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Journey to the Center of BIM: Fluor's EPCV Digital Transformation

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Learning Objectives

- Explore BIM data mapping to support project life cycle
- Discover industry best practices to be utilized in the implementation of BIM execution plans
- Learn how to leverage BIM 360 tools to support team collaboration and coordination
- Evaluate how to better manage and leverage BIM data in support of project execution

Description

This industry talk will highlight Fluor's Building Information Modeling (BIM) transformations over the last 10 years within the Advanced Technologies & Life Sciences (ATLS) business line. Fluor has seen a dramatic shift in client expectations, EPCmV demands, and subcontractor and supplier sophistication that have changed the BIM landscape in some new and exciting ways. Fluor will walk though some innovative methods the firm has implemented to meet the challenges facing the industry. The focus will be on use of Autodesk collaboration tools such as Navisworks software and BIM 360 platform to support a focused approach to client involvement, better BIM data management, and collaboration that supports an integrated project delivery (IPD) strategy to capitalize on worldwide resources. Fluor will also highlight some of the industry lean execution principles that are accomplished utilizing the BIM process and how Fluor has focused on upfront team alignment through use of concise BIM execution plans (BEP) and alignment meetings.

Speaker(s)

John Attebury has been the BIM manager at Fluor since 2016 and is responsible for the development, implementation, and support of BIM execution for Fluor's ATLS operations. John has more than 15 years of experience in BIM execution as well as extensive knowledge in the implementation of BIM processes and the utilization of BIM technology to support project execution. John has over 25 years of construction management experience with a focus on pre-fabrication and installation processes.

W. Scott Carlson is a principal project information manager with Fluor and has been with Fluor since 1988. Scott is an expert in planning, deployment, implementation, and support of platforms for the execution of EPCmV projects for multiple industries. Scott has extensive execution experience in all phases of work in the ATLS industries.

Jaroslaw Szczepanek is a structural senior design supervisor, Fluor subject matter expert (SME), discipline application specialist (DAS), and innovation catalyst. He has more than 20 years of experience from conceptual engineering, through FEED to EPCM with Energy & Chemicals and ATLS. Jaroslaw is focused on data-centric execution, digital transformation, BIM, IPD, lean construction, and software, including BIM, Plant, and CAD.

BIM Data Mapping to Support Project Life Cycle

BIM has evolved a great deal over the last 10 years, and projects are looking to get more from BIM than ever before. The projects that supported the baseline information in this document ranged in size from a couple hundred thousand dollars to multibillion dollars TIC. No matter which industry, each client has their own BIM expectations and unique BIM data they require, and a good BIM execution approach will help meet the clients' specific needs. The key to getting more out of BIM is a disciplined approach to BIM processes, solid work flows in the management of the Federated Model, and an organized plan to manage BIM data in a common data environment (CDE). In *Figure 1*, these three functions represent the center of BIM execution and the key to get the most out of a BIM program. The center of BIM supports key BIM outputs (Color Wheel in *Figure 1*) such as field BIM delivery, 4D simulation, 5D cost analysis, 6D asset life-cycle management, 7D facility management (FM), virtual reality (VR), augmented reality (AR), and digital twin. To successfully set up the BIM program to deliver the required results, it is critical to focus on three main areas (the three corners of the triangle in *Figure 1*): BIM execution plan (BEP aka BxP) implementation, collaboration and coordination, and BIM data management. The following sections will focus on these three areas and provide some insight on how to best approach them in BIM execution.

