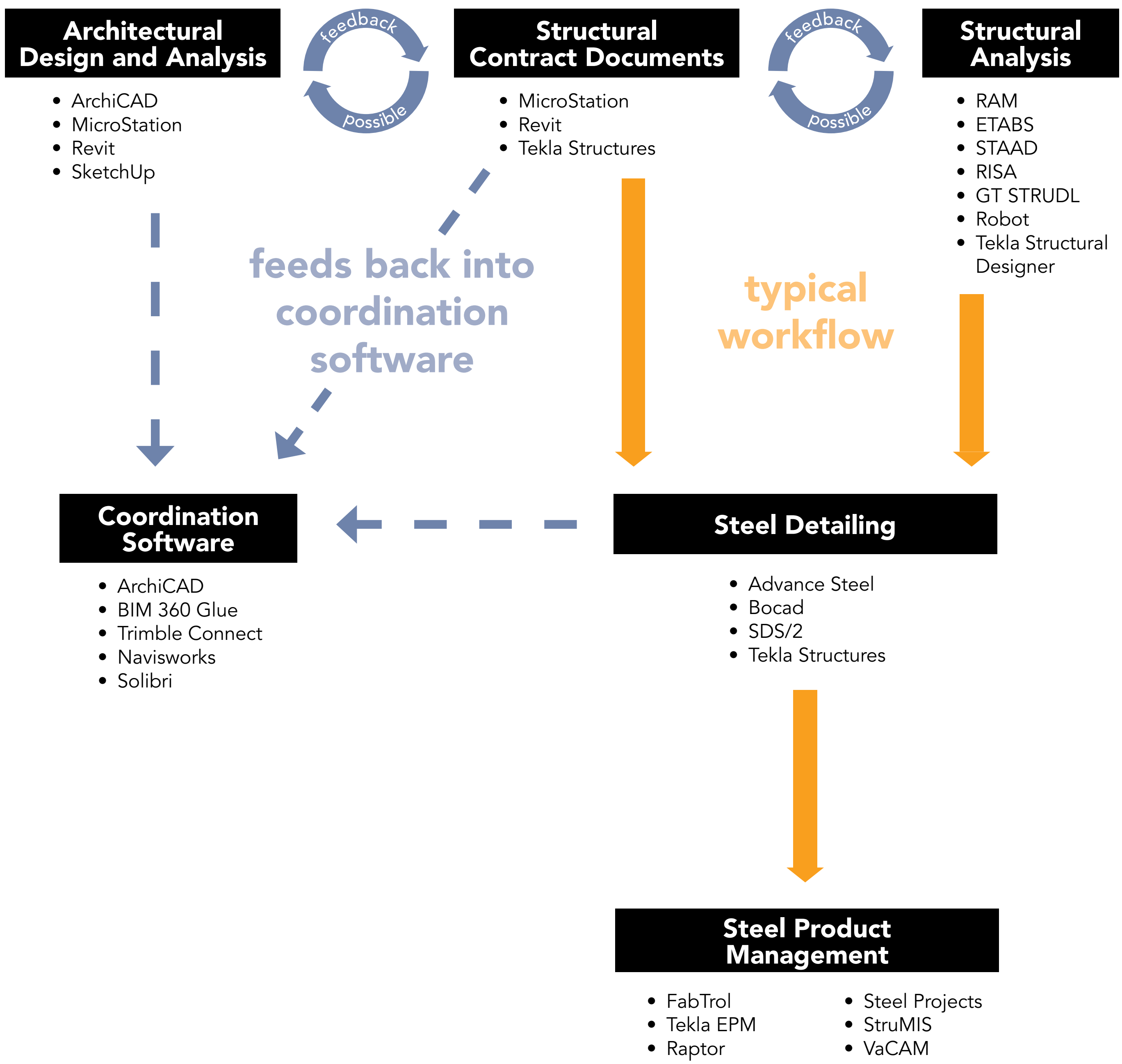
Fillable Word document with key dates, stake-holders, benchmarks etc. Designed for GSA projects.



SECTION 7

BIM Software Ecosystem

Structural Steel BIM Ecosystem



This list is representative of software typically used at the time it was published. It is not intended to be exhaustive.

SECTION 8

Overview of File Formats

3D DWF
Proprietary file type used in AutoDesk products like Revit.

3D DXF
Proprietary file type used in AutoDesk products like Revit.

AP203, AP214, AP242
The STEP standard focuses on product data representation to support CAD/CAE and PDM data exchange, system integration, visualization, and long term preservation of product information. The automotive and aerospace industry in the U.S. and Europe helped establish organizations to ensure the overall consistency of CAD and PDM information interoperability specifications. Two STEP standards that are widely implemented are AP 203 (maintained by PDES, Inc.) and AP 214 (maintained by ProSTEP iViP and SASIG). AP 203 is primarily supported by the aerospace and defense industry. AP 214 is used primarily in the automotive industry. Both standards are widely used in the supply chains of many industrial sectors.

