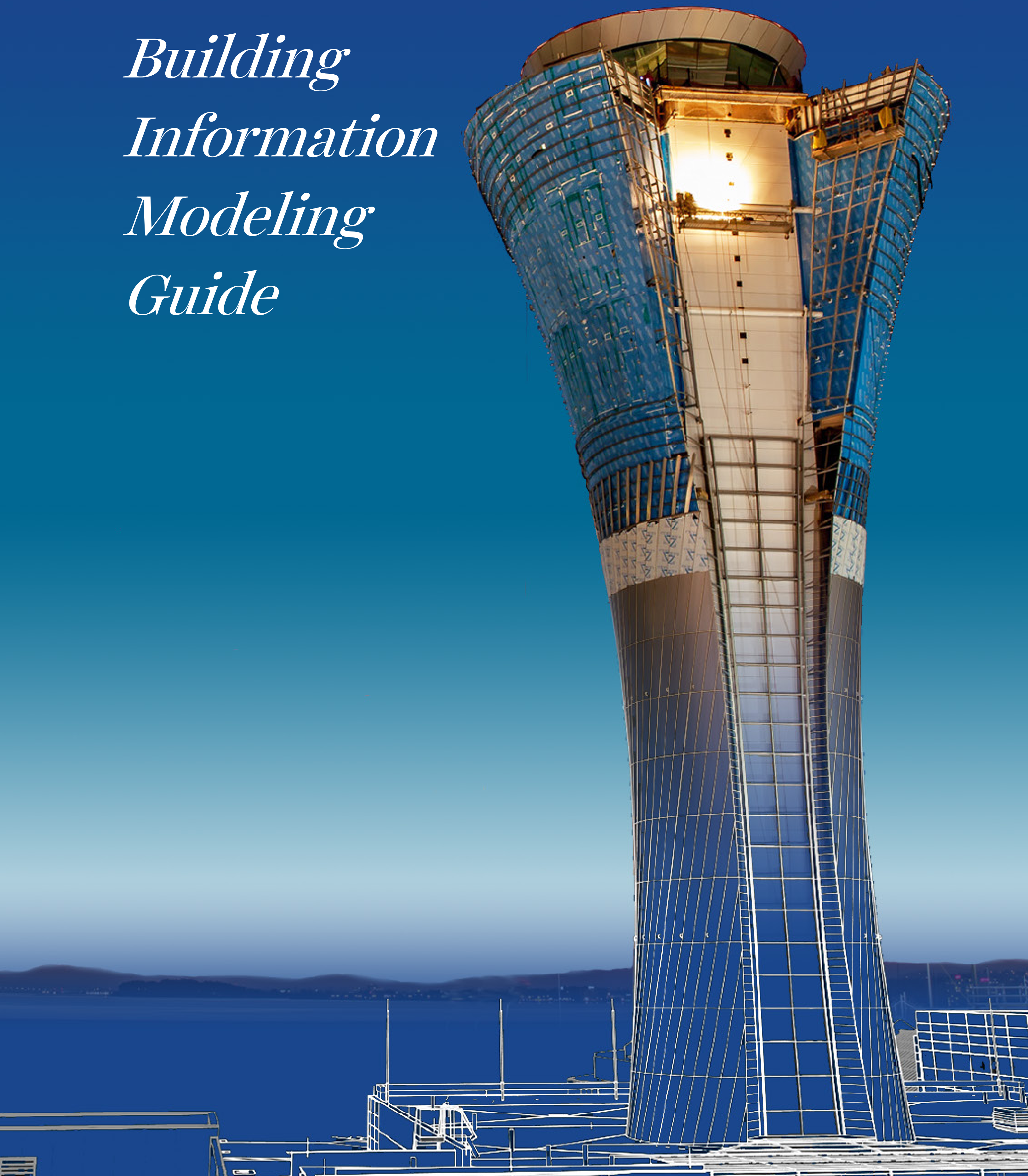
San Francisco International Airport

SFO

Building Information Modeling Guide



INTENDED AUDIENCE

- Airport Employees
- Current and potential designers, contractors, and project managers
- All other stakeholders who have stake in the outcomes of the Airport's design and construction activities

THE PURPOSE OF THIS DOCUMENT

The purpose of the SFO Building Information Modeling (BIM) Guide is to explain the Airport's vision for incorporating BIM into our holistic, collaborative and integrated approach to Delivering Exceptional Projects. This document articulates how BIM can support the Airport's vision of "Reaching for #1".

Building Information Modeling supports efficient planning, design, construction, and operations workflows, delivers quality data, and streamlines communication of information throughout the life cycle of the Airport's infrastructure. Realization of these benefits depends on the development of multidisciplinary, concurrent and collaborative processes and consistent technical requirements. The SFO BIM Guide highlights BIM uses in planning, design, construction, infrastructure management and operations related best practices. It describes technical requirements and processes that help the Airport and project teams get more value from design and construction to support exceptional project outcomes, and infrastructure life cycle management.

The SFO BIM Guide is an outcome of the Airport's Infrastructure Information Management group's pioneering work to develop a comprehensive BIM implementation program by identifying stakeholder needs, developing data requirements, and engaging in-house and capital project teams, to ensure that verified integrated infrastructure information can flow into the Airport's target systems.

Key Definitions

Airfield — The area of land designated for takeoff, landing and maintenance of aircraft.

As-Built Model — A 3D Model prepared by the builder and field-verified, accurate representation of the infrastructure.

As-Managed Model — A Conformed Design Model is transferred from the builder to the Airport and converted into an As-Managed Model during project closeout. The As-Managed Model functions as the updated and verified virtual representation of the Airport's facilities and fixed assets. Whenever any changes are made to the infrastructure during maintenance and operations, they are also captured in this model to represent the central verified source of information.

Attribute — Also known as parameters, these store and communicate information about all elements in a model. They can be used to define and modify elements, as well as to communicate model information in tags and schedules.

BIM Execution Plan (BIMx Plan) — A comprehensive document, which outlines the protocols and procedures that the design and construction team must follow to ensure successful utilization of BIM and VDC practices.

BIM Integration Team (BIT) — A multi-disciplinary group of SFO personnel to enable the central management of BIM deliverables, BIM-related data and other digital assets across the enterprise. The primary function and role of this "task force" is to serve SFO stakeholders and AEC project teams to develop standards and processes for data collection and validation and maintain the virtual representation of SFO buildings and assets.

BIM Use — The process of using the embedded information and parametric capabilities of a Building Information Model during an infrastructure's life cycle to achieve one or more specific objectives.

Builder — An individual or an organization that builds, develops and constructs buildings and infrastructure. The Airport considers everyone involved in the construction team, including the General Contractor and Trade Partner as a builder.

Building Components — The smallest subset of a building system is a building component, which can be an object (e.g., doors, windows, mechanical or electrical fixtures) or an assembly of objects (e.g., walls, roofs, air handling units) and is installed with consideration to site conditions and its relationship with other building components and systems.

Building Envelope — The physical separator between the conditioned and unconditioned environment of a building, including resistance to air, water, heat, light and noise transfer.

Building Information Model (BIM) — A digital representation of the infrastructure that consists of model elements that represent spaces/rooms, systems and components that comprise the facility. The model elements represent physical geometry and attributes (also called properties) that describe functional and performance characteristics of modeled components and systems that are installed in the facility.

Building Systems — Supporting, enclosing and functional systems, subsystems and components that make up a building or structure.

Computerized Maintenance Management System (CMMS) — A software platform that maintains a database of information about an organization's maintenance operations. Preventive maintenance work orders can be requested and generated from a CMMS platform. SFO currently uses Mainsaver© as the CMMS of choice.

Conformed Design Model — A 3D Model prepared by designers and includes all the information that is released by the design team throughout the course of the bidding and construction processes. This is commonly known as the Record Model.

Construction Operations Building Information Exchange (COBie) — A data exchange file format for system-to-system exchange of space and asset information. COBie is part of the United States National Building Information Model Standard (NBIMS-US V3).

Data Authoring — The process of creating design-construction and infrastructure management data in Building Information Models.

Data Transfer File Formats — Specific file format that project teams must deliver to the Airport to facilitate data transfer between systems.

Data Verification — The process of checking Building Information Model features such as file names, object names, geometry and attributes, for compliance with the Airport's standards or acceptance criteria. Data verification allows stakeholders to build trust in the data and to make it useful for queries by computer applications.

Data View Definition (DVD) — A filtered view of the Element Attribute Dictionary that helps project team members input data relevant to their scope of work at specific project milestones.

Design — The process of thinking, planning and conceptualizing an idea into a usable set of drawings and specifications that is buildable and responds to the original intention of the designer.

Design Model — The Building Information Model used by designers to develop a project through all phases of design. Each discipline has their own model. These models are maintained by the designers through construction and ultimately become the Conformed Design Model for that discipline.

Discipline — A functional area (such as structural, mechanical, electrical or architectural), or an area of expertise (such as architecture, structural engineering or construction).

DWG — A drawing file format supported by AutoCAD® and other Computer-Aided Design and Drafting (CADD) applications.

Element Attribute Dictionary (EAD) — A specification outlining names for model elements and element attributes that satisfy the Airport's business needs in managing its infrastructure across their entire life cycle. It also specifies patterns for element names and an enumerated list of values for elements and attributes that must be validated.

Element/Object — An element or an object is a unique model geometry with data that represents a building component or system in a Building Information Model.

Equipment — A manufactured unit, fixture and piece of equipment furnished, installed or provided under a specific project. An equipment can be a fixed and/or facility asset.

Fabrication Model — A model created by trade partners that is used for creating shop drawings and ultimately reflects the most detail of the components being installed. This model can later serve as the As-Built Model.

Facility — A building built for a specific use or purpose.

Facility Asset — Mechanical, electrical, plumbing and fire protection equipment, interior furniture and fixtures etc., that are maintained and managed by the Airport stakeholders in their respective target systems.

Federated Model — A combination of all distinct discipline and trade models from the project team to create a single representation of the facility. This model is primarily used for coordination and may also be referred to as a 'Merged Model'

Field Verified — Model data and geometry that has been physically verified in the field by a member of the project team.

Fixed Asset — The City and County of San Francisco and the Airport Commission defines Fixed Assets as long-lived tangible assets obtained or controlled as a result of past transactions, events or circumstances. Fixed Assets have more than a year (365 days) of useful life and meet certain value thresholds.

Industry Foundation Classes (IFC) — A platform-neutral, open file format specification that is not controlled by a single vendor or group of vendors. The .ifc file extension is used to transfer model geometry and data and is exportable from most Building Information Modeling authoring software.

Infrastructure — Site and air-fields, civil, underground, utilities and campus buildings.

Layout Points — Layout points are the physical or virtual markings used by trades to layout components in the field.

Model Content Author (MCA) — The project team or team member responsible for a specific model element.

Model Progression Specification — A high level overview that outlines what model element is to be input by which project team member for a specific scope of work.

Model—A virtual representation of the infrastructure composed by various 3D authoring programs such as AutoCAD or Revit®. This includes models for each phase such as design model, construction model, fabrication model, etc.

Parameter See definition for "attribute."

Parametric Modeling — The creation of building information models based on a set of rules or algorithms that operate through the manipulation of parameters. The model is created by an internal logic rather than through manual maneuvers.

Project Parameter — Parameters which are specific to a particular project in Revit.

Revit Family—A Revit family is a group of elements with a common set of properties, called parameters (or attributes) and a related graphical representation. Different elements belonging to a family may have different values for some or all of their parameters, but the set of parameters (their names and meanings) is the same.

Revit Family Type—Variations within a Revit family are called family types or types. Each type in the family has a related graphical representation and an identical set of parameters. These are called the family type parameters. Examples include CSI Masterformat number, manufacturer or model number. These are uniformly applied parameters for the same type of element.

Revit Instance — Instances are individual model elements that are placed in a model and have specific locations in the building. Examples of instance parameters include location, serial number, drawing tag etc.

Robotic Total Station—Advanced survey tool used to layout and collect point data to and from a model.

RVT—A model file extension whose format is native to Autodesk® Revit.

Scope of Work—The division of work to be performed under a contract or subcontract in the completion of a project, typically broken out into specific tasks with deadlines.

SFO — Designated airport code for San Francisco International Airport. This term is used interchangeably with "the Airport" throughout the SFO BIM Guide.

Shared Parameter — Parameter definitions that can be used in multiple Revit families or projects. The definition is stored as a separate .txt file and can be shared between projects.

Target System — A database or software platform used by an Airport stakeholder group to support specific business objectives. Mainsaver (an example of CMMS - Computerized Maintenance Management System) is a target system used by the Airport's Facility Scheduling group. A goal of the Airport's BIM Implementation Program is to enable the standardized transfer of infrastructure information developed by project teams to Airport's target systems.

Trade Partners — Builders who are typically sub-contracted by a general contractor and specialize in a particular aspect of the construction trade such as drywall, mechanical, plumbing, concrete etc.

Vendors — A person, company or a manufacturer that provides a product for sale.

Virtual Design and Construction (VDC) — CIFE Methodology used in the management of integrated multi-disciplinary performance models of the Airport's facility and fixed assets, including existing, planned and current infrastructure in development, as well as concurrent and collaborative work processes and organization of the planning - design - construction - operations team in order to support explicit business objectives.

VDC Workflows — VDC workflows mirror the way in which projects are delivered at the Airport. In this framework, "VDC workflows" are the concurrent and collaborative methods that the entire team has agreed to follow. It begins with the Airport's stakeholder engagement process, partnering and collaborative systems and incorporates decision-making protocols, knowledge networks, value stream mapping, pull planning, short-term interval planning and so forth.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Part One

BIM at SFO

What is BIM?

A Building Information Model (BIM) is a digital representation of the Airport's assets and infrastructure that consists of model elements that represent spaces, infrastructure components, and building systems that comprise the facility. The model elements represent physical geometry and attributes that describe functional and performance characteristics of the infrastructure. An important characteristic of BIM is the ability to automatically associate model elements with their containing spaces (locations) in the virtual environment.

In basic terms: BIM = Virtual Model (3D Geometry + Location) + Data **(see Figure 01).**

The ability to locate model elements in virtual space aligns naturally with Geographic Information System (GIS), which is founded on the association of data and spatial relationships. Finding and querying model elements by location is critical for accessing information by all stakeholders, and is supported by the integration of BIM and GIS at the Airport.