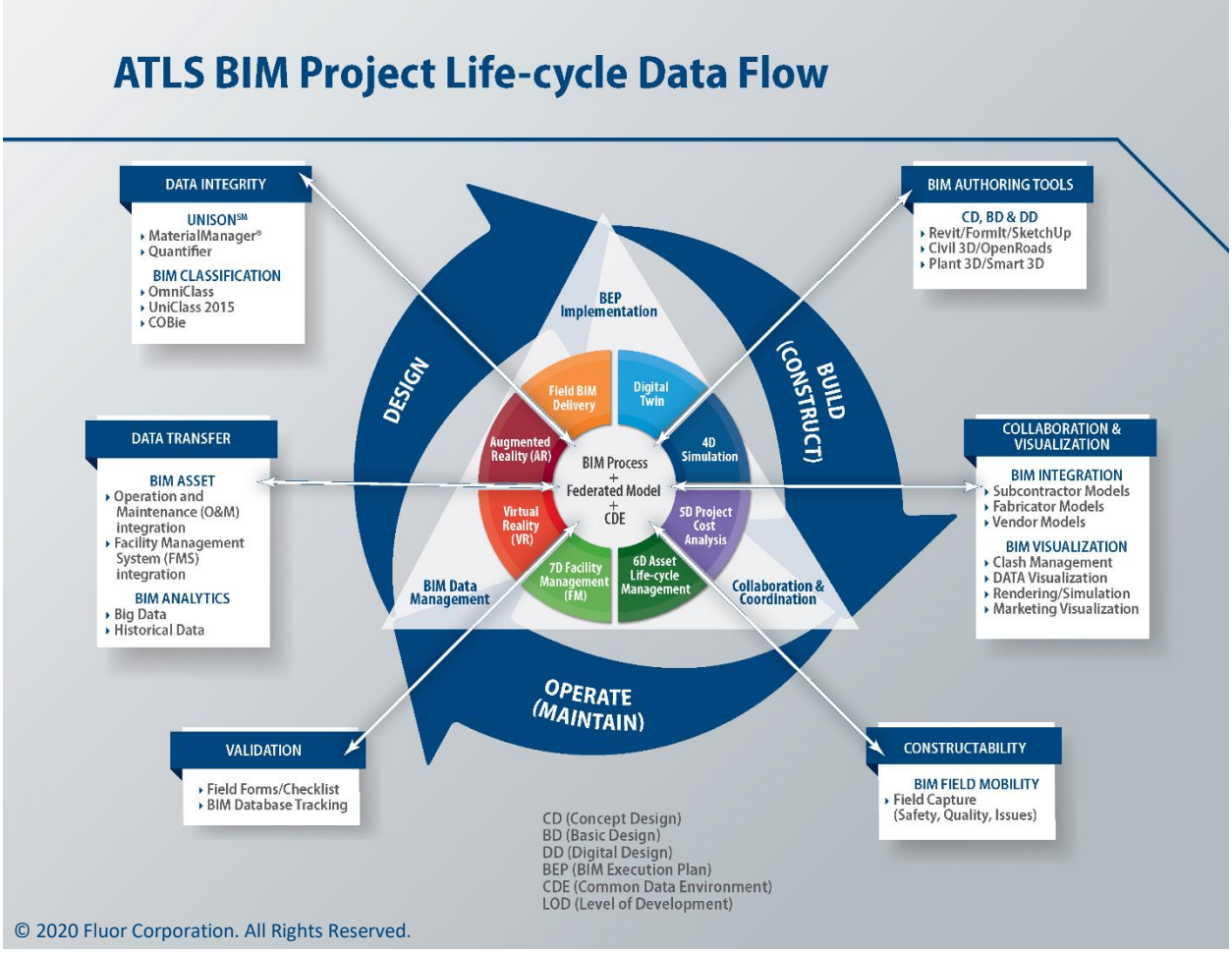


Figure 1 – BIM Project Life-cycle Data Flow.

BEP Implementation

The industry and clients are requiring more from a BIM program than ever before, and to meet these needs Fluor has focused to standardize how BIM is implemented and executed on a project. *Figure 2* shows the current industry standards around the BIM maturity levels (stages of maturity according to ISO 19650), and most of the current projects are operating at a Level 2 (which requires an integrated Federated Model with file-based collaboration and in some cases requires 4D-7D data requirements). The D requirements vary based on the sophistication of the client's systems, and it is critical to align with the client up front. To support industry standards as well as our client's BIM needs, there is a need to establish solid BIM workflows (such as clash management, data management, team collaboration, etc.). Additionally, one must develop a clear and concise BEP up front which will align the project teams and provide the framework in which to execute BIM on the project in a way that will meet the project's collaboration and BIM data needs.

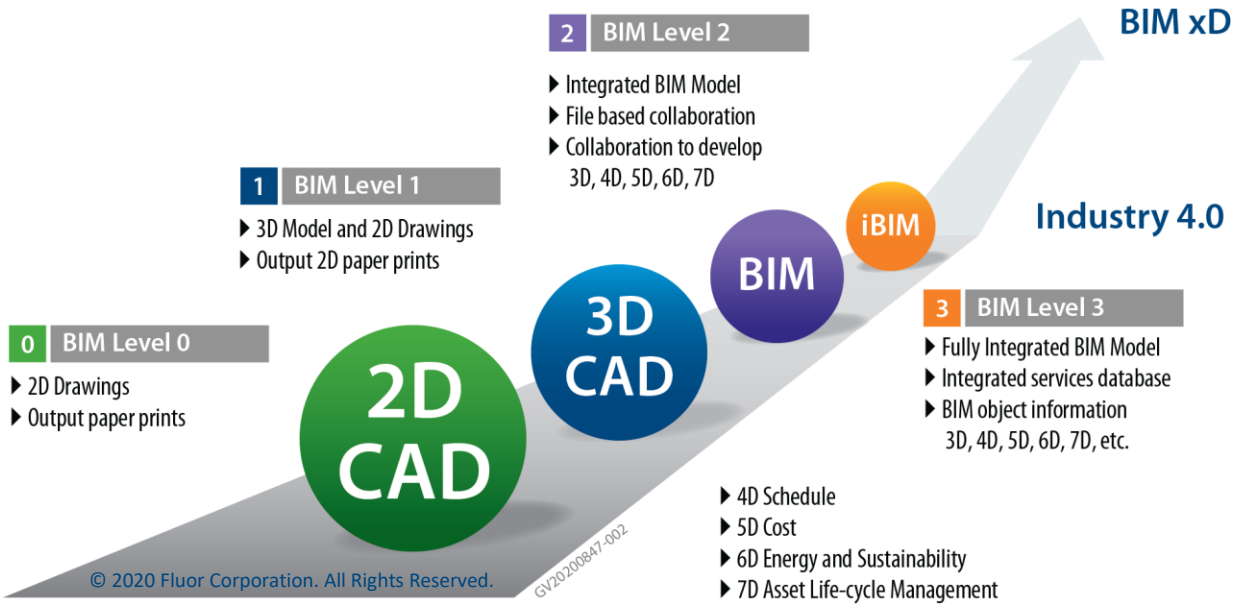


Figure 2 – BIM Maturity Levels and Industry Standards.

BEP Development/Implementation

The BEP is a vital component to the success of BIM on a project and serves as the master execution document for BIM on the project. The document is initiated at the beginning of the project and maintained (updated) as required throughout the project. The BEP is a *living* document and should be updated periodically through the project life cycle to document updates in BIM workflows or capture changes as BIM participants are added to the project. The intent of the BEP is to have shared ownership across project team members and key stakeholders. It is critical that the BEP has been established up front and that all interested parties sign off on the document as it will serve as the guiding document for BIM execution on the project. It is imperative that the entire team be properly trained on the BEP to make sure the BIM goals and requirements are understood and that everyone on the project is aligned with a common understanding and direction. It also serves as a guide to align the BIM professionals from multiple firms in the BIM execution for that project. In the delivery of the project, it is key that the BEP requirements are included in the contracts, with specific requirements of compliance tied to payment and performance metrics.