CIS/2
CIMsteel Integration Standard version 2. Developed originally at Leeds University in the U.K., AISC adopted CIS/2 as the prefered neutral file format for steel. CIS/2 is intended to be used as an exchange platform to support model-based workflow from start to finish, including round tripping. Like IFC, CIS/2 is STEP-based file type. Unlike IFC, CIS/2 does not support materials other than steel.

CNC/NC1
Path files created for cutting plates.

DSTV
Numerical control file type created by German Steel Construction Association.

DXF
Stands for Drawing eXchange Format. This is a CAD file format developed for AutoCAD in 1982, meant to be a universal format for storing CAD models.

DWG
Proprietary file type used in AutoDesk products like Revit.

EM11
A variant of the IFC file developed by AISC in an attempt to standardize the IFC file format for structural steel.

IFC 2×3, IFC4, IFCXML
Industry Foundation Classes. IFC is a neutral file type that supports a wide range of construction model views. IFC formerly offered little depth for steel beyond geometry but has since been expanded to include steel fabrication information.

KISS
KISS is developed and maintained by FabTrol but has been put into the public domain as a free file type for fabrication information.

PCD
Point cloud data format which comes in many file extensions such as .fls, .ptg, .ptx, .zfs, .e57, .txf, sfprj, .dp, .pts, etc. These files are produced from the field and in essence are a number of points that together form an image. Many 3D programs can import these point maps but a conversion to polygon faces is generally required.

SDNF V2.0 and v3.0
Steel Detailing Neutral File. A neutral file format for point-to-point exchange of steel data objects. Developed by Intergraph.

XML
Proprietary Extensible Markup Language. Commonly used to share metadata between software. It is sometimes used as a shell with IFC embedded to add more data to the model exchange.

XSR, BSWX, XML
Formats used to transfer to MIS products such as FabTrol, StruMIS, Tekla EPM, etc.

AECXML
An XML schema that allows a vendor-neutral way to access BIM data. aecXML uses Industry Foundation Classes.

API
Applications Programming Interface. A set of programming subroutines. In the context of BIM, an API is used to describe the connection of third-party applications to software. This is usually done by users to add functionality to their software.

Authoring Software
Software used to create a 3D model.

Big BIM
BIM from a whole project level. Commonly what people are referring to when talking about the use of BIM on a project. This is often multiple trades and companies using BIM from design through construction and even extending beyond to building operations.
see also: Little BIM

BIM Collaboration Format (BCF)
A file format for tracking issues within BIM, for example reporting on clash detection. See **www.buildingsmart.org** for more information.

BIM Execution Plan (BxP)
A BxP defines the appropriate uses of BIM on a given project.

Clash Detection
A process in which 3D BIM from various trades are combined in order to identify overlapping elements.

COBie
An information exchange specification for the life cycle capture and delivery of information needed by facility managers. COBie can be viewed in design, construction, and maintenance software as well as in simple spreadsheets.

Common Data Environment
Where all work processes are handled in the same base platform(s).

Coordination Model
BIM used for the purpose of coordinating with other trades (i.e., clash detection).

Design Model
A dimensionally accurate 3D digital model of the structure that conveys the structural steel requirements given in section 3.1 of the AISC *Code of Standard Practice (Code)*.

Erection Model
A dimensionally accurate 3D digital model produced to convey the information necessary to erect structural steel. This may be the same digital model as the fabrication model but it is not required to be. See the AISC *Code of Standard Practice (Code)* for more information.

Fabrication Model
A dimensionally accurate 3D digital model produced to convey the information necessary to fabricate the structural steel. This may be the same digital model as the Erection Model. See the AISC *Code of Standard Practice (Code)* for more information.

Federated Model or Collaborative Model
An assembly or linkage of distinct discipline models to form a complete model of the building. It is debated if they must share a database.

GUID
Global Unique ID. GUIDs identify an object regardless of what software is using it, allowing updates to synchronize across different applications.

Industry Foundation Classes
An industry-developed product data model for the design and full life cycle of buildings, supported by buildingSMART and broadly supported by most software companies. See the *BIM Handbook* for more information.

Level of Development (LOD)
The Level of Development (LOD) *Specification* is a reference that enables practitioners in the AEC industry to specify and articulate with a high level of clarity the content and reliability of BIMs at various stages in the design and construction process.

Metadata
A set of data that describes and gives information about other data. In the context of BIM, metadata can refer to data such as timestamps and GUIDs.

Little BIM
BIM from a team or company level. Though an entire project may not be using BIM (Big BIM), there can still be benefits of BIM on the individual level. An example of this might be where a structural engineering firm uses BIM to create and coordinate a model, create construction documents, and/or analysis when BIM is not a project deliverable or used by others of the design/construction team.

Model Checker
A model checker or model checking software will validate BIM data against a predetermined rule set to ensure accuracy and validity, e.g., Revit Model Checker, Solibri Model Checker.

OpenBIM
OpenBIM is an initiative of buildingSMART and several leading software vendors using the open buildingSMART Data Model. See **www.buildingsmart.org** for more information.