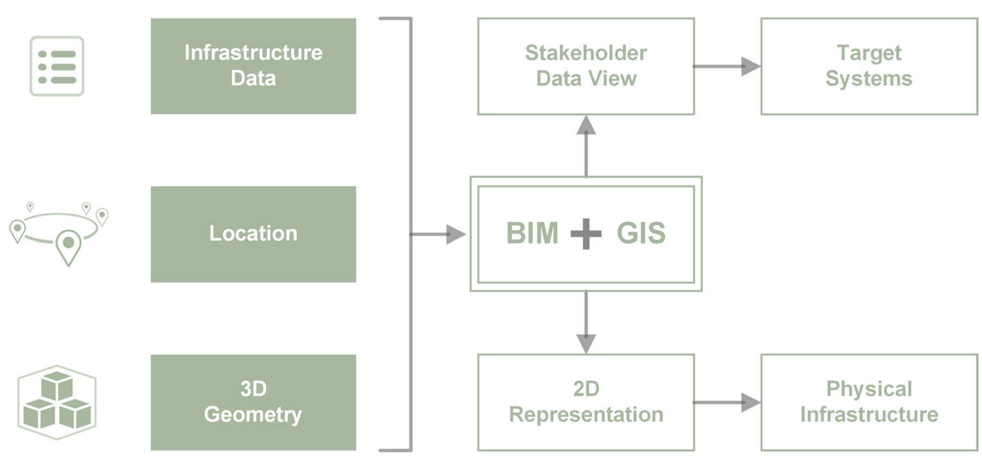


Figure 01. BIM and GIS at the Airport

BIM is an enabler of Virtual Design and Construction (VDC). VDC is the management of integrated multidisciplinary performance models of the Airport's facility and fixed assets, including existing, planned and current infrastructure in development, as well as concurrent and collaborative work processes, and organization of the planning - design - construction - operations team in order to support explicit business objectives. VDC is a collaborative process that aligns with the Airport's methodology for exceptional project delivery through the stakeholder engagement process, partnering and collaborative systems. VDC is facilitated by goal alignment and the shared commitment to partnering and by technologies such as GIS and BIM. The Airport is establishing a centralized integrated infrastructure information platform for the collection of data associated with design and construction projects. This will enable the Airport to deliver sustainable and resilient infrastructures with optimized life cycle values, streamlined operational processes, and minimized cost of operations and maintenance.

BIM, VDC, and GIS are concepts that are synonymous with successful design and construction projects. The wide-ranging definitions of BIM create different perceptions of what BIM encompasses. In the Architecture, Engineering, and Construction community, BIM is commonly referred to as Building Information ***Modeling***, when a process is described, and a Building Information ***Model*** when a product is described.

For the purposes of the Airport, BIM is a digital representation of the product and VDC is the collection of processes and methods that support integrated and concurrent, planning, design, construction, operations and maintenance of its infrastructure.

Why the Airport uses BIM

The Airport believes in the benefit of BIM for the facility life cycle because it supports the approach to project delivery, improved quality of data and streamlining the communication of building information. The Airport is actively involved in collaborating with project teams for goal setting and implementation in terms of BIM uses, best practices, standards, and tools. This ensures that projects develop consistent content that the Airport can use throughout the infrastructure's life cycle.

The following goals highlight the Airport's top priorities of BIM use. They are complementary to the BIM uses defined by project teams for design and construction.

1. Improved documentation and review
2. Data consistency through all lifecycle phases
3. Verified information exchange and handover

Improved Documentation and Review

BIM use in the planning, design, construction and operations phases facilitates design, analysis, documentation, review, pre-construction and construction coordination. These activities are primarily executed by designers, builders and trade partners. The SFO BIM Guide specifies performance requirements for such uses, while allowing builders the flexibility to meet the project specific goals and requirements. The Airport has established design documentation requirements for the use of Autodesk Revit, as described in the attachment "SFO Revit Standard". **Figure 02** conceptually illustrates the use of BIM at the Airport for documentation and review.

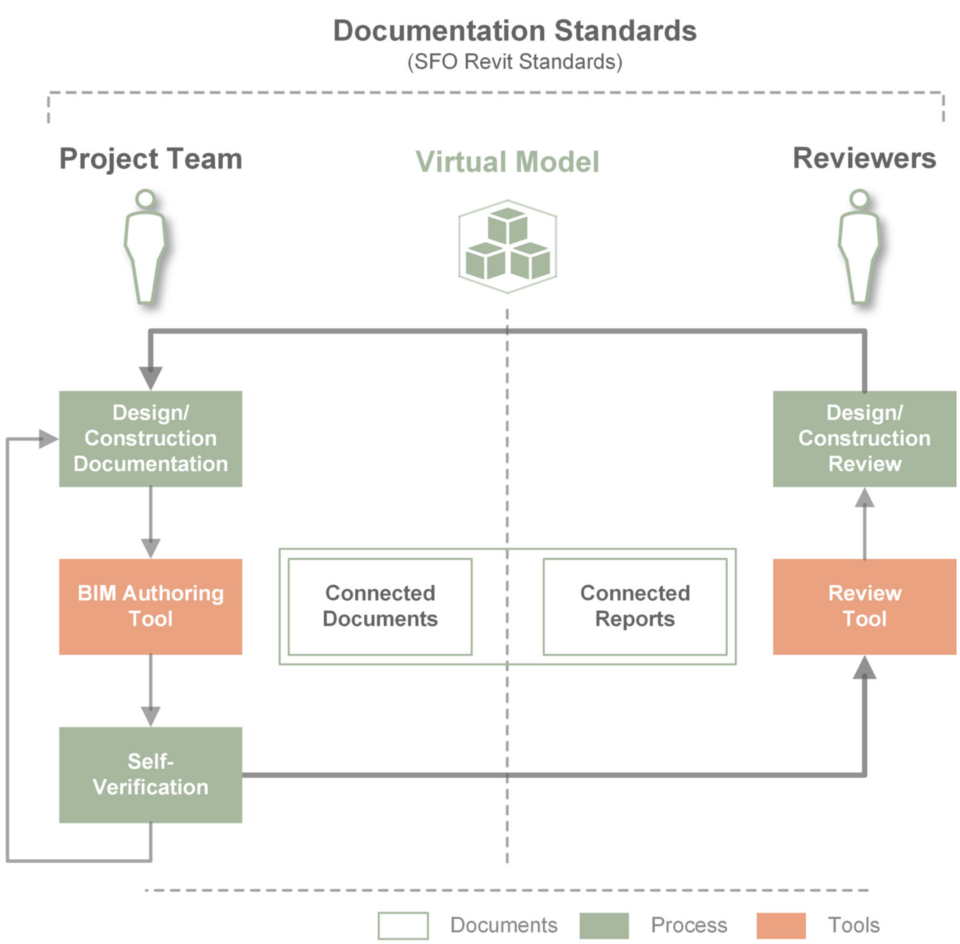


Figure 02. Documentation Standards at the Airport

Data Consistency through all Life Cycle Phases

Model-based data can be used during all phases of an infrastructure's life cycle. Some of this data is created by project teams during one phase and used during another. The SFO BIM Guide promotes continuous and consistent data authoring and verification through data standards, i.e., it specifies what data must be delivered, the data format and the verification criteria. The SFO BIM Guide also encourages project teams to determine how they develop data, by suggesting best practices, given specific project needs and project delivery methods. **Figure 03** illustrates the concept of the incremental collection of infrastructure data through design and construction and the transition to As-Managed Data.

Incremental data collection and verification focuses on the point of data authorship for project stakeholders e.g., designer, builder, trade partners, commissioning agent, etc. This has the effect of breaking a large effort into smaller and more manageable ones and leveraging the project specific and professional knowledge of original data authors who are most familiar with the work product.

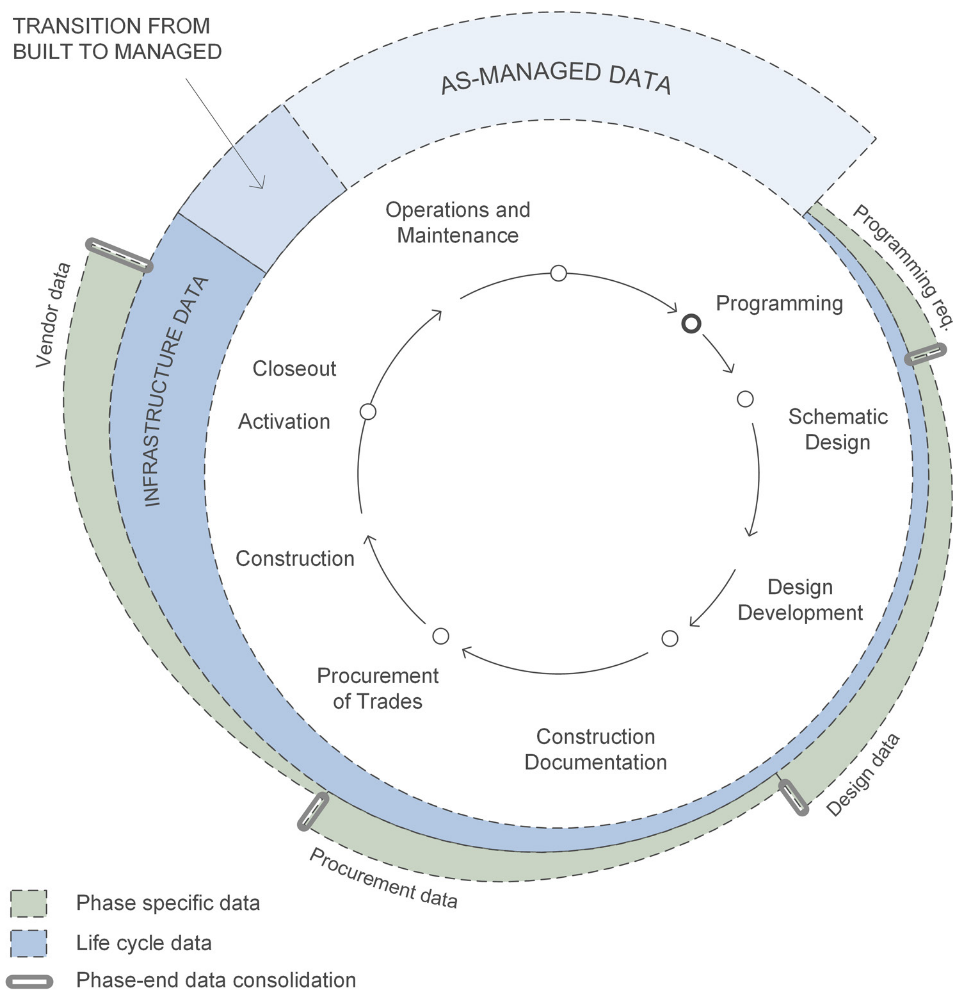


Figure 03. Data Through Life Cycle

Verified Information Exchange and Handover

The Airport seeks to bridge the gap between how building information is delivered and how stakeholders use it for their business processes. Relevant information from multiple documents and sources should not be manually pieced together for infrastructure operations and management uses. The Airport recognizes that a standard structure and incremental collection and verification of infrastructure data through planning, design and construction make it possible to directly transfer verified information into the Airport's target systems (GIS, CMMS, financial and space management databases, etc.). The Element Attribute Dictionary (EAD) specifies a standard nomenclature for the Airport's BIM elements and attributes to ensure the development and verification of information are consistent across all projects. This makes facility data collection and handover more efficient and scalable. **Figure 04** is a conceptual illustration of how BIM is used at the Airport for authoring, verifying and handing over Infrastructure Data.

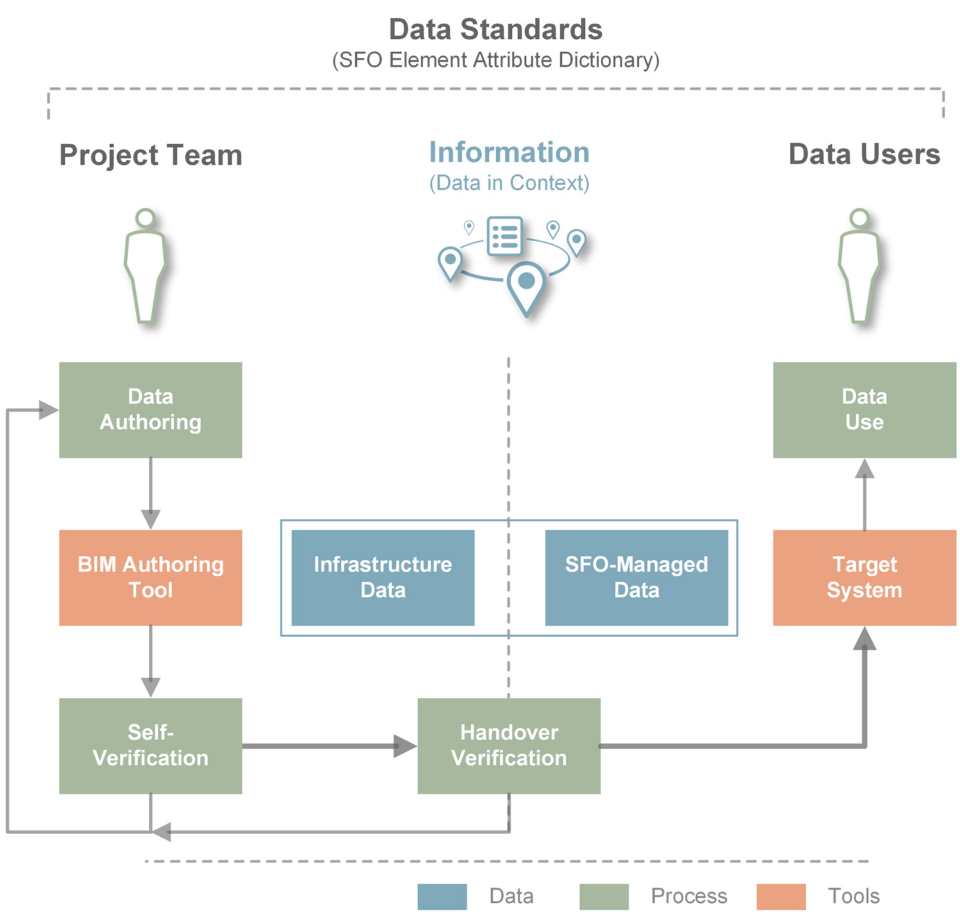
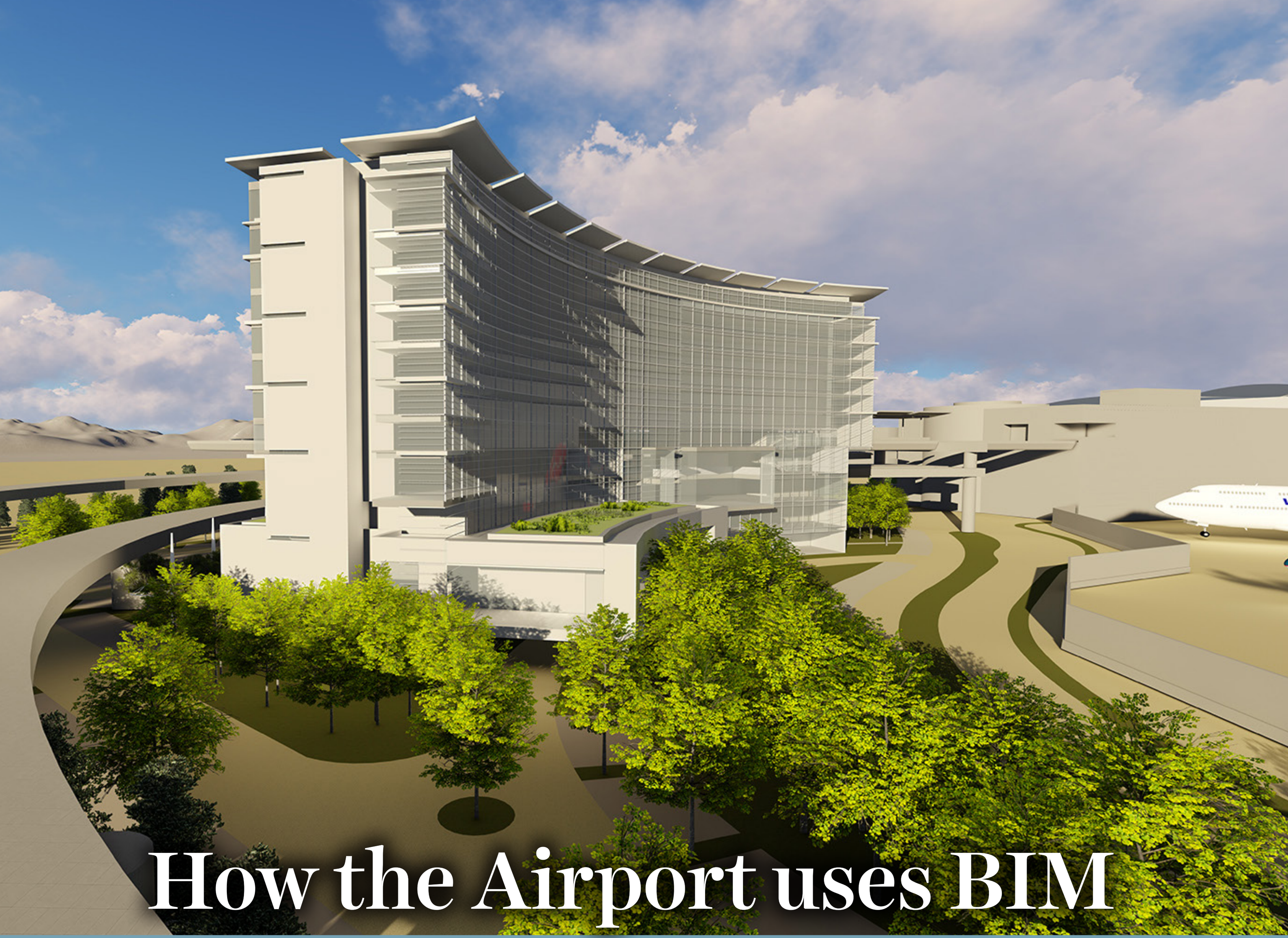