Below are the basic components that every BEP should include at a minimum:

- BEP purpose and basic project specifics
- Specific BIM goals and BIM uses
- BIM deliverables and requirements
- Roles and responsibilities
- Level of development (LOD) according to AIA
- Level of information need (LOIN) according to ISO 19650
- BIM data requirements
- Hardware and software requirements
- BIM information exchanges
- BIM collaboration procedures

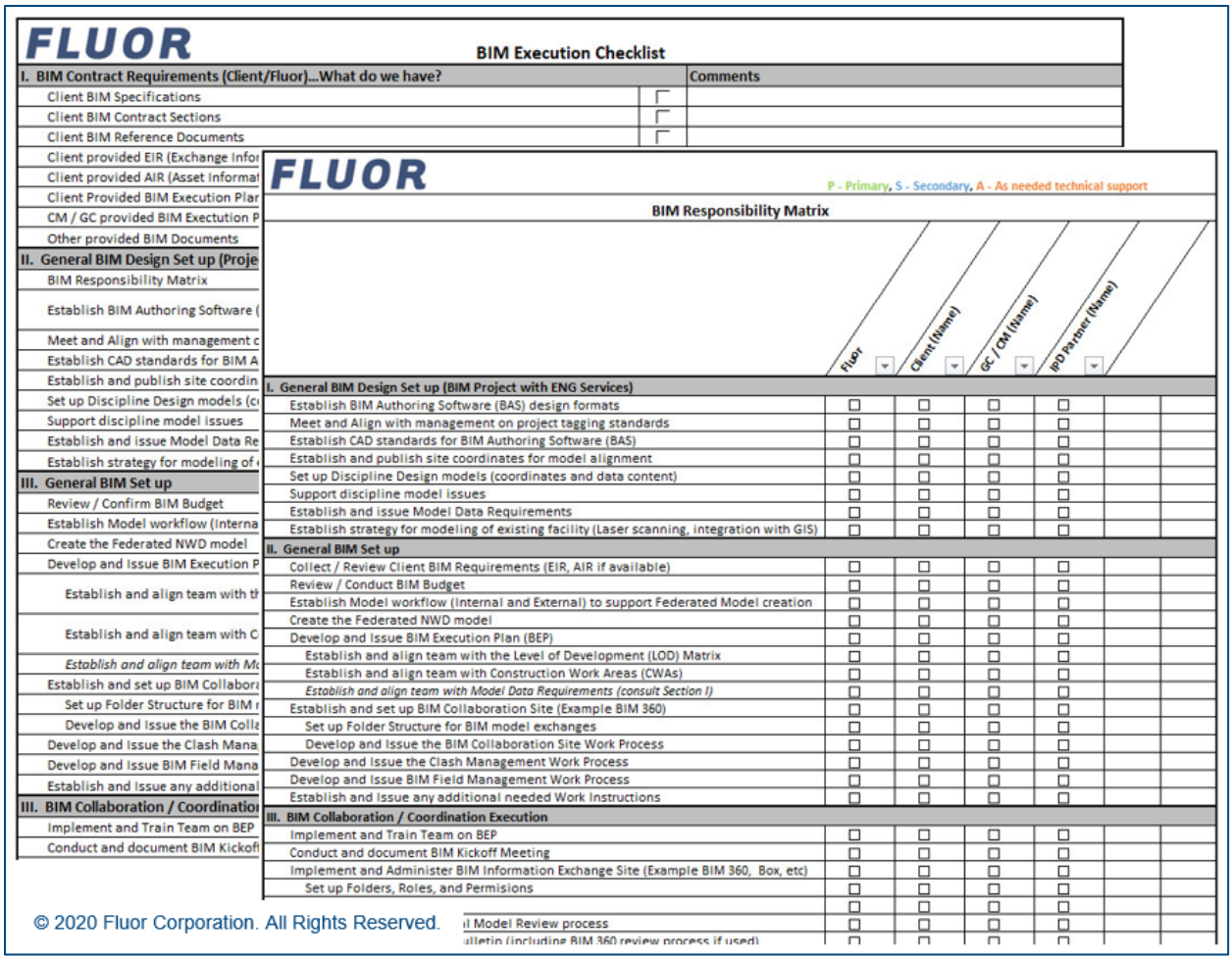
- Collaboration strategies
    - Trade participants
    - Model partitions/construction works areas (CWAs)
    - Design review coordination/documentation
    - Model content management
    - Model handover requirements
    - Clash prevention and clash detection
    - Coordination sign-offs (release for fabrication plan)
- Isometric plan
- Quality control

Team BEP Alignment

The most critical element to successfully implementing the BEP on a project is early buy-in and team alignment. The best way to accomplish this is to schedule BEP meeting(s) and use aids such as a BIM execution checklist/responsibility matrix (see *Figure 3*) to document the specific BIM needs for the project and assign ownership which will assist in the development of the formal BEP. This is especially critical when executing IPD on a project with shared design responsibilities and specific transition points and design ownership. It is critical to have regular BIM coordination meetings both during design as well as during construction to reinforce the requirements, provide guidance, and verify compliance. It is very common in today's projects to see clients require regular BIM meetings as a part of the contract, and this requirement should always flow downstream to all project participants.

BIM Collaboration and Coordination Supported by Leveraging Navisworks and BIM 360 tools

BIM coordination has been one of the primary functions of BIM since the very beginning and has seen the most evolution over the last 10 years. Navisworks has been at the center of most BIM coordination processes from the inception of BIM, and now combined with true BIM collaboration platforms, it has taken the coordination process to a whole new level. Fluor has determined that effective coordination requires two key components, a strict and disciplined approach in management of the Federated Model (organization, content, and data management) and utilization of BIM 360 to provide the collaborative environment to support all the BIM participants. Productivity is dramatically enhanced by combining the file exchange platform with a true collaboration environment where all participants can actively participate in the coordination process. It is key that regular coordination meetings are held both during design and construction. The practice of having these meetings reinforces the execution of the BEP and requires a reliable Federated Model and an environment to document these meetings. While there are advantages to design model collaboration, this section will focus on the Federated Model management with a focus on model file exchange workflows and the review of functionality of BIM 360, highlighting both client and construction contractor reviews.