Virtual Design and Construction (VDC)
The use of integrated multi-disciplinary performance models of design-construction projects to support explicit and public business objectives.

Cost of Participating in the BIM Process

	Case 1 New user who needs steel detailing software and participation in the BIM process.	**Case 2** Steel detailer who needs to be able to participate in the BIM process.	**Case 3** Project manager looking to participate in the VDC process only (using BIM 360, NavisWorks, Trimble Connect, etc.)
Computer	Specs vary—see the guidelines given by the provider of the steel detailing software to be used. **$$**	It is assumed that an existing steel detailer will have a computer powerful enough to interface with any necessary BIM software.	Specs vary—see the guidelines given by the provider of the steel detailing software to be used. **$$**
Detailing Software	Costs here may vary significantly by software, provider, type of license, etc. **$$$$**	Existing User	Not participating in the steel detailing process.
BIM Participation—Export Needs	Consult with detailing software provider to see if additional licensing is required for export capabilities. **$**	Consult with detailing software provider to see if additional licensing is required for export capabilities. **$**	Not participating in the steel detailing process.
BIM Participation—View/Manipulate BIM Models (minimum)	Free Viewer	Free Viewer	Free Viewer
BIM Participation—View/Manipulate BIM Models (recommended)	Purchase the native BIM software package so that the user may manipulate your files in the native BIM software prior to providing them to the BIM Coordinator. **$$$**	Purchase the native BIM software package so that the user may manipulate your files in the native BIM software prior to providing them to the BIM Coordinator. **$$$**	Purchase the native BIM software package so that the user may manipulate your files in the native BIM software prior to providing them to the BIM Coordinator. **$$$**

BIM & VDC for Structural Steel

10 Guidelines for a Successful Model Export

1. **Know your contract.** Know ahead of time what you are obligated to provide and what forms of documents (model vs. paper) govern.
2. **Coordinate the origin point.** Nothing gets the BIM process started on a bad note more than a model that does not align with all other trades. Make sure that your model is in the correct position to work with the rest of the team.
3. **Review your export prior to sending the file.** This goes hand-in-hand with #1. It is good practice to view your file in the native BIM software and see that it is aligned prior to sending the file. Compare your model to a reference grid file or the architectural/structural model. Also make sure that you have everything you wanted to export and not any extraneous material (reference model parts, test connections, stacks of plate, etc.).
4. **Read the BIM Execution Plan.** This plan should outline your obligations and provide models, attend meetings, etc. It should also outline the coordination software to be used, color schemes, file naming conventions, etc.
5. **Model EVERYTHING.** The term "everything" is of course relative to your contract, but model what you have agreed to detail. A good example here is a kicker angle for a hospital exam room or operating room light. As the detailer, you may not know the exact position of this angle and it may be able to fluctuate 15–20 degrees, but the BIM coordinator needs to know it is there. If you have the ability, establish a special identifier to acknowledge that an item is adjustable (perhaps by using a special color).
6. **Participate in the BIM coordination meetings.**
7. **Track approval/fabrication status in the detailing model.** This information is extremely valuable but often overlooked. Fabricators and detailers who track status information bi-directionally with an MRP package often have this data included in the detailing model but others often do not.
8. **Color coordinate the export model.** Colors may be pre-determined by the BIM Execution plan. If not, then perhaps colors can be set to reflect the approval/fabrication status or to show items that have been specifically modified due to BIM Coordination since the last meeting.
9. **Be willing to import as well as export.** Most other trades are doing all coordination in the BIM model, routing work around each other and using the model to measure clearances. The steel fabricator and detailer must be willing to participate in this manner as well.
10. **Have a "decision maker" involved in the BIM meeting.** Many times, the person who models the steel is the only person in attendance at a BIM meeting, and is not necessarily authorized to make financial or design decisions on changes. Where possible, ensure that a decision maker is also in attendance.

Interoperability—Background and History

When 3D Digital models were introduced in the structural steel engineering and fabrication sectors in the 1980s, interoperability between models was also introduced to increase efficiency and communication within the construction industry. Early proprietary formats (such as the SDNF file) were being developed. A few years later, in an attempt to bring some harmony to the software that was being developed, AISC promoted the CIS/2 file format as a common standard for structural steel. This format was sufficient for primary structural steel but was not sufficient for other trades in the construction industry. Thus, the IFC file format came about and was adopted, eventually replacing the CIS/2 format. IFC then became the exchange file format norm for structural steel. Unfortunately, as with any common file format, information would get lost in translation. There were misinterpretations of vague areas within the standard and this would cause issues when moving data from one 3D modeling program to another. To clarify the standard, AISC developed the EM11 to work with NC machinery, specifying where data was to be located in the IFC 2×3 file format. As the industry continues to develop, we are now seeing software companies developing APIs, which allow a more controlled push and pull of information between software, in a way reverting back to the old days of the proprietary formats—but with better efficiency and no large, cumbersome files to be transferred and stored.

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