Figure 04. Handover of Infrastructure Data

BIM helps project teams align the facility and fixed asset data they develop with the Airport's strategic vision, operations and maintenance procedures. It also has uses that project teams can leverage to aid the efficiency and effectiveness of planning, design and construction work. These uses are described in the section titled "BIM Uses".



How the Airport uses BIM

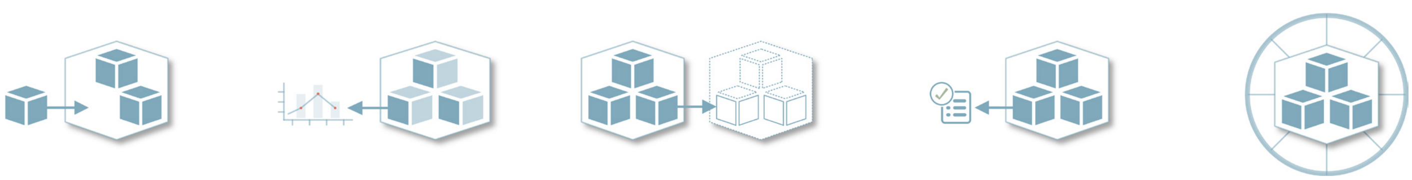
The Airport uses BIM as part of VDC to support Stakeholder Engagement and Collaborative Partnering processes, and to ensure that design and construction information can flow into the Airport's target systems, through the implementation of an Element Attribute Dictionary, Data View Definitions and verification methods.

Furthermore, the Airport has adapted its organization to include a dedicated group of subject matter experts, the BIM Integration Team (BIT), to provide leadership for BIM implementation through each project's life cycle. The BIT functions as a bridge for the in-house stakeholders, design reviewers and project teams to ensure the correct implementation of the SFO BIM Guide. The BIT serves in-house architects and engineers to support their BIM goals. They also engage with capital project teams to develop standards and processes for data collection and verification, and enable Airport stakeholders to collect design and construction information.

Technology changes rapidly and solutions must be aligned with each project's scope. Project teams and the BIT collaboratively overcome challenges and develop solutions related to implementing software solutions to meet the Airport's goal.

BIM Uses

The Airport has identified and organized the following BIM uses during design, construction and operations into five categories. Project teams should use their knowledge and expertise to assess and align the use of BIM with their project specific scope and requirements, and address their plan for achieving the Airport's vision in the BIMx Plan. Their project specific BIMx Plans supports the definition of responsibilities across the entire team and provides a benchmark for how teams work together to execute BIM and deliver integrated infrastructure information.



Authoring

- Design Documentation
- Shop Drawings
- Digital Fabrication

Analysis

- Design Review
- Engineering Analysis
- Clash Coordination
- Virtual Mockups

Execution

- Logistics Modeling
- Supply Chain Management

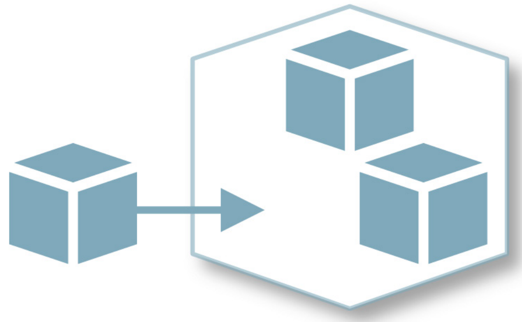
Verification

- Laser Scanning
- Model Data Verification
- Robotic Layout

Operations

- Facility Management
- Geographic Information System (GIS) Integration
- Space Management

Authoring



BIM replaces traditional CAD-based workflows with a more efficient content creation and documentation process. The models also enable processes such as digital fabrication by serving as the source files for machining technologies.

Design Documentation

What is it?

Design documentation is the process of translating the design intent for a building to a realistic virtual representation using a BIM authoring tool (i.e., modeling software). BIM authoring tools utilize a library of explicit 3D elements (also known as, objects or components) with embedded data, represented in the form of attributes or properties. The spatial location of the elements is automatically recorded and tracked in BIM. The relationship between these elements are governed by implicit rules and constraints that can be modified parametrically. Design documentation using BIM replaces individual static drawings with views generated from a virtual model. Therefore, changes made in one place are automatically propagated throughout the model. The primary BIM authoring tool used at the Airport for Architecture and Engineering is Autodesk Revit and Autodesk Civil 3D®. For detailed requirements see the SFO Revit Standard.

How does it benefit stakeholders at the Airport?

- Efficient design documentation, changes and review
- Supplementary uses of design models (e.g. analysis, visualization, coordination)
- Availability of uniform updated design models for re-design after handover

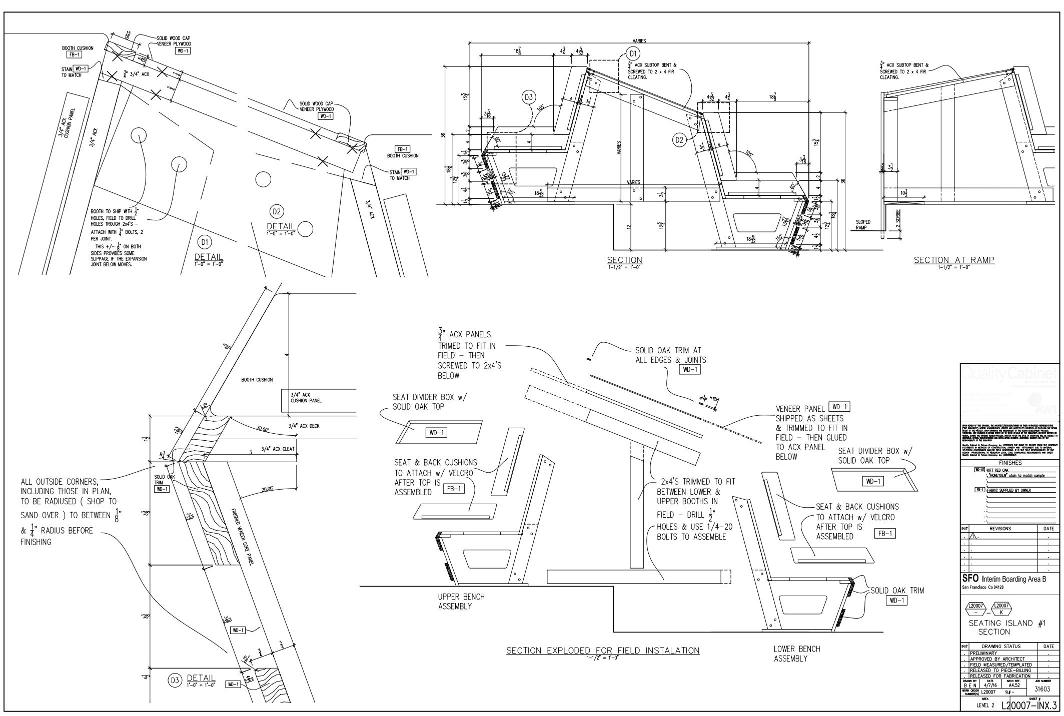
Shop Drawing Authoring

What is it?

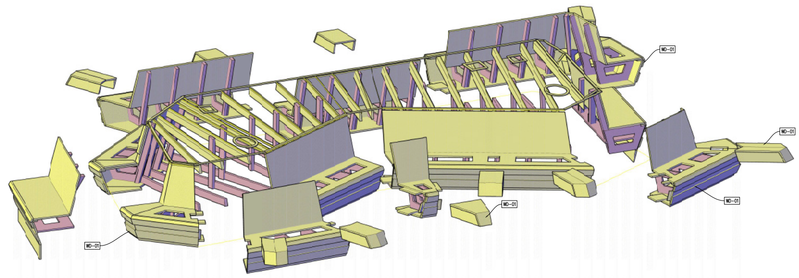
Trade partners create shop drawings, which include drawings, diagrams and schedules. These documents serve as a submittal for designers to demonstrate the approach to executing the work in accordance with the intent of the approved design documents. Shop drawings also communicate the fabrication and installation procedure to the fabricator and field installer. The trade partner can generate discipline specific shop drawings directly from a *fabrication model*, if created using a BIM authoring tool. As a best practice, trade partners manage a custom library of elements to streamline the production process. The practice of clash coordination ensures that the trade partners' models are coordinated, accurate and contain all the elements required by the approved design documents. Further detailing the coordinated model for shop drawings translates to quality fabrication and efficient installation in the field.

How does it benefit stakeholders at the Airport?

- ◻ Clear conformance between construction and approved design documents
- ◻ Accuracy and reliability of shop fabrication models (representing as-built conditions)
- ◻ Clear communication of design requirements to field installers

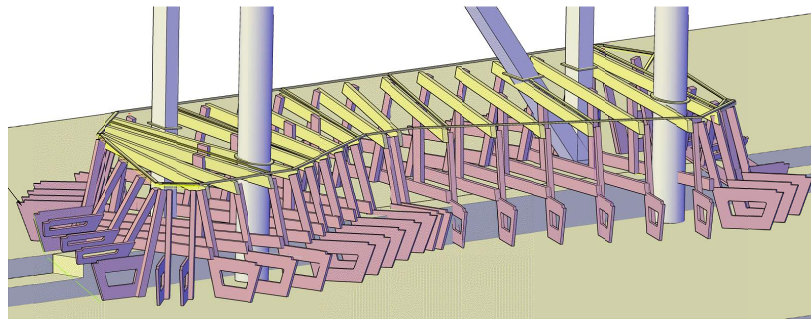


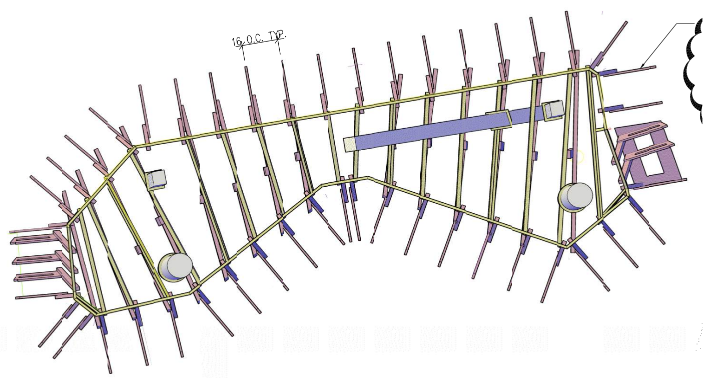
Digital Fabrication



What is it?

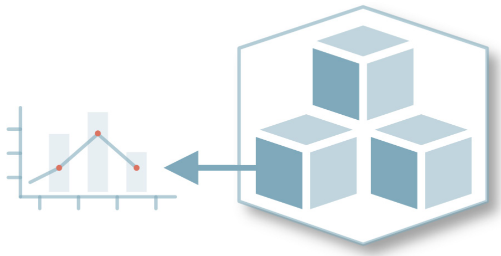
Digital fabrication is a computer-aided design and manufacturing process based on technologies such as Computer Numeric Control (CNC), laser cutting and 3D printing. Trade partners use this process to fabricate components from a source 2D or 3D model. Trade partners create highly detailed fabrication models that accurately capture all the components to be installed. This process is highly dependent on properly resolving conflicts during clash coordination to ensure accuracy of the fabricated components. Shop drawings are then generated from a 3D model, which can be set up such that the components are prefabricated off site using fabrication and machining technologies, pre-assembled as a kit of parts and shipped to the site ready to be installed.





How does it benefit stakeholders at the Airport?

- Clear conformance between construction and design intent
- Reduction of waste (material, labor, staging area etc.)
- Lean construction process
- Improves construction productivity
- Improves on-site safety



Analysis

BIM facilitates iterative design review at any stage of model development, providing the ability for stakeholders to visualize decisions made during the design process. Accurate geometry in 3D models enables clash coordination and virtual mockups by enabling collaboration, communication and decision making in a virtual environment prior to building on site.

3D Design Review

What is it?

The Airport reviews building designs at project milestones to ensure alignment with project requirements and to confirm the outcome of design decisions. The design review also serves as a platform for the project team to highlight design related issues and discuss potential solutions in upcoming project phases.

BIM supports design review by Airport stakeholders, who are not experienced designers and engineers, but are active users of building information. It allows comprehensive feedback from these stakeholders by offering the ability to view and navigate assets and related information in 3D space. BIM also enhances the review process with an additional perspective that traditionally was not possible because of the significant time to generate, but now is inherent to the design process. In addition, BIM allows design teams to perform iterative design review on multiple design options as part of schematic design and development, which leads to exceptional project outcomes.

How does it benefit stakeholders at the Airport?