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BIM Execution Checklist

I. BIM Contract Requirements (Client/Fluor)...What do we have?		Comments
Client BIM Specifications	☐	
Client BIM Contract Sections	☐	
Client BIM Reference Documents	☐	
Client provided EIR (Exchange Infor		
Client provided AIR (Asset Informat		
Client Provided BIM Execution Plar		
CM / GC provided BIM Exectution P		
Other provided BIM Documents		
II. General BIM Design Set up (Proje		
BIM Responsibility Matrix		
Establish BIM Authoring Software (		
Meet and Align with management c		
Establish CAD standards for BIM A		
Establish and publish site coordin		
Set up Discipline Design models (c		
Support discipline model issues		
Establish and issue Model Data Re		
Establish strategy for modeling of		
III. General BIM Set up		
Review / Confirm BIM Budget		
Establish Model workflow (Interna		
Create the Federated NWD model		
Develop and Issue BIM Execution P		
Establish and align team with th		
Establish and align team with C		
Establish and align team with Mo		
Establish and set up BIM Collabor		
Set up Folder Structure for BIM r		
Develop and Issue the BIM Colla		
Develop and Issue the Clash Mana		
Develop and Issue BIM Field Mana		
Establish and Issue any additional		
III. BIM Collaboration / Coordinatio		
Implement and Train Team on BEP		
Conduct and document BIM Kickoff		

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P - Primary, S - Secondary, A - As needed technical support

BIM Responsibility Matrix

	Fluor	Client (Name)	GC / CM (Name)	IpD Partner (Name)		
I. General BIM Design Set up (BIM Project with ENG Services)						
Establish BIM Authoring Software (BAS) design formats	☐	☐	☐	☐		
Meet and Align with management on project tagging standards	☐	☐	☐	☐		
Establish CAD standards for BIM Authoring Software (BAS)	☐	☐	☐	☐		
Establish and publish site coordinates for model alignment	☐	☐	☐	☐		
Set up Discipline Design models (coordinates and data content)	☐	☐	☐	☐		
Support discipline model issues	☐	☐	☐	☐		
Establish and issue Model Data Requirements	☐	☐	☐	☐		
Establish strategy for modeling of existing facility (Laser scanning, integration with GIS)	☐	☐	☐	☐		
II. General BIM Set up						
Collect / Review Client BIM Requirements (EIR, AIR if available)	☐	☐	☐	☐		
Review / Conduct BIM Budget	☐	☐	☐	☐		
Establish Model workflow (Internal and External) to support Federated Model creation	☐	☐	☐	☐		
Create the Federated NWD model	☐	☐	☐	☐		
Develop and Issue BIM Execution Plan (BEP)	☐	☐	☐	☐		
Establish and align team with the Level of Development (LOD) Matrix	☐	☐	☐	☐		
Establish and align team with Construction Work Areas (CWAs)	☐	☐	☐	☐		
Establish and align team with Model Data Requirements (consult Section I)	☐	☐	☐	☐		
Establish and set up BIM Collaboration Site (Example BIM 360)	☐	☐	☐	☐		
Set up Folder Structure for BIM model exchanges	☐	☐	☐	☐		
Develop and Issue the BIM Collaboration Site Work Process	☐	☐	☐	☐		
Develop and Issue the Clash Management Work Process	☐	☐	☐	☐		
Develop and Issue BIM Field Management Work Process	☐	☐	☐	☐		
Establish and Issue any additional needed Work Instructions	☐	☐	☐	☐		
III. BIM Collaboration / Coordination Execution						
Implement and Train Team on BEP	☐	☐	☐	☐		
Conduct and document BIM Kickoff Meeting	☐	☐	☐	☐		
Implement and Administer BIM Information Exchange Site (Example BIM 360, Box, etc)	☐	☐	☐	☐		
Set up Folders, Roles, and Permisions	☐	☐	☐	☐		
	☐	☐	☐	☐		
l Model Review process	☐	☐	☐	☐		
ulletin (including BIM 360 review process if used)	☐	☐	☐	☐		

Figure 3 – BIM Checklist and Responsibility Matrix.

Federated Model Management

The Federated Model (a combined model that includes all individual design models from BIM authoring software) is the cornerstone of the project BIM coordination process, and it is critical that the creation and management be clearly defined and documented in the BEP. It is imperative that a consistent and documented 3D model file naming convention (see *Figure 4*) is established and strictly followed by all to support model organization and automation. There are two keys that support effective management of the Federated Model: establishment of a model workflow that supports timely updates, so that the latest conditions are represented for effective coordination both during design and construction, and effective collaboration with the Federated Model in BIM 360 supporting design and construction reviews and documentation utilizing the issue tracker.

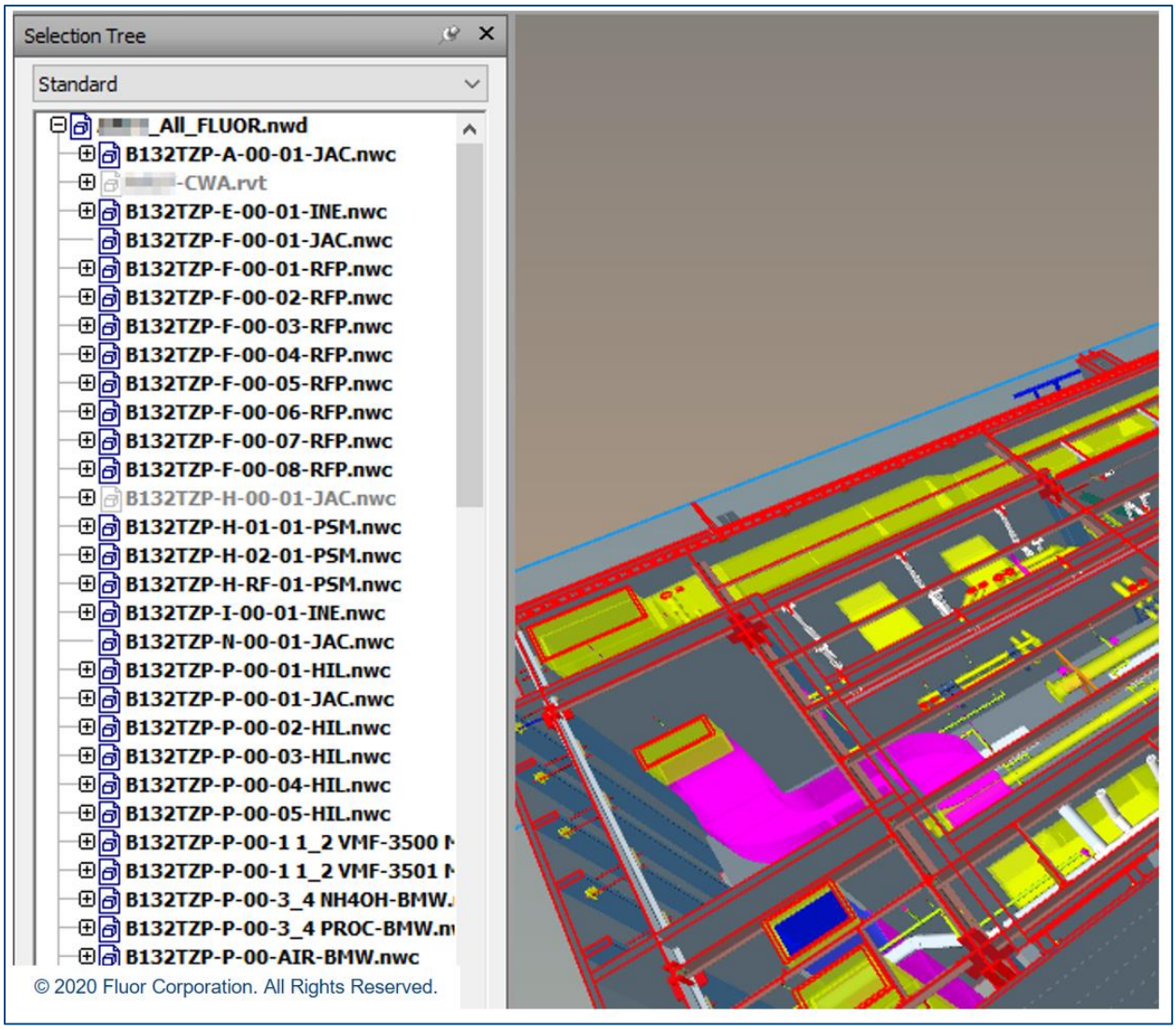

Figure 4 – Navisworks Federated Model Organization Sample.

Model File Exchange Workflows

The Federated Model is the lifeline of the coordination process and is critical to make sure it is always up to date and reflective of the current conditions. BIM 360 has dramatically improved the model file exchange workflows. By setting up an organized folder structure (see *Figure 5*), establishing a specific upload schedule, and utilizing web-published BIM 360 APIs (upload and download), a project team can better manage the Federated Model update process. Fluor leverages the BIM 360 APIs to download all the models each evening, uses Navisworks scripts to update and combine the models in the Federated Model, and then uses the Upload API to update the Federated Model in BIM 360. This process verifies that the Federated Model is always up to date and available to the entire project team for coordination.

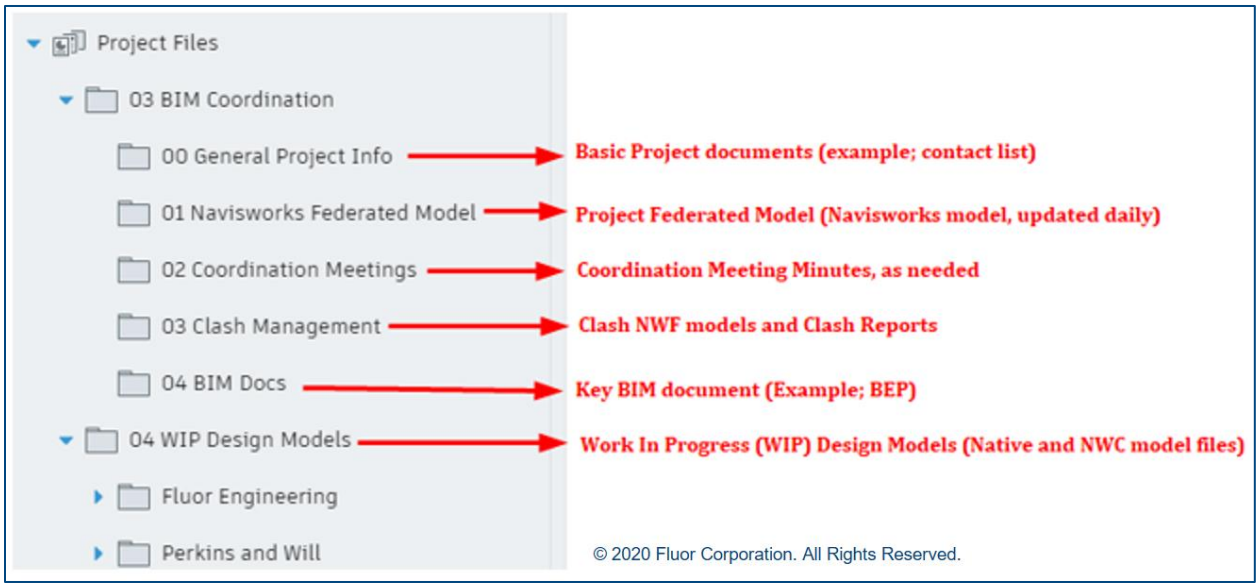

Figure 5 – BIM 360 BIM Coordination Folder Sample.