- More efficient design review by Airport stakeholders
- Improve accessibility and facilitate design review for non-practitioners
- More efficient design review with multiple design options

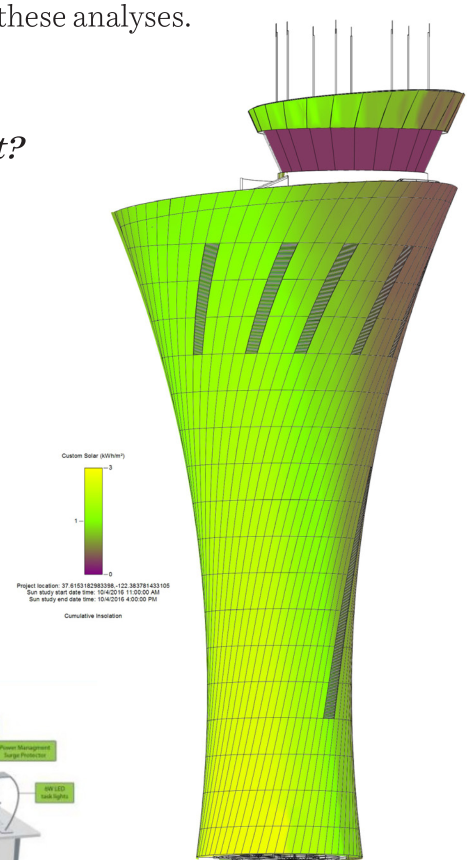
Engineering Analysis

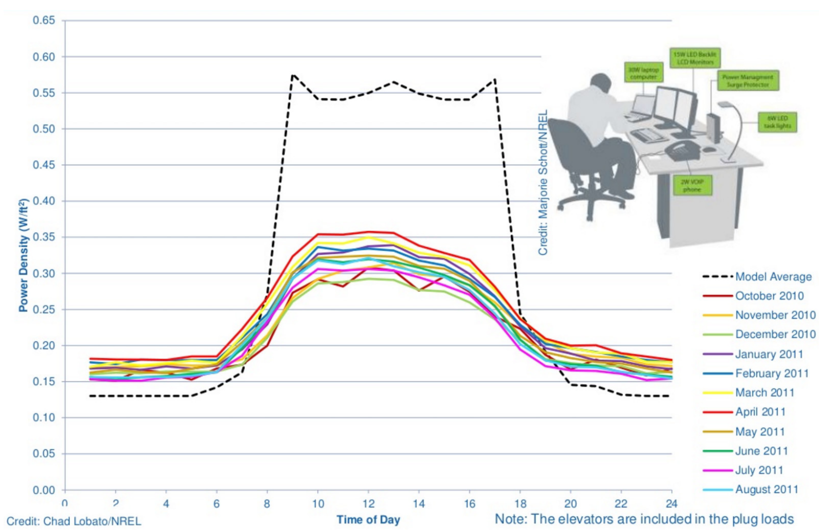
What is it?

Designers and builders use BIM analysis tools with information rich 3D models to simulate engineering options based on design and performance specifications for mechanical, electrical, structural, lighting and sustainability factors. Examples of these analysis tools include energy modeling, seismic modeling, queing modeling and flexibility modeling. These analysis tools help in better decision-making for project teams, assess the viability of their design, improve the design of the facility, and manage sustainability and resiliency in the facility life cycle. Various software applications require specific modeling standards to perform these analyses.

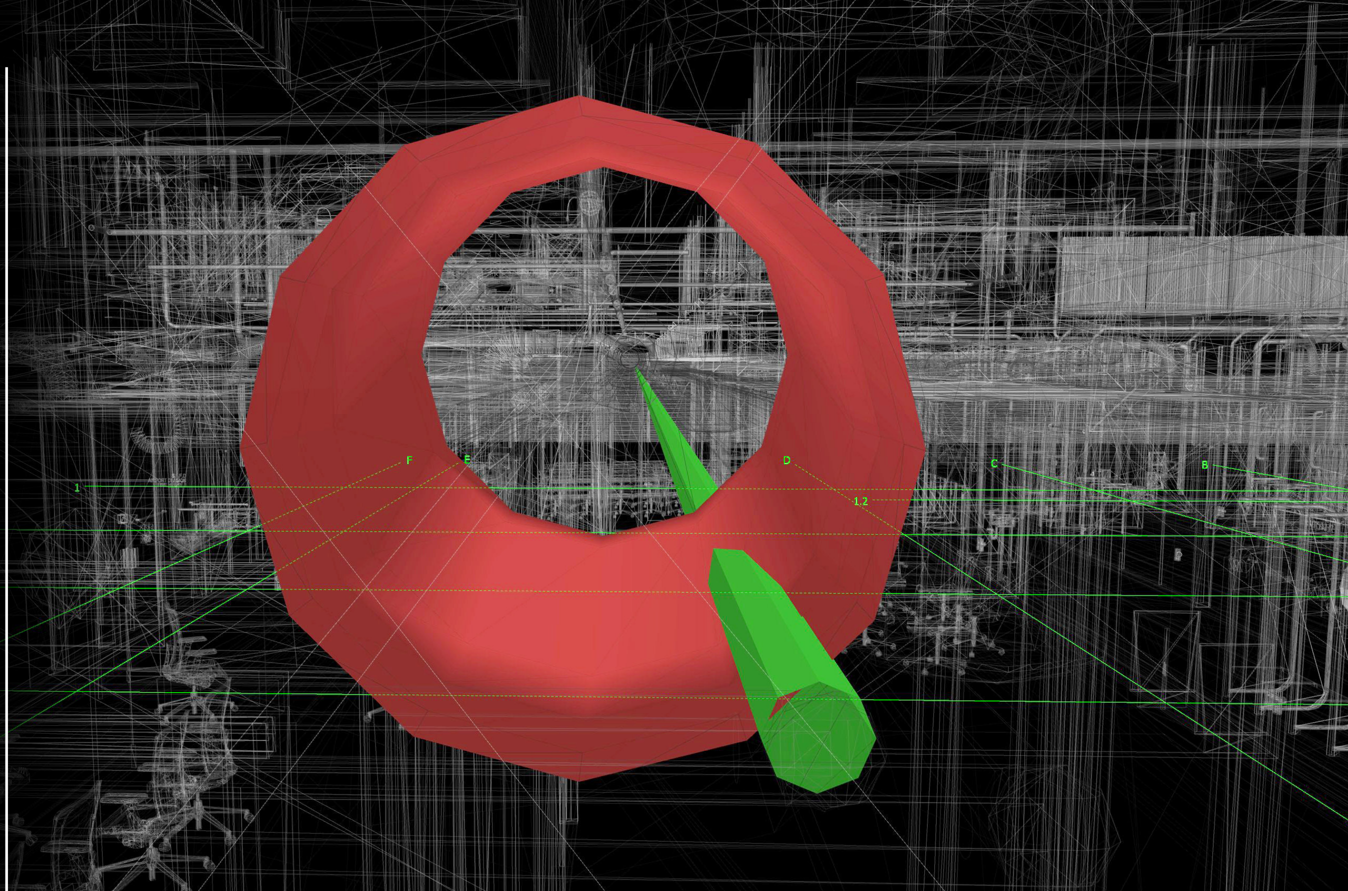
How does it benefit stakeholders at the Airport?

- ◻ Design and engineering efficiency
- ◻ Improves decision-making
- ◻ Enhances feedback and design review
- ◻ Better performing facility






PASSENGERS
COMFORT
AMENITY
PROVIDES SEATING FOR
80% LOAD FACTOR



Clash Coordination

What is it?

Clash coordination or clash detection are terms that refer to the process of resolving design conflicts in a federated model using a BIM based coordination software such as Autodesk Navisworks®, with the primary goal of eliminating design and construction conflicts prior to fabrication and/or installation. A federated model is the combination of all distinct discipline and trade models from project teams to create a single representation of the building or facility.

Through the process of clash coordination, each discipline-specific model is compared to another to determine if building components are occupying the same physical space. This is known as a “hard clash”. A “soft clash”, also known as a “clearance clash”, refers to components that violate a minimum clearance requirement, tolerance requirement or are in conflict with components that have not yet been modeled. Project specific clash coordination workflows are documented in the BIMx Plan developed by the project team.

How does it benefit stakeholders at the Airport?

- ☐ Resolves issues before anything is fabricated
- ☐ Reduces waste, rework and construction delays due to redesign
- ☐ Reduces design tolerances due to increased design accuracy
- ☐ Increased efficiency and optimization of components

Virtual Mockups

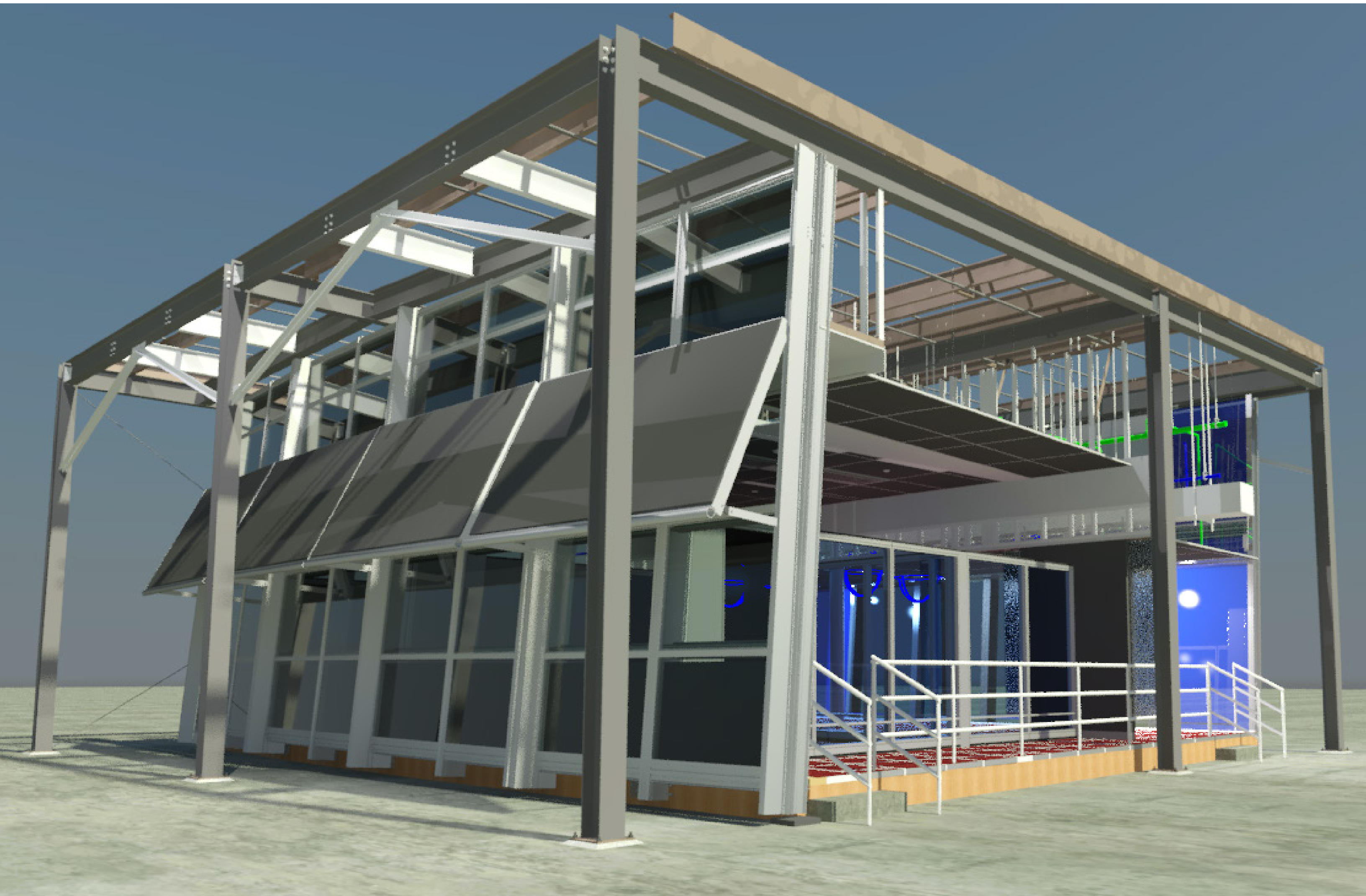
What is it?

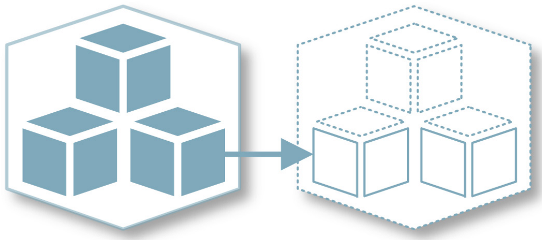
Virtual mockups are realistic 3D representations of building assemblies and their construction methods. They are not intended to replace physical mockups, but rather to cost effectively narrow down design options before creating the final physical mockups. Virtual mockups help proactively detect and rectify potential construction challenges faced by installers.

Geometric 3D assemblies can be created in a BIM authoring software and then rendered photo realistically by applying samples of real materials. The assembly can be deconstructed and sequenced based on the method of construction. Field installers can review this process and derive lessons learned before fabrication begins.

How does it benefit stakeholders at the Airport?

- Review and visualize a realistic representation of an assembly
- Constructability review of an assembly prior to shop drawing creation





Execution

BIM enables VDC workflows such as design reviews, logistics modeling and supply chain management. The BIM uses mentioned in this section are aspirational goals that the Airport encourages project teams to consider by illustrating how they benefit Airport stakeholders.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Logistics Modeling

What is it?

3D virtual models enable project teams to plan the logistics of the building and the surrounding site to optimize areas for material staging, delivery sequencing and safety planning during construction. This enables project teams to visualize and explore options of their logistics plan prior to mobilization. Logistics modeling is also a way to communicate ongoing construction work, safety hazards and detours to Airport stakeholders, employees, visitors and passengers at the Airport, such that the Airport operations and construction activities can function without interruption.

How does it benefit stakeholders at the Airport?