BIM 360 Model Review Support

The model review is a critical aspect to the coordination and collaboration process, both formal and informal. It allows all BIM participants and key stakeholders to provide feedback that facilitates the quality of the final model. Fluor has leveraged the BIM 360 environment to allow teams to review and provide comments using the BIM 360 Issue Tracker. By publishing the Federated Model to BIM 360 Docs, teams can access the model directly in BIM 360 using the Large Model Viewer (LMV) (see *Figure 6*) or utilizing Navisworks (using the BIM 360 Issues Plugin). Navisworks now has a plugin that allows users to access the BIM 360 Issues directly from Navisworks (see *Figure 7*). By utilizing this process of publishing the latest Federated Model to BIM 360 and using BIM 360 Issues to track comments for both formal design reviews and weekly contractor coordination meetings, a team can effectively track and manage model issues in a single environment. The issues captured in these meetings can then be exported out of BIM 360 to support meeting minutes and regular status updates for open model issues (see *Figure 8*).

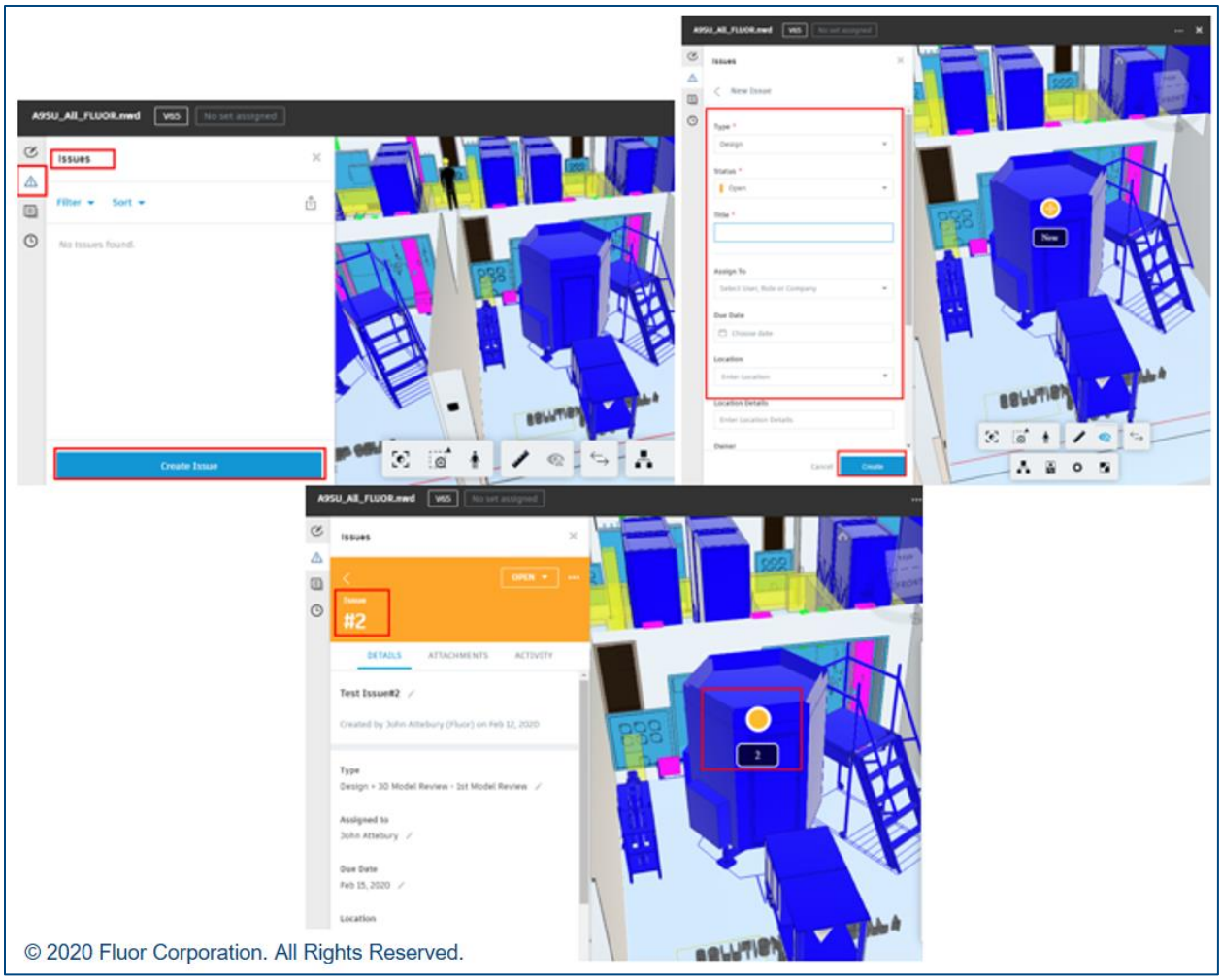

Figure 6 – BIM 360 Direct Model Sample with Comments.

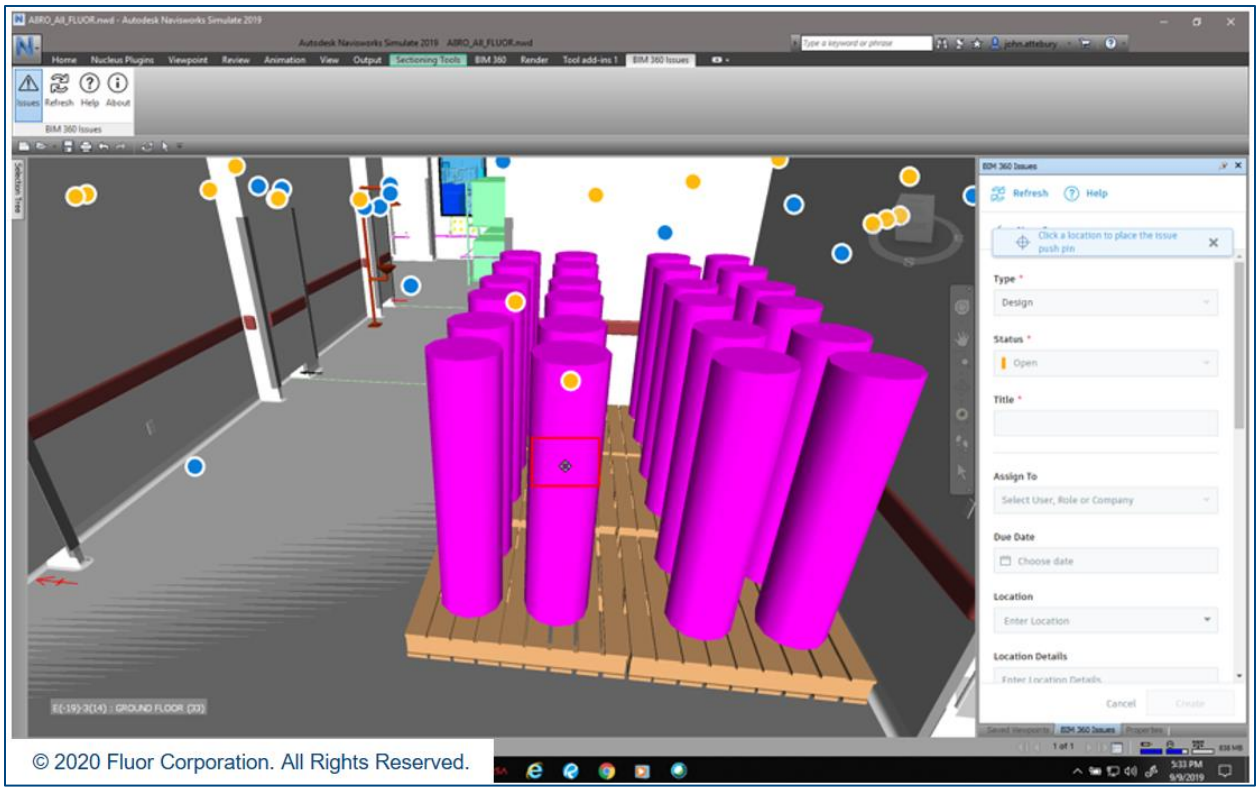

Figure 7 – Navisworks BIM 360 Issues Plugin.

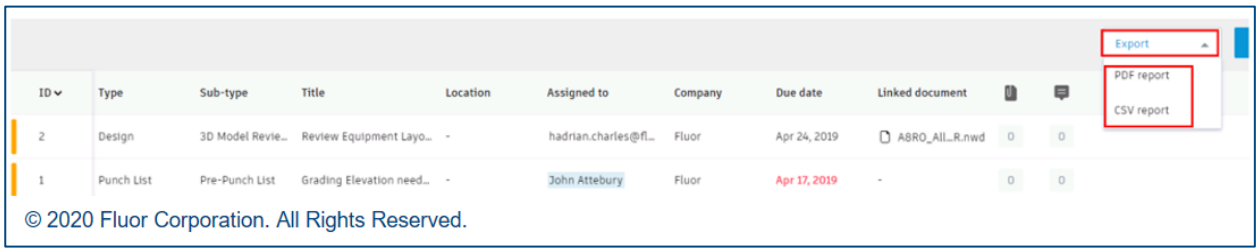

Figure 8 – BIM 360 Issue Export.

BIM Data Management

Data has always been a critical element to BIM execution, but over the last 10 years the focus on BIM data and management of that data has intensified. As mentioned in the BEP section above, specific clients and projects may have very different data requirements; to be able to meet these needs, it is imperative that the requirements get documented in the BEP and be enforced throughout the project. The BIM authoring software (Revit, Plant 3D, etc.) can vary depending on the specific project and the participants, but it is important to specify the model data requirements in the BEP and drive the teams to meet these data requirements. To make sure the specific BIM goals are met specific to BIM data, it is ***critical to align with the client and key participants up front***.

Data Management Overview

Data management is made up of three main pillars: data integrity, data transfer, and data validation. Individual clients' and specific projects have unique data requirements, and it is critical that these requirements are documented internally by the client and included in pre-contract documents (the RFP to the design and construction parties). When they do not exist, it is critical that the BIM data requirements are established and documented at the very beginning of the project and driven throughout the project life cycle. When Fluor is the BIM lead on a project, we will support the client with options that help define the project BIM data requirements. The two most vital industry documents that can assist clients in development of the data requirements (according to ISO 19650) are the exchange information requirements (EIR) and asset information requirements (AIR). AIR pre-tender documents set out the asset information (data) to be delivered for operation and maintenance (O&M), facility management (FM), and standards and processes to be adopted by the supplier as part of the project delivery process. AIR could be created as part of EIR. The EIR pre-tender document sets out the information (data) to be delivered (who, what, when, and why), and the standards and processes to be adopted by the supplier as part of the project delivery process.

Data integrity is a multifaceted standardization with the standardization of items such as the LOD in project stages, materials definitions, object construction classification, and other attributes which will be used for data reporting, and quantification purposes.

Data transfer is divided into two main areas, BIM assets and BIM analytics. The key document that Fluor uses on every project to define model data transfers is an attachment to the BEP called the model data requirements. This document is intended to answer the data requirements as defined in EIR (AIR). It is a roadmap for BIM data transfer necessary both for asset data in O&M and FM and data analysis of big data, smart data, and as a repository of historical data.

Data visualization accelerates the understanding of the processes taking place in CDE. With a focus on well-defined attributes, all participants can view materials, actions defined in schedule, and clashes in a single source of truth, the CDE. In addition, data visualization could be separated from a model by using data from the model in conjunction with additional asset databases for visualization in business analysis tools.