- Optimizes usable space for material staging and sequencing
- Provides multiple options and solutions for projects with space constraints
- Early resolution of space and workspace conflicts prior to construction

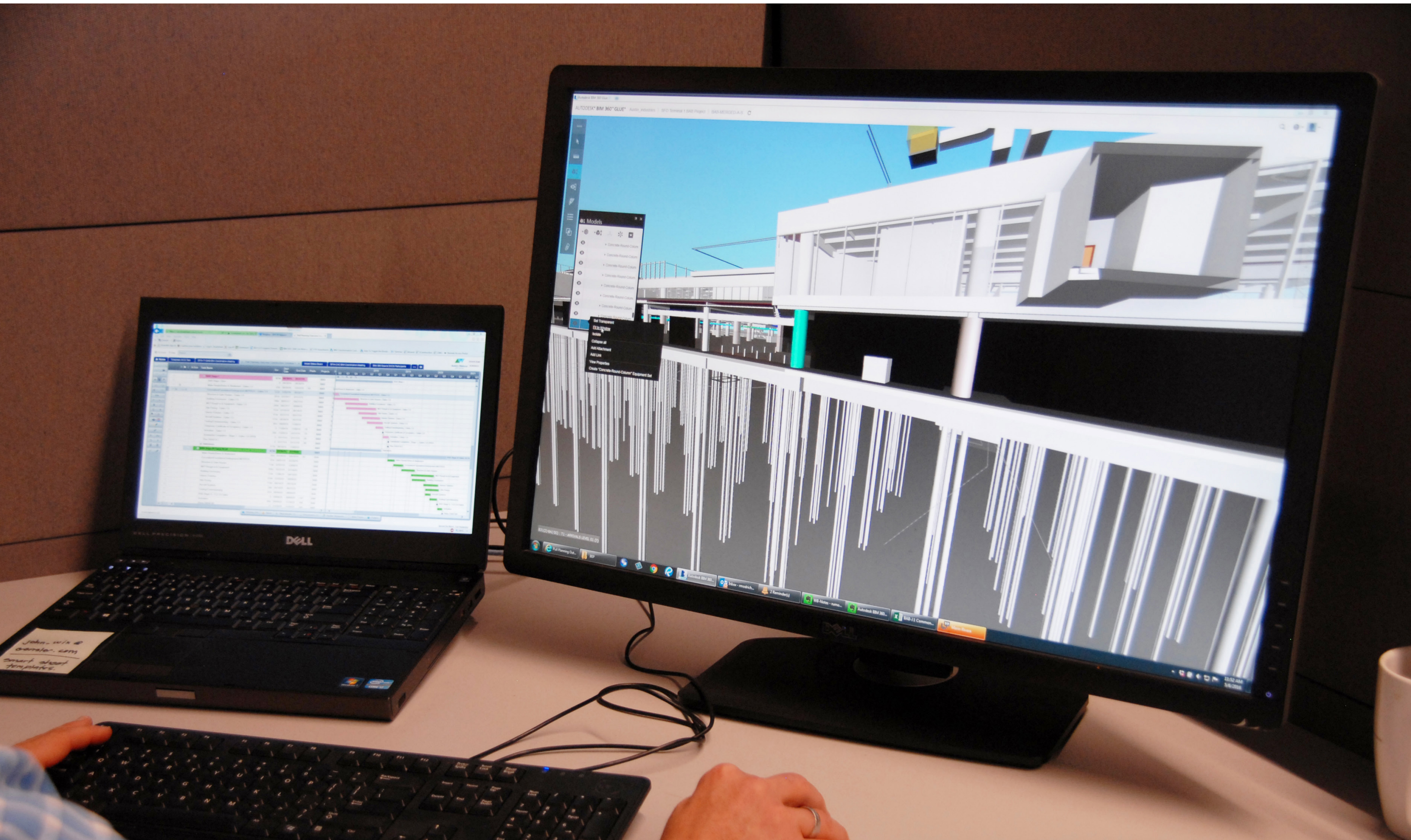
Supply Chain Management

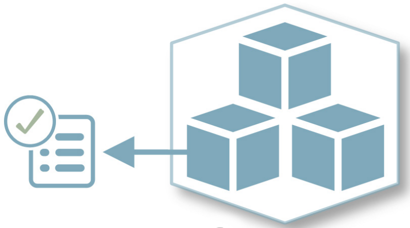
What is it?

Supply chain management is the coordination of various upstream and downstream relationships and activities with a network of organizations that include suppliers and customers, to deliver value in a timely fashion to the customer. BIM adds value in the form of schedule savings, cost savings, reduced variability and increased reliability for the entire supply chain. It achieves this by transferring activities from the site to the supply chain with the use of prefabrication. Other applications include material tracking using barcodes, development of online model repositories and real-time tracking of components using RFID tags. The Airport's Element Attribute Dictionary includes standard attributes assigned to model elements for RFID to support this use.

How does it benefit stakeholders at the Airport?

- Value-added process to the Airport and its partners
- Improves the delivery of quality projects through automation
- Improves efficiency and optimization of work processes





Verification

The usability of BIM depends on its reliability and accuracy. BIM permits project teams to conduct Model Data Verification through rule-based data validation implemented through the Airport's Element Attribute Dictionary. Geometric integrity can be verified for as-built conditions using 3D Laser Scanning and Robotic Total Stations. The Airport relies on its project teams to demonstrate the expertise to manage field changes and communication within their teams and deliver high quality, accurate and reliable Conformed Design Models.

Laser Scanning

What is it?

3D laser scanning is a technology that digitally captures a physical object's exact geometry. 3D laser scanners create point clouds (i.e., a large group of individual points representing the external surface of an object) that can be converted to accurate models which reflect existing or as-built conditions. 3D laser scanning can also capture built elements that will be ultimately concealed by other building components in subsequent construction steps (e.g., in-wall systems or small components).

A 3D laser scanner must be setup in strategic locations around a building to capture its geometry. Laser scanners work with direct line of sight to collect surface points. Therefore, the segments of point clouds must overlap and be tied together. The laser scanners capture digital photos of the environment as well. These digital photos can be aligned with the scans to enable expedited navigation in the viewing software since their processing time is faster than the data intensive point clouds.

How does it benefit stakeholders at the Airport?

- Capturing precise existing or as-built conditions
- Fast access to the virtual representation of accurate as-built conditions

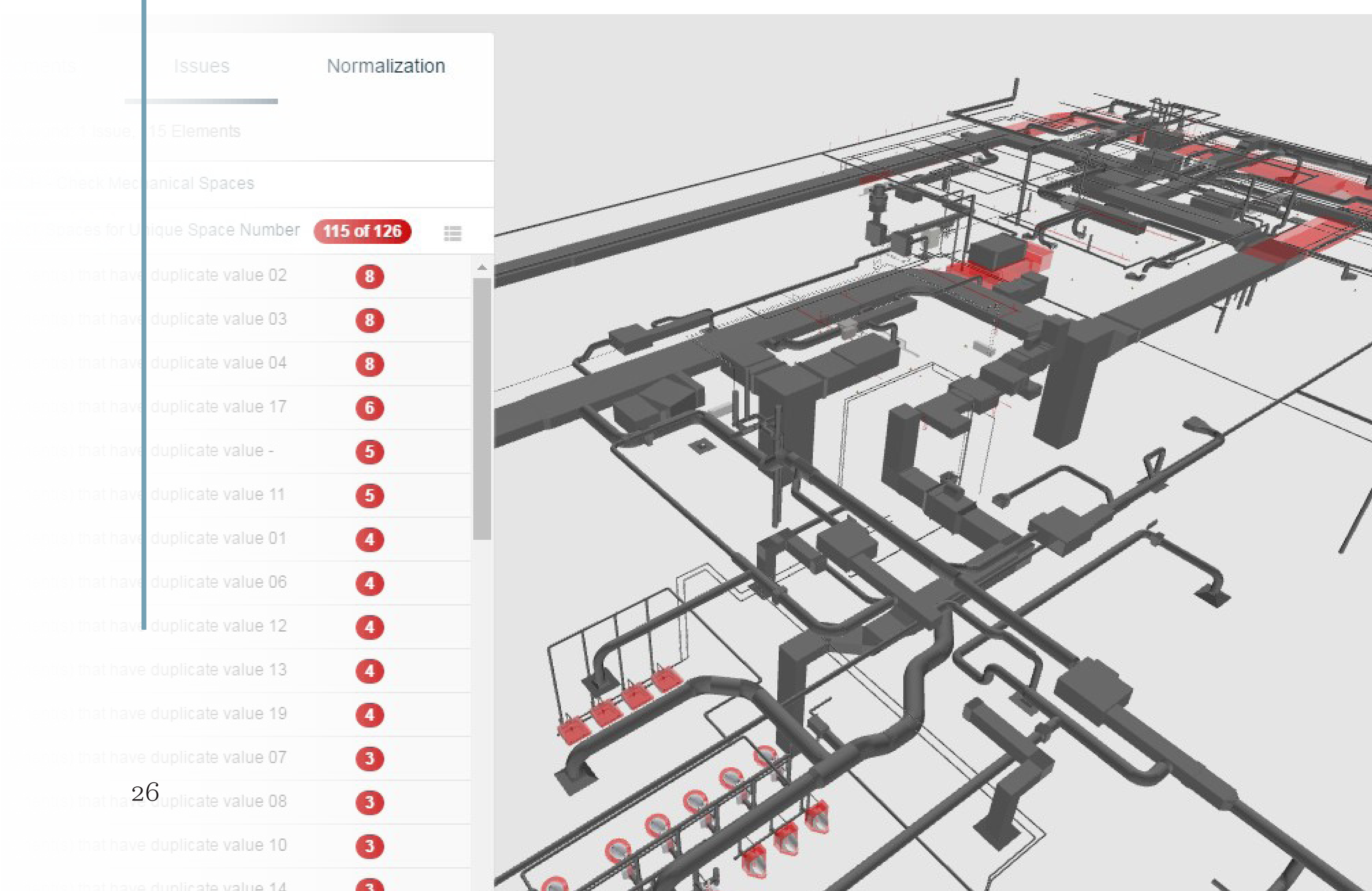
Model Data Verification

What is it?

The foundation of BIM is the delivery of standardized, accurate and consistent information. Without a standardized approach to data, the authoring of file names, element names, geometry and attributes will be inconsistent. This may produce invalid results for project schedules, cost estimates, facility management and operations data, and other information-related queries. Facility and fixed asset data collected through the design and construction phases must be verified to confirm its accuracy. Model checking software applications automate the comparison of model data with acceptable criteria. Refer to Section 2.4 for specific Airport guidelines for Model Data Verification.

How does it benefit stakeholders at the Airport?

- Higher quality, accurate and reliable data
- Automated verification of project data
- Standardized data helps standardize operational workflows



Robotic Layout

What is it?

Robotic layout is the process of using a Robotic Total Station (RTS) to translate 3D points from a model to the field. The same tool can be used to collect data points from the field. Trade partners can precisely layout their work with fewer people and less time using these devices. A Quality Manager can adopt this process to verify layout points of a trade partner's work to confirm its accuracy. Surveyors set up monuments that are tied to control points in the model. The RTS is set up and calibrated to these monuments. A model author places layout points in a model and sends it to the layout team. The layout team loads the model into the RTS and places points around the site. The person laying out the points carries a reflector pole and a tablet to control the RTS. A Quality Control Manager can take an RTS, collect various points and then load it into the model to compare the collected points to the layout points in the model.

How does it benefit stakeholders at the Airport?

- Increased accuracy
- Fewer people to lay out work
- Enhanced quality control process

Operations

All stakeholder groups at the Airport can benefit from receiving standardized information from the design and construction phases of building projects. Standardizing data structures and the incremental collection and verification of facility and asset data through design and construction make it possible to directly transfer the relevant verified information into the Airport's target systems (GIS, CMMS, financial modeling software, space management databases, etc.). See Section 2.3 Model Data Development and Management for more information on data requirements.

Facility Management

What is it?

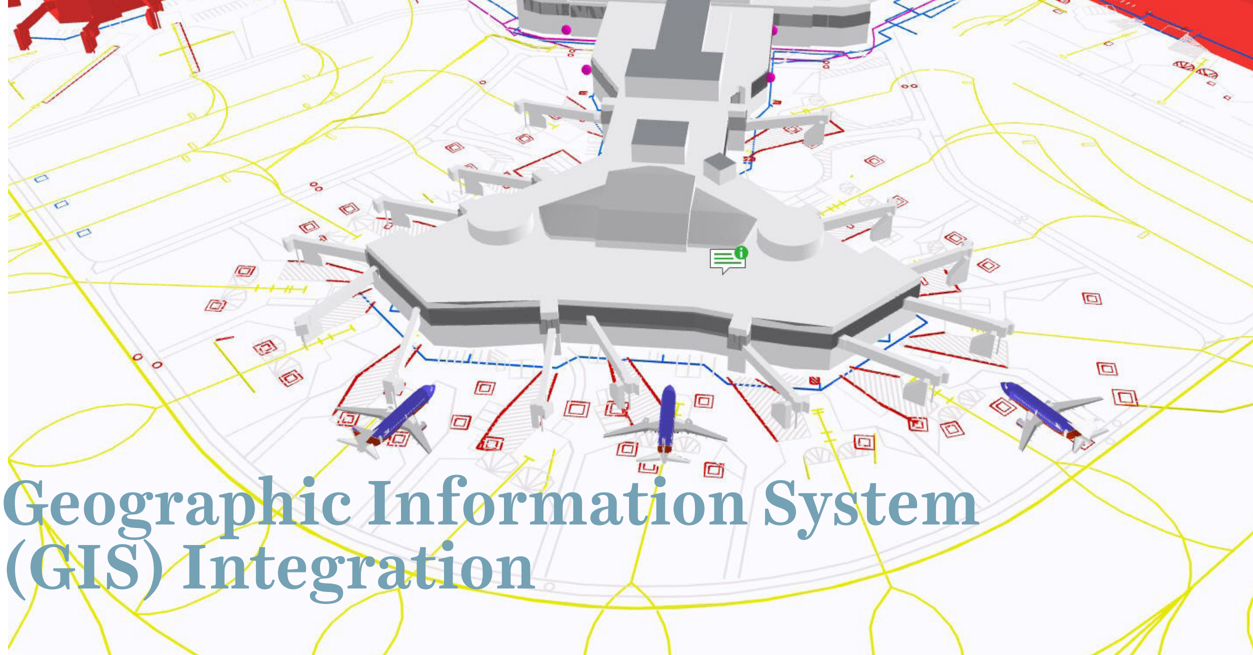
According to the International Institute of Facilities Management (IFMA), facility management "encompasses multiple disciplines to ensure functionality of the built environment by integrating people, place, process and technology." The Facility Management team requires, at a minimum, access to up to date, accurate and reliable facility and asset information to make informed decisions. BIM serves as a robust database for facility information, which can streamline the data transfer to any CMMS, Energy Monitoring and Management Systems and/or Building Automation Systems.

Given the cost of managing and operating facilities constitutes over 80% of facility life cycle costs, BIM represents an opportunity for the Airport to accelerate the transfer of information from contractors to operations and management. This will lead to a better understanding of the condition of major systems, including regular servicing and preventive maintenance, unplanned repairs, consumables and energy consumption.

SFO Facility Scheduling uses Mainsaver, a CMMS platform, to store and manage information about facility assets. Mainsaver is also used for generating and updating maintenance work-orders.

How does it benefit stakeholders at the Airport?

- Standardizes information management
- Reliable, accurate and timely information available at handover
- More efficient data transfer to the Airport's target systems



Geographic Information System (GIS) Integration

What is it?

At this time, information in BIM is not easy to query and scale across multiple facilities. GIS, on the other hand, is specifically suitable to visualize, analyze, model and forecast facility and infrastructure information at a campus level. Integrating BIM with GIS introduces a greater level of efficiency to organize and consolidate a large amount of data, and to put data in spatial context. GIS has the ability to combine and overlay layers of data from different sources, further promoting information exchange and collaboration. Highly customizable, web-enabled applications in GIS can also serve as potential viewers for BIM.

GIS is a dynamic platform used through the life cycle of infrastructure and it is capable of combining building geometry with live sensor data. This ability is particularly important in order for the Airport to support operational functions including emergency response, wayfinding, as well as the forecast of building use for revenue development based on passengers' behavior and movements.

BIM authoring tools can export validated geometry for background floor plans and tabulated data (e.g., space area, or space numbers) for input to GIS. This bi-directional integration of BIM and GIS represents the verified central source of infrastructure information at the Airport.

How does it benefit stakeholders at the Airport?

- Standardizes information through the life cycle of facilities
- Reduces risk of isolated software applications and data use
- Uniform access to information related to infrastructure
- Scalability of information access and management

Space Management

What is it?

There are numerous benefits that BIM offers to design, coordinate, document and manage space resource allocations of Airport facilities. During design, project teams use BIM authoring software to create multiple iterations of space and floor plans to satisfy the project program. Space boundaries are automatically generated and adjusted based on changes to space bounding elements (e.g., walls), improving the accuracy of space reporting.

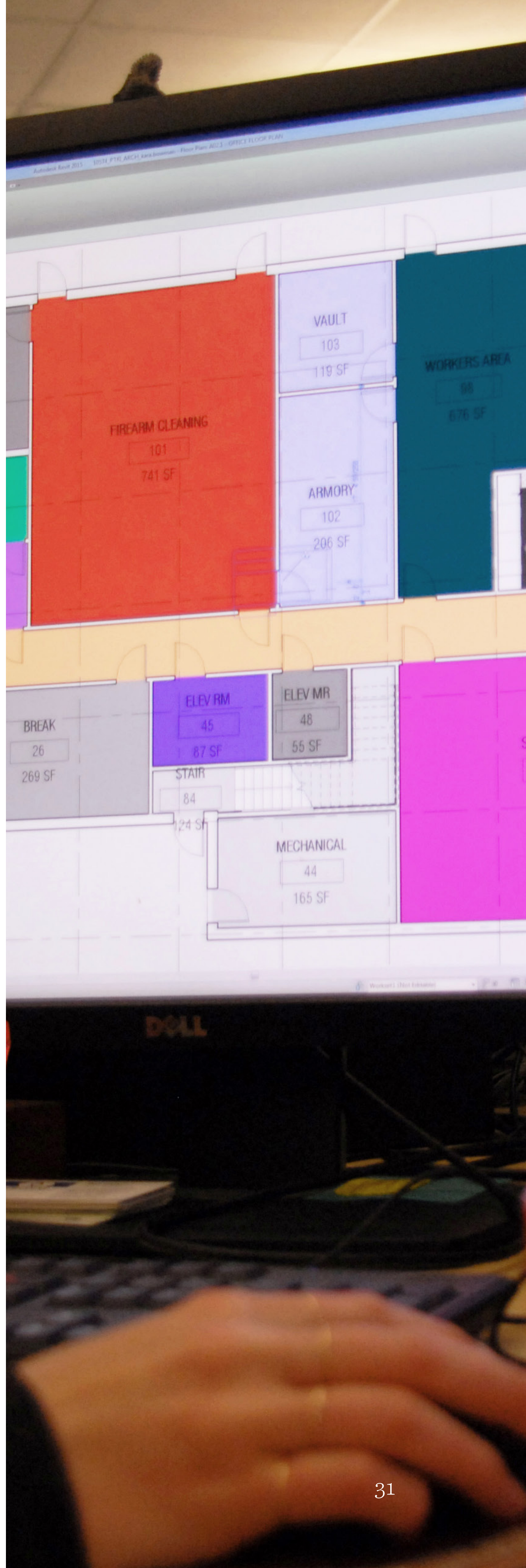
Designers can also adjust space boundaries and area calculations parametrically to reflect gross or net square footage, without recreating space elements in the model. They can use area elements (a custom function in Revit) to define spatial relationships and rapidly visualize area color schemes for review.

Although basic space management tasks (e.g. tenant assignment or area take-offs) can be performed directly in Autodesk Revit, a prominent advantage of using BIM is the ability to extract space information from conformed design models and bi-directionally share it with the Airport's space management target systems. This supports revenue development, aviation management, and safety and security activities, among other operations.

For detailed standards of space numbering, refer to the SFO Building Level and Space Numbering Guidelines in the Attachments.

How does it benefit stakeholders at the Airport?

- More efficient and accurate space reporting
- Enhances space information transfer
- More efficient program validation with multiple design options
- Space Resiliency Planning




SAN FRANCISCO INTERNATIONAL

Part Two
Technical Standards

2.0 Project Engagement

The Airport employs project teams with the necessary talent and resources required to deliver exceptional projects. SFO's BIM Integration Team (BIT) supports project teams with a structured engagement process to ensure implementation of BIM is streamlined through the phases of a project's life cycle.

Planning

SFO BIT works with the Project Management team of the candidate project to develop a clear strategy for BIM Implementation. A BIM Guide download meeting is scheduled with the entire project team to review contents of this document, collaboratively identify milestones and align BIM uses with the project scope. Thereafter, the project teams develop their BIMx Plan (refer to Appendix A - BIM Execution Plan). At this stage, the BIT will provide subject matter support and review of the BIMx Plan to support the project team.

Setup

The BIT will engage with the project team to resolve and clarify queries related to the Airport's Model Data Development and Management requirements as defined in Section 2.3. During this time, the Airport and the project team collaboratively develop technical solutions customized to the scope of the project.

Execution

During the design and construction phases, the project team and BIT will collaboratively define the Data View Definition requirement as defined in Section 2.3.2.2. At major milestones, the BIT will also review BIM compliance with the project team per this document.

Handover

The BIT will work with the project teams to ensure a smooth delivery of verified models by conducting one final verification of model data and geometry at handover. The BIT will also ensure the receipt of a Conformed Design model for the smooth transition to the Airport's target systems.

2.1 BIM Information Exchanges

The Airport's in-house architects and engineers require the use of Autodesk Revit as their design platform, which makes Revit the preferred BIM authoring software for all models delivered by project teams. Per the Submittals specification document 01 03 00 and the Project Record Documents specification document 01 78 39, the Airport requires all Building Information Models and AutoCAD models to be submitted from project teams including but not limited to:

- Trade Coordination
- Conformed Design Model with infrastructure data
- Shop/Fabrication Model
- Federated Construction Model

The format of model and database submission requirements are detailed in the BIM Requirements specification document 00 73 87. The details of data required by the Airport are described in the SFO Element Attribute Dictionary, Appendix C.

Recommended BIM Authoring Software:

Building data includes all elements within five feet of the building envelope. This model data is to be tied to a project internal coordinate system. The project internal coordinate system then must be tied to the SFO-B local coordinate system. Site data (typically including elements five feet or greater, outside the building envelope) must also be tied to the SFO-B local coordinate system.

- Design Models (everything within five feet of the building envelope) – Autodesk Revit
- Design Models (everything outside five feet of the building envelope) – Autodesk Civil 3D
- Construction / Fabrication Models – Autodesk Revit

RECOMMENDED MODEL EXCHANGE PROCESS:

Unimpeded access to the models that are created by project team members helps prevent duplication of efforts and ensures clear communication between team members. As such, all formally submitted documents (including submittals from builders and contract drawings or drawing revisions from the design team) should be accompanied by the model that was used to create them (including a model version/date). This helps to address the creation of separate and informal "model signoff documents" which do not have a formal review process that is supported by contract language. It also engages the entire team in the review and approval of model content so that model content can be relied upon with as much confidence as an approved shop drawing. Another option is to create composite drawings for review, approval and "sign-off" of a coordinated model by project teams before the creation and submission of shop drawings.

2.2 Sensitive Security Information

Content authors must carefully handle data provided by the Airport, as well as data created for the Airport's use. Specifically, content authors must ensure data is properly handled and distributed in conformance with CFR Parts 15 and 1520 which pertain to Security Sensitive Information (SSI). Security Sensitive Information is governed by Title 49 of the Code of Federal Regulations, CFR, Parts 15 and 1520. The content author shall follow effective data management processes to ensure that, prior to delivery, data related to existing or proposed Airport infrastructure is not distributed to inappropriate parties or stored in unsecure locations.

The content author shall transport data in a secure manner to Airport staff. Chain-of-custody documentation is required for delivery of electronic data and is to be included with a formal transmittal for all SSI related data transfers. Data that is hand-delivered requires a delivery handling receipt that is retained by the content author. All SSI related data and geometry in BIM must be created in standalone models that can be referenced by authorized users only.

2.3 Model Data Development & Management

This section outlines the technical criteria, data specification, documents and references that project teams use to create and validate facility data. The goal is to provide a specification for delivering normalized and verified data to the Airport as part of project delivery, as well as defining a data collection and verification process for project teams. The Airport is developing the Element Attribute Dictionary and Data View Definitions to describe the relationship between a project model progression specification and the Airport data specification for facility data.

The Airport has provided the following document templates to help teams collect and verify data in a reliable and efficient manner during the appropriate phase of each project.

2.3.1 Model Progression Specification (See Appendix B)

The Model Progression Specification (MPS) is an overview document that outlines what model geometry is input by each project team member for a specific scope of work. The SFO BIM Guide includes an example model progression specification that project teams must use as a template for their own BIMx Plans.

To effectively communicate modeling expectations, the Airport has adopted BIM Forum's LOD Specification. Please review this document carefully before proceeding to fill out the MPS. Like BIM Forum, when we refer to LOD we mean Level of Development, not Level of Detail. This is an important distinction as the two definitions have very different meanings. BIM Forum differentiates between Level of Detail vs Level development as follows. "Level of Detail is essentially how much detail is included in the model element. Level of Development is the degree to which the element's geometry and attached information has been thought through – the degree to which project team members may rely on the information when using the model. In essence, Level of Detail can be thought of as input to the element, while Level of Development is reliable output." One key difference in the Airport's approach is that we have removed "attached information" or "data" from this classification and made a separate classification known as the Element Attribute Dictionary which will be covered in Section 2.3.2. The breakdown of LOD can be found on the next page.

Level of Development (LOD)

LOD 100

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

LOD 200

The Model Element is graphically represented within the Model as a generic system, object, or assembly with approximate quantities, size, shape, location, and orientation.

LOD 300

The Model Element is graphically represented within the Model as a specific system, object or assembly in terms of quantity, size, shape, location, and orientation.

LOD 350

The Model Element is graphically represented within the Model as a specific system, object, or assembly in terms of quantity, size, shape, orientation, and interfaces with other building systems.

LOD 400

The Model Element is graphically represented within the Model as a specific system, object or assembly in terms of size, shape, location, quantity, and orientation with detailing, fabrication, assembly, and installation information.

LOD 500

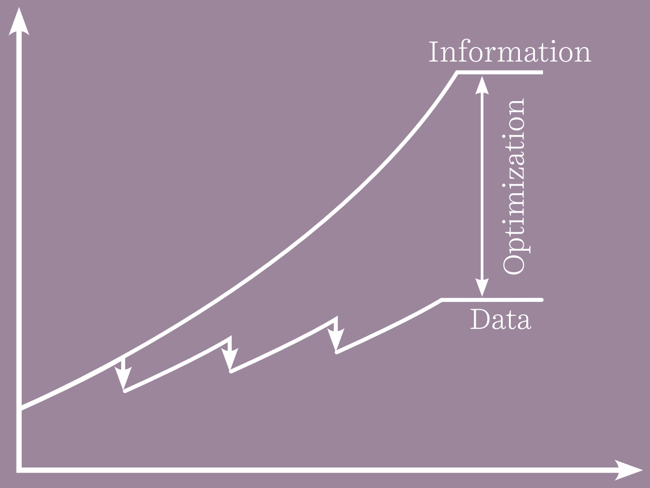
The Model Element is a field verified representation in terms of size, shape, location, quantity, and orientation.

It is very important to understand the distinction between these classifications. They are a tool used to help communicate intent to ultimately achieve the BIM Goals outlined in your BIMx Plan. For more information on these classifications, visit BIM Forum's website and download the latest LOD Specification document.

The model progression specification must be incorporated into the project specific BIMx Plan and amended to serve the BIM uses identified by the project team per the Airport's contract requirements. The goal of BIM use must be determined at the beginning of the project as it will influence the Level of Development to which the model should be authored to successfully serve its purpose.

Responsibilities for modeling and data entry should be split between various project team members (architect, design engineers, trade partners, etc.) during specific phases of design, construction and operations. Project teams are responsible for assigning model authors to each project phase. This document serves as the central point of reference for the content specification for model elements and links to the element attribute dictionary, which further details element names and element-attribute names for data views at project milestones.

The model progression specification is arranged according to the latest version of the CSI/CSC UniFormat system (basis for OmniClass Table 21–Elements) of classification which is based on functional elements of a facility, without regard to the materials and methods used to accomplish them. The general contractor is responsible for updating the MasterFormat (basis for OmniClass Table 22–Work Results) classification per the specifications of the project and subcontractor assignments.


Information
Optimization
Data

2.3.2 Element Attribute Dictionary (See Appendix C)

The Element Attribute Dictionary is a specification of the Airport's naming conventions for model elements and element attributes to manage its facilities across their life cycle. The EAD also specifies patterns for element names and an enumerated list of attribute values that must be verified by the project teams for compliance with the Airport's acceptance criteria (Appendix C).

Content data authors shall coordinate with the Airport through partnering, to specify and create data for building spaces, installed building systems and components using the terminology specified in the Element Attribute Dictionary. In cases where the dictionary does not provide Airport standard terminology, content authors should work with the Airport to add new model element definitions into the dictionary.

The EAD is a working document. It specifies model elements and attribute sets independent of how they are implemented in a given BIM authoring system. Additionally, it provides standards for how model element names can be implemented in Autodesk Revit so that element data can be exported from building information models for consumption by the Airport's CMMS and other target systems. **Figure 05** illustrates the structure of the Element Attribute Dictionary.

Project teams must coordinate the data requirements with the most up to date version of the Appendices. The Airport recommends the inclusion of the following activities as part of the EAD development process:

- Define the scope for model elements and attribute sets that the project will deliver, based on the Airport's business goals outlined in Part One of this guide. At a minimum, the content author must populate the attributes outlined in the Equipment Inventory Specification Document 01 78 23.23.
- Define model element names per the Airport's requirements (Appendix C.1)
- Develop data view definitions for data collection that are specific to project milestones and content author (see Appendix C.3 for an example)
- Normalize attribute sets across model element types
- Develop and implement a data collection workflow, incorporating industry best practices
- Incrementally populate data views for verification by the Airport
- Develop and implement the workflow to self-audit and report quality model data iteratively as part of regular model coordination and for each milestone defined by the data views