CDE and Data Management

While some of the data on the project will come directly from the models (BIM authoring software or Federated Model), it is critical to establish a CDE to assemble both data from the models as well as from other sources. Establishment of this will better support the execution of project specific Ds (4D, 5D, 6D, and 7D). It is often required to share model information to other sources to provide information to the model and a CDE along with a specific data management plan will assist in providing this interface. The process of management of multi-disciplinary design models (Federated Model) during the design and construction phases of a project for the purpose of coordination can also be referred to as virtual design and construction (VDC). VDC will make sure the Federated Model is utilized in a practical and highly effective manner throughout the life cycle of the project to support overall project objectives. CDE is in the center of BIM project life-cycle data flow and supports BIM data flow like a heart pumping blood; therefore, setting up the proper data flow in CDE arteries is both important and necessary before we create any design data. Within the CDE, activities are discussed and developed and cover such topics as interoperability, model transfer, naming convention, and folders structure.

Fluor distinguishes four statuses for CDE development:

Work in Progress – design teams working area

Shared – review, coordination, and collaboration exchange area

Published – current officially approved model

Archived – tracking of previous versions and revisions stored for audit purposes

Clash Management driven by BIM Data

Clash management is a vital component in BIM execution and is best supported by a solid workflow and management of the clash data. By utilizing a system that ties the data generated from the clash detection tool (Navisworks Manage as example) to a database, the users can leverage that data in the management of the clashes. Fluor has implemented a corporate tool that allows users to interact with the clash data (both data and visualization) to provide real-time feedback, thus reducing the requirement of back and forth communication via other media such as Excel. By linking (two-way communication) the clash data to the database, it dramatically reduces the time to resolve key interferences in the model. In addition to real-time feedback, it also supports advanced filtering and grouping of the clashes as well as leveraging key model data attributes to support this filtering and grouping directly in the Federated Model (see *Figure 9*). This process allows for teams to quickly review open clashes and address issues as well as provide real-time feedback. This is a prime example of how leveraging BIM data and management of that data can provide critical productivity advantages when executing a BIM project.

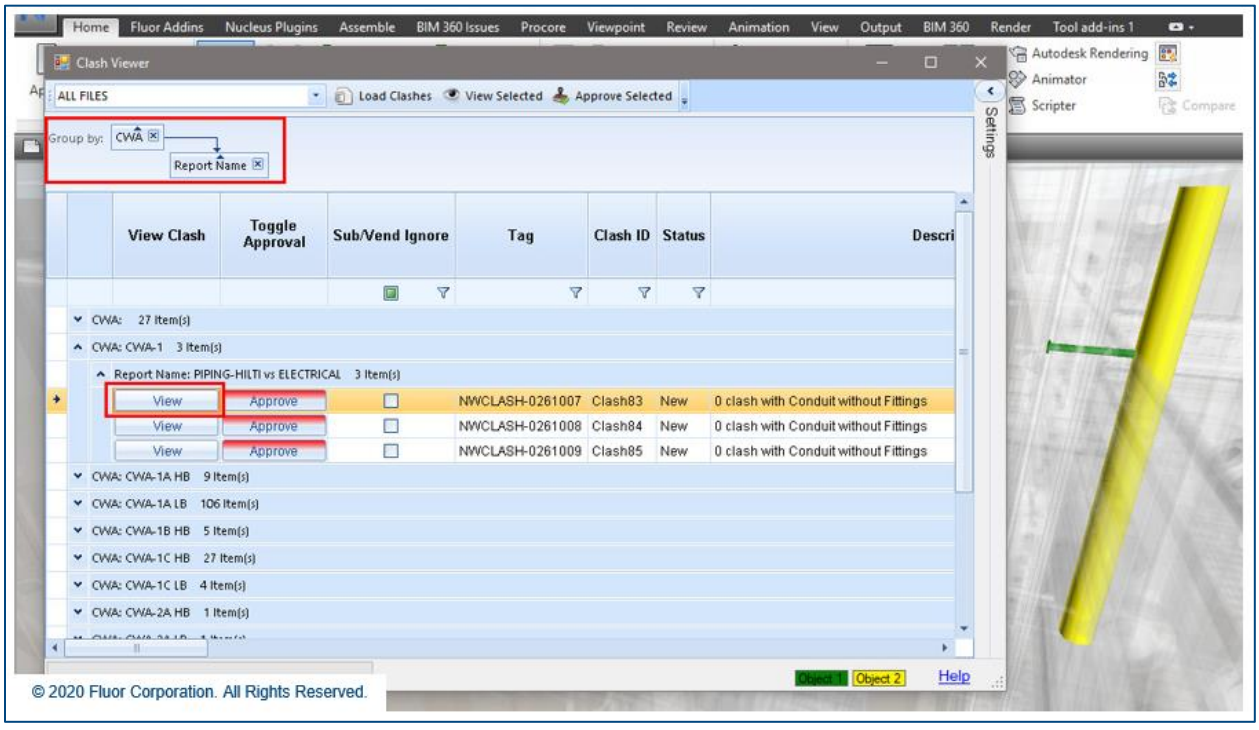

Figure 9 – Clash Data Example (Visualization).

Conclusion

Over the last 10 years, Fluor has seen a movement in the industry with a focus on BIM data, the “I” in BIM, and a need to drive coordination in a more collaborative environment. Fluor has initiated some innovative solutions to meet these challenges. It is critical to develop the BEP early and align with participants and key stakeholders in order to successfully execute BIM on projects and meet specific requirements. Fluor has implemented the use of BIM 360 to support project communication and better support BIM collaboration. In order to meet the growing needs around BIM data, it is critical that these requirements are defined early, clearly communicated to all project participants, and monitored to make sure the requirements are being met.