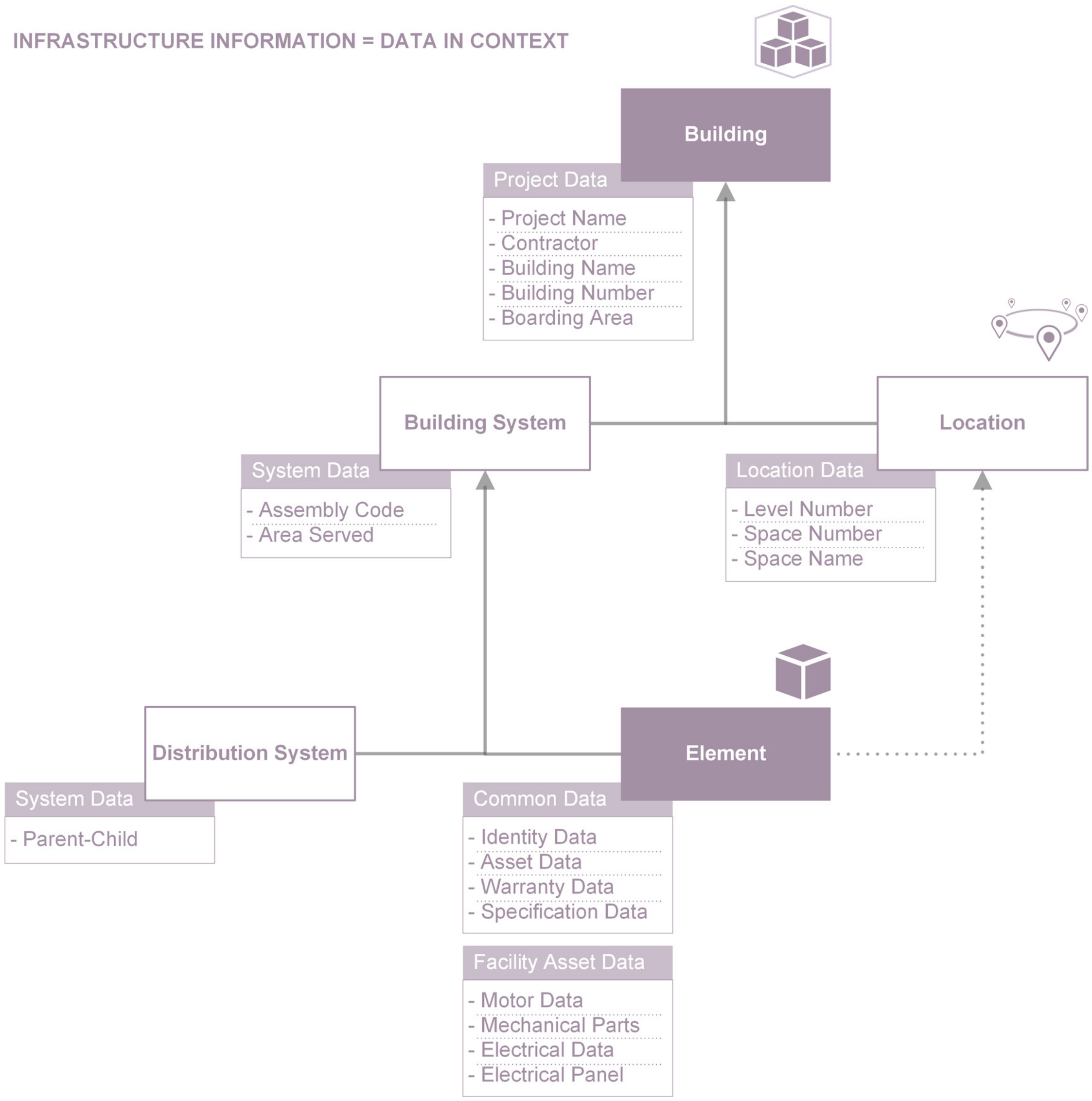


Figure 05. Element Attribute Dictionary Structure

2.3.2.1 Attribute Sets (See Appendix C.2)

The ***Common Attribute Set*** specifies the minimum Data View Definition for each model element, which the Airport requires for stakeholder use cases. In addition to the minimum requirements, model element attributes that serve specific Airport stakeholder business cases are captured in a growing list of data views. For example, the SFO Equipment Inventory Spreadsheet collects information that is specific to equipment tracked in the Airport's CMMS and is utilized by Maintenance personnel to service equipment. The Element Attribute Dictionary specifies this information through additional attribute sets such as the Facility Asset attributes.

The link between the concepts explained above is illustrated in **Figure 06** below.

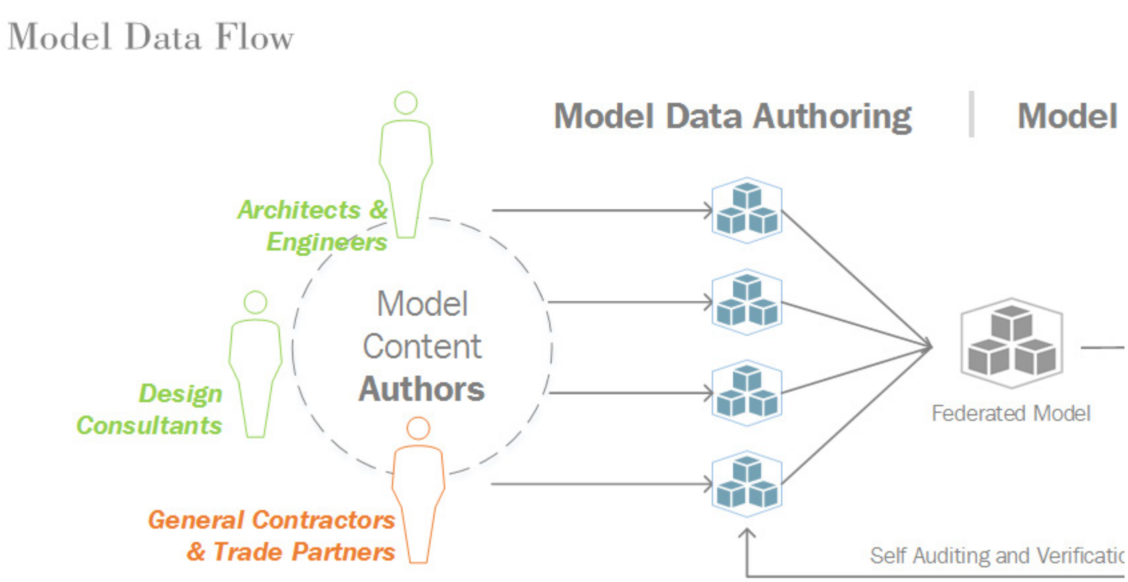


Figure 06. Model Data Development and Management Infographic

2.3.2.2 Data View Definitions (See Appendix C.3)

Data View Definitions are filtered views of the Element Attribute Dictionary that define the data relevant to project team member's scope of work at specific project milestones.

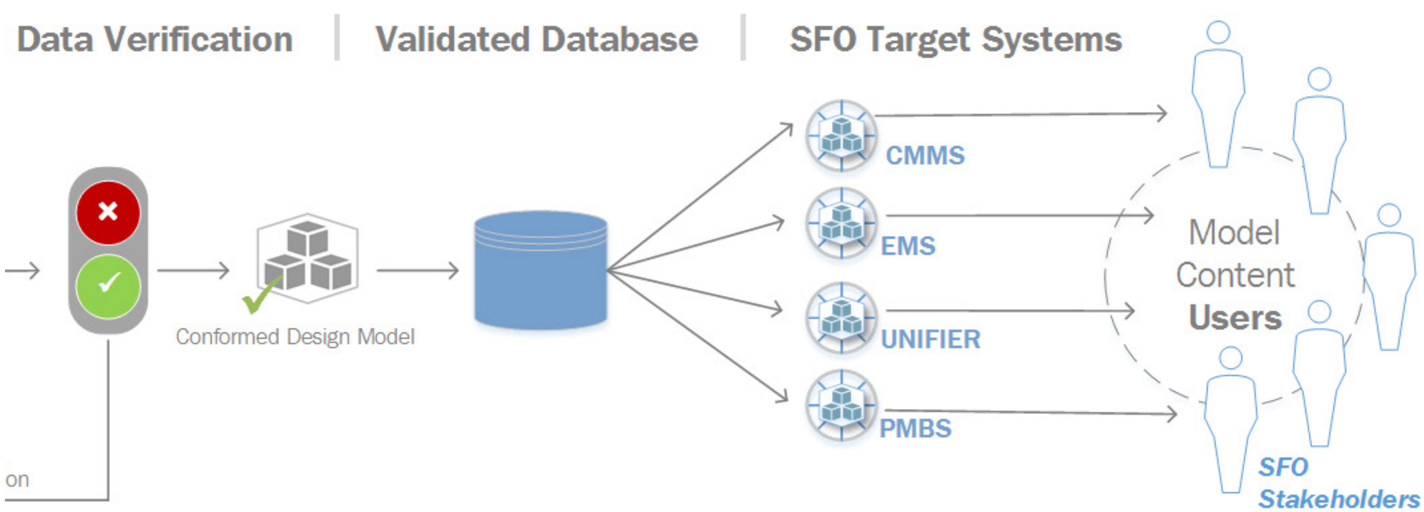
Data view definitions help each project participant understand what data they are responsible for delivering and when they need to deliver it. The data views can be aligned with project milestones, coordination schedules, submittal schedules or other logic that works for the project team, based on the delivery method, team organization etc.

The Airport will partner with the project teams through a series of project engagement meetings to define the data views in a DVD matrix. The DVD matrix is designed to serve as a decision-making tool for the project teams, and a communication tool between the project teams and the Airport to establish a baseline of expectations at each milestone.

This also helps in maintaining the momentum for data collection and verification.

The baseline expectation established for each data view can be encoded in data verification tools that project team members should run regularly at project milestones. The views establish a technical foundation for developing incremental and continuous data development and acceptance test processes, which will lead to high quality data at project handover.

Project teams will need to coordinate with the Airport to validate and extend the element attribute dictionary and data views upon project setup. They should implement the naming conventions and develop data acceptance tests to continuously self-audit and self-report model conformance according to the Airport's requirements.



2.3.3 Building Level and Space Numbering

The Airport's space numbering convention shall be followed on all Airport projects unless otherwise specified by the SFO Project Manager. The purpose of this space numbering convention is to standardize all spaces within both the physical and virtual environments. This convention provides a universal numbering system that is to be applied consistently to Airport's spaces. Refer to the SFO Building Level and Space Numbering Guidelines in the Attachments.

2.4 Verification

One of the Airport's goals for BIM is the delivery of standardized and consistent information. Without a standardized approach to authoring file names, element names, geometry and attributes, outputs from models developed for different projects will be inconsistent. Errors must be identified early to avoid unnecessary revisions.

2.4.1 Model Data Verification

The project team shall develop a model data test plan based on distinct tests for the data view definitions that are required for each milestone. The test plan shall be incorporated into the project BIMx plan. The data verification tests shall check:

- Conformance to element name definitions in the Element Attribute Dictionary
- Existence of attributes that are bound to element instances in the model
- Conformance to the attribute name definitions in attribute sets
- Conformance to acceptable attribute values for attributes that have a testable name pattern or enumerated list of values in the Element Attribute Dictionary

For example: The space numbering criteria is specified in the SFO Building Level and Space Numbering Guidelines to conform to the pattern: <BuildingNumber>.<BoardingArea>.<Level Number>.<Space Number>.

The data acceptance tests must check for conformance with the pattern for the space number as well as define a pick-list for acceptable values for individual attribute fields for Building Number, Boarding Area, Level Number and Space Number.

The tests may be implemented in a model checking software application that is approved by the Airport. Project team members that author BIM content shall run acceptance tests based on data verification rules approved by the Airport. Project teams will be responsible for running tests as frequently as necessary to achieve appropriate data conformance results at each project milestone.

The Airport recommends that the project teams run tests as a regular activity associated with the model coordination processes until all tests indicate conformance to Airport requirements for model submission. The Airport will also spot-check the models at major milestones to ensure data conformance.

The Airport will partner with the project teams to define and implement the process and expectations of model data verification through spot-checks.

2.5 Additional Standards

The Airport's existing standards that may be related to BIM are included in the Appendix of this document. The additional SFO standards are attached for informational purposes as applicable to a specific project. The additional standards not created by SFO are available online.

- Revit Standard
- GIS Standard
- CAD Standard
- Building Level & Space Numbering Guidelines
- Sheet Numbering Guidelines
- Pennsylvania State University BIM Execution Plan Template
- Laser Scanning Standards (LoA) from USIBD

Bibliography

Project BIM Execution Plan Template

The Airport requires consultant teams to use the Pennsylvania State University BIM Execution Plan Template found at http://bim.psu.edu. When applicable, the SFO BIM Guide appendices are to be used in lieu of the Pennsylvania State University BIM Execution Plan Templates. The sections listed in Part 3 of the BIM Guide are intended to provide teams with content suggestions for completion of this template.

The Pennsylvania State University BIM Execution Plan template for use by SFO project teams is referenced as:

Computer Integrated Construction Research Program. (2013). “BIM Planning Guide for Facility Owners.” Version 2.0, June, The Pennsylvania State University, University Park, PA, USA.

Laser Scanning Standards – USIBD Level of Accuracy Specification

For more information on the industry standard surrounding laser scanning, please visit: http://www.usibd.org/resources/usibd-standard-documents-version-1_0

The Construction Specification Institute. (2010).

UniFormat: A Uniform Classification of Construction Systems and Assemblies. Alexandria, VA, USA. Retrieved from http://www.csinet.org/uniformat

The Construction Specification Institute. (2016).

MasterFormat: Master List Numbers and Titles for the Construction Industry. Alexandria, VA, USA. Retrieved from http://www.csinet.org/masterformat

Omniclass™

The OmniClass Construction Classification System (known as OmniClass™ or OCCS) is a classification system for the construction industry. Retrieved from http://www.omniclass.org/

BIM Forum 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 Building Information Models (BIMs) at various stages in the design and construction process. Retrieved from http://bimforum.org/lod/

The National BIM Standard-United States® (NBIMS-US™)

The National BIM Standard-United States® (NBIMS-US™) provides consensus based standards through referencing existing standards, documenting information exchanges and delivering best business practices for the entire built environment.
Retrieved from https://www.nationalbimstandard.org/

Referenced Specification Sections

00 73 87 - BIM Requirements

01 31 19 - Project Meetings

01 33 00 - Submittals

01 78 39 - Project Record Documents

01 78 23.23 - Equipment Inventory

Appendices - BIM Integration Team | BIT@flysfo.com

Appendix A – BIM Execution Plan Framework

Appendix B – Model Progression Specification

Appendix C.1 – Element Attribute Dictionary: Family Naming Conventions

Appendix C.2 – Element Attribute Dictionary: Attributes Set

Appendix C.3 – Data View Definition example

Appendix D – Coordinate Systems

Attachments

Revit Standard – Stephanie Jaeger | Stephanie.Jaeger@flysfo.com

GIS Standard – Jason Hill | Jason.Hill@flysfo.com

CAD Standard – Anna Lam | CADStandard@flysfo.com

Building Level & Space Numbering Guidelines – Josephine Pofsky | Josephine.Pofsky@flysfo.com

Sheet Numbering Guidelines – Stephanie Jaeger | Stephanie.Jaeger@flysfo.com

Appendix A – Project BIM Execution Plan Checklist

What is it?

A BIM Execution Plan, also referred to as a BIMx Plan, is a comprehensive document which outlines the protocols and procedures that the design and construction team must follow to ensure successful utilization of BIM and VDC practices. The BIMx Plan must address workflows required to communicate between the various application platforms, incorporate the requirements of appropriate Airport end-users and address the capabilities and workflows required to integrate with other existing systems.

When is it needed?

The project BIMx Plan shall align with the specific project contract delivery method and the organization-wide use cases set forth in this document. The BIMx Plan shall be created by the project team before any modeling begins. If the project delivery method is Design Build, the BIMx Plan must encompass both design and construction procedures and be submitted to the Airport for review. If the project delivery method is a Design, Bid, Build, or CMGC, the design team and the builder can both submit separate BIMx Plans, but it is recommended that these teams collaborate around a single document. The builder must submit their BIMx Plan before distribution of subcontractor RFP. BIM Execution Plans created by project teams shall meet the requirements of this SFO BIM Guide so models and databases created by project teams meet SFO goals.

The Airport understands that this is a living document and will evolve throughout the project's life cycle, but it is vital to establish baseline requirements to which everyone must adhere. Any revisions made to the BIMx Plan must be submitted to the Airport for review and approval prior to distribution. The use of a change log is required for submission to the Airport for review. All BIMx Plan drafts will be collaboratively developed with the BIM Integration Team (BIT) using the template provided by the airport and submitted as a Microsoft Word document with the "Track Changes" feature enabled.

Appendix B: Model Progression Specification

Delivery Method: Design-Build

In-House Projects Handover | *Capital Projects Handover*

	DESIGN	BUILD	CONSTRUCTION CLOSEOUT
Suggested BIM Use	Existing Conditions Modeling, Cost Estimation, Phase Planning, Programming, Site Analysis, Design Reviews, Design Authoring, Energy Analysis, Structural Analysis, Lighting Analysis, Mechanical Analysis, LEED Evaluation, Code Validation	3D Coordination, Site Utilization Planning, Digital Fabrication, 3D Control and Planning	Record Model
Lifecycle Phases	Schematic Design, Design Development, Construction Documents	Construction	Commissioning / As-Builts

Elements/System	Classification			Schematic Design		Design Development		Construction Documents		Construction		Commissioning / As-Builts	
	OmniClass Table 21-Elements	MasterFormat / OmniClass Table 22 - Work Results	OmniClass Table 23-Products	LOD	MCA	LOD	MCA	LOD	MCA	LOD	MCA	LOD	MCA
Substructure	**21-01 00 00**												
Foundations	21-01 10	03 - Concrete, 31 - Earthwork	23-13 00 00: Structural & Exterior Enclosure Products, 23-39 00 00: Utility and Transportation Products	200	SE	300	SE	300	SE	300	SE	300	SE
Subgrade Enclosures	21-01 20	03 00 00				200	SE	300	SE	300	SE	300	SE
Slabs on Grade	21-01 40	03-Concrete, 07-Thermal & Moisture Protection, 31-Earthwork		200	SE	300	SE	300	SE	300	SE	300	SE
Water and Gas Mitigation	21-01 60	31 - Earthwork, 33 - Utilities											
Substructure Related Activities	21-01 90	31 - Earthwork				200	SE	300	SE	300	SE	300	SE
Shell	**21-02 00 00**												
Superstructure	21-02 10	03-Concrete, 04-Masonry, 05-Metal, 06-Wood, Plastics & Composites, 07-Thermal & Moisture Protection	23-13 00 00: Structural and Exterior Enclosure Products, 23-17 00 00: Openings, Passages	200	SE	300	SE	300	SE	300	SE	300	SE
Exterior Vertical Enclosures	21-02 20	04-Masonry, 08-Openings, 09-Finishes, 10-Specialties	23-13 00 00: Structural and Exterior	200	ARCH	300	ARCH	300	ARCH	400	ARCH	500	ARCH
Exterior Horizontal Enclosures	21-02 30	07-Thermal & Moisture Protection, 08-Openings	23-13 00 00: Structural and Exterior	200	ARCH	300	ARCH	300	ARCH	300	ARCH	300	ARCH
Interiors	**21-03 00 00**												
Interior Construction	21-03 10	08 - Openings, 09-Finishes, 10 - Specialties	23-15 00 00: Interior & Finish Products	200	ARCH	300	ARCH	300	ARCH	300	ARCH	500	ARCH
Interior Finishes	21-03 20	09 - Finishes	23-15 00 00: Interior and Finish			200	ARCH	300	ARCH	400	ARCH	500	ARCH
Services	**21-04 00 00**												
Conveying	21-04 10	14 - Conveying, 41 - Material Processing & Handling, 34 - Transportation	23-23 00 00: Conveying Systems and Material Handling	100	ARCH	200	ARCH	300	ARCH	300	ARCH	300	ARCH
Plumbing	21-04 20	22 - Plumbing	23-31 00 00: Plumbing Specific	100	PLUM	200	PLUM	400	PLUM	400	PLUM	500	PLUM
HVAC	21-04 30	23 - HVAC	23-33 00 00: HVAC Specific Products	100	MECH	200	MECH	400	MECH	400	MECH	500	MECH
Fire Protection	21-04 40	21 - Fire Supression	23-29 00 00: Facility and Occupant	100	FIRE	200	FIRE	400	FIRE	400	FIRE	500	FIRE
Electrical	21-04 50	26 - Electrical	23-35 00 00: Electrical and Lighting	100	ELEC	200	ELEC	400	ELEC	400	ELEC	500	ELEC
Communication	21-04 60	27 - Communications	23-37 00 00: Information and			200	LV	400	LV	400	LV	500	LV
Electronic Safety and Security	21-04 70	28 - Electronic Safety & Security	23-29 00 00: Facility and Occupant			200	SEC	400	SEC	400	SEC	500	SEC
Integrated Automation	21-04 80	25 - Integrated Automation				200	CONT	400	CONT	400	CONT	500	CONT
Equipment and Furnishings	**21-05 00 00**												
Equipment	21-05 10 00	11 - Equipment	23-21 00 00: Furnishings, Fixtures and Equipment Products			200	ARCH	300	ARCH	300	ARCH	300	ARCH
Furnishings	21-05 20	12 - Furnishings				200	ARCH	300	ARCH	300	ARCH	300	ARCH
Special Construction & Demo	**21-06 00 00**												
Special Construction	21-06 10	13 - Special Construction	N/A			200	ARCH	300	ARCH	300	ARCH	300	ARCH
Facility Remediation	21-06 20 00	02 - Existing Conditions	N/A										
Demolition	21-06 30 00	02 - Existing Conditions	N/A	200	ARCH	300	ARCH	300	ARCH	300	ARCH	300	ARCH
Sitework	**21-07 00 00**												
Site Preparations	21-07 10 00	02-Existing Conditions, 31-Earthwork	23-11 00 00: Site Products										
Site Improvements	21-07 20	32 - Exterior Improvements		100	CE	200	CE	300	CE	300	CE	300	CE
Liquid and Gas Site Utilities	21-07 30	33 - Utilities	23-39 00 00: Utility & Transportation			200	CE	300	CE	300	CE	300	CE
Electrical Site Improvements	21-07 40	26 - Electrical, 33 - Utilities	23-35 00 00 : Electrical and Lighting										
Site Communications	21-07 50	33 - Utilities				200	CE	300	CE	300	CE	300	CE
Miscellaneous Site Construction	21-07 90	31 - Earthwork	N/A			200	CE	300	CE	300	CE	300	CE

Notes:

1. The LOD and MCA values are rough assignments and are to be revised & confirmed by the Contractor per SFO contract requirements for a BIM Execution Plan.
2. The BIM use by phases are suggested values and are to be updated by Contractor per SFO contract requirements for a BIM Execution Plan.
3. The classification codes for OmniClass Table 22 (MasterFormat) are to be updated by Contractor to reflect project requirements.

OmniClass Table 21- Elements is based on the 2010 CSC/CSI UniFormat™

OmniClass Table 22 - Work Results is based in part on CSC/CSI MasterFormat™, 2011 Update

OmniClass Table 23 - Products, classifies products (materials, assemblies, and systems) intended for potential or actual use in any construction project. A single product will have a single location in this Table, whereas Table 22 - Work Results (or MasterFormat) may have more than one heading that references the same product in a number of locations, depending on its use within the facility.

Instructions:

1. Save As this document and review the fields. Note that this document currently shows the minimum requirements from SFO. Any changes must be called out and explained
2. Remove Lines of scope that are not applicable to your project
3. Expand the rows using the "+" signs on the left side of the chart. This will reveal the 3rd level of omniclass assets.
4. Enter the LOD for each phase as it applies to your project.
5. Highlight any LOD numbers that differ from the level 2 specification of that category.
6. Submit this specification as part of the review of your BIM Execution Plan.
7. Do not modify the graphic layout of this document. If necessary, you may make an additional MPS if required by your project team.

Level of Development (LOD) Definitions	
100	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 (i.e., cost per square foot, tonnage of HVAC, etc.) can be derived from other Model Elements.
200	The Model Element is graphically represented within the Model as a generic system, object, or assembly with approximate quantities, size, shape, location, and orientation. Non-graphic information may also be attached to the Model Element.
300	The Model Element is graphically represented within the Model as a specific system, object or assembly in terms of quantity, size, shape, location, and orientation. Non-graphic information may also be attached to the Model Element.
400	The Model Element is graphically represented within the Model as a specific system, object or assembly in terms of size, shape, location, quantity, and orientation with detailing, fabrication, assembly, and installation information. Non-graphic information may also be attached to the Model Element.
500	The Model Element is a field verified representation in terms of size, shape, location, quantity, and orientation. Non-graphic information may also be attached to the Model Elements.

Model Content Author (MCA) Definitions	
ARCH	Architect
CE	Civil Engineer
ELEC	Electrical Engineer / Subcontractor
FIRE	Fire Protection Engineer / Subcontractor
LV	Low Voltage Engineer / Subcontractor
MECH	Mechanical Engineer / Subcontractor
PLUM	Plumbing Engineer / Subcontractor
SE	Structural Engineer / Subcontractor
SUB	Subcontractor

Note: In cells with two model content authors, the stakeholder highlighted in **bold** and underline is the primary model content author followed by the model content (data) supplier. *example:* **ARCH**/SUB; Architect is the primary model content author and Subcontractor is the model data supplier

Refer 'Data View Definition' (Example) for minimum attributes required by phase and author

Appendix C – Element Attribute Dictionary

C.1 Element Naming Conventions

The Element Attribute Dictionary (EAD) – Element Naming Conventions provides a recommended schema and guidelines for creating standardized model element names. Standardization allows easy identification, filter and search capabilities in BIM and in schedules based on known descriptors. Conforming to a naming pattern in BIM also allows for better communication & coordination across project teams based on the readable model element names. The examples in the document are provided for implementation in Revit and can be used for any CAD or BIM authoring software. The Airport will partner with the project teams through a series of engagements to develop the element naming conventions.

LOADABLE FAMILY NAMES

Loadable families in Revit are elements that can be *"purchased, delivered and installed in and around a building"*[1], such as:

- Building components, e.g. doors, windows, casework, fixtures, furnishings & equipment etc.
- System components or equipment, e.g. boilers, water heaters, air handlers and plumbing fixtures etc.
- Customizable annotation elements, e.g. symbols and title blocks

Family Name:	[Functional Type]	_	[Subtype]	_	[Descriptor 1]	_	[Descriptor 2]
Required / Optional:	*Required, Use Asset Class from DVD*		*Required*		*As-needed*		*As-needed*

Implementation guidelines:

- Each family must have a unique name.
- The family name should describe how the element (product) is identified in the real world.
- Limit the use of acronyms to known industry terminology (e.g. AHU, VAV) or as approved by SFO.
- Keep the names short.
- The system category must not be included in the family name (unless the functional type is the same as the category, e.g. Door, Window)

[1] https://knowledge.autodesk.com/support/revit-products/learn-explore/caas/CloudHelp/cloudhelp/2016/ENU/Revit-Model/files/GUID-A6600994-DFBE-4079-87F9-D6AC8681A915-htm.html

- Use ‘CamelCase’ (i.e. capitalize first letter of word without spacing) for family names
- When adding optional descriptors to family names, the order in which the descriptors are listed must ensure that the families appear in BIM and schedules in the most logical and intuitive order.
- Use an underscore (_) to separate fields in the family name.
- Performance range can be designated with a hyphen (-) separated range enclosed in parentheses, for example, (230-250Ton).
- Avoid using attributes that are part of the EAD Common Attributes Set, such as Model Number, Classification Codes etc., in the family or type name. OK to use Manufacturer as a Descriptor.
- Hierarchical order of descriptors may be determined by its importance or level of detail in describing the element using OmniClass Table23 Levels.
- To the extent possible within Identity Data, the family shall include the CSI Master Format numbering system in the keynote field and UNIFORMAT Assembly Code.

Examples:

Category	Family Name
Air Terminals	Grill_Return_LayIn_Eggcrate
Mechanical Equipment	Chiller_Absorption_Classic_(112-465)Tons
Mechanical Equipment	AHU_SplitSystem_Horizontal
Door	Door_Interior_Single_HollowMetal

Type Names

A type is a specific representation in a family defined by distinct parametric, graphical and documentation characteristics which makes it unique from other types in the family. The type name generally mirrors actual real-world usage, such as size, dimensions and/or capacity.

Implementation guidelines:

- Category or family name should not be repeated in the type name.
- Type names should indicate the key differences between types (size, count, material) and when applicable, reflect standard sizes.
- If the type is named by size, use the dimensions followed by the dimensions indicator, e.g. inch, feet, mm, or use industry standard conventions, e.g. W12x200.
- If the type is named by capacity, use the industry standard acronym for the unit indicator, e.g. CFM, Hz, A, V.

Examples:

Category	Family Name	Type Name
Air Terminals	Grill_Return_LayIn_Eggcrate	12inch x 12inch
Mechanical Equipment	Chiller_Absorption_Classic_(112-465)Tons	200Tons
Mechanical Equipment	AHU_SplitSystem_Horizontal	30000Btu
Door	Door_Interior_Single_HollowMetal	36inch x 84inch

Refer to the Revit Standard for further details about System Family Naming

Appendix C: Element Attribute Dictionary

C.2 Attributes Set [1, 2]

(Contact SFO BIM Integration Team for latest version)

TABLES[3]	ATTRIBUTE READABLE NAME	DESCRIPTION	EXAMPLE
COMMON ATTRIBUTES[4]			
PROJECT INFORMATION	SFO_BuildingName	Name of building or terminal	International Terminal (IT)
	SFO_BuildingNumber	Building number (as applicable)	N/A
	SFO_BuildingCode	Building code for terminal or building (as applicable)	IT
	SFO_BoardingArea	Boarding area letter (as applicable)	N/A
	SFO_ContractorName	Contractor installing the equipment	Brady Air Conditioner
	SFO_ContractName	Name of contract	SFIA SAO
	SFO_ContractNumber	Number of contract	10009
	SFO_ProjectManager	Name of SFO Project Manager	John Doe
IDENTITY_type	SFO_Family&TypeName[6]	Name of facility asset per SFO-EAD	AC_Split_FanCoil_9000btu
	SFO_TypeDescription	Description of type, can use Omniclass Table 23 Name if applicable	Air Conditioning Unit, Split System
	SFO_OmniClassT23Number	OmniClass Table 23 Number	23-33 39 21
	SFO_CSIMasterFormat	CSI MasterFormat Number	21 11 16
	SFO_AssemblyCode	Uniformat Number or Assembly Code	D3050
	SFO_AssetClass	To be provided by SFO	AIRC
IDENTITY_instance	SFO_ParentChild	Number of equipment in hierarchy (as applicable)	Fan Coil Unit-ITFC510, Condenser-ITCU510
	SFO_CreatedBy	Model author	Dimitry Y.
	SFO_CreatedOn	Model authoring date	5/17/2016
	SFO_BIMUniqueID	Revit generated GUID	7D4C2370-9205-4327-9D8B-376D635E5ECA
	SFO_Tag	Drawing Tag	ITFC510
	SFO_AssetID	To be provided by SFO	AIRC510
LOCATION_instance	SFO_LevelNumber	Include in Room Number	5
	SFO_RoomNumber	Follow Space Naming and Numbering Guideline	IT.5.SSR
	SFO_RoomName	If applicable	N/A
	SFO_AreaServed	Equivalent to Revit Space: Zone property	N/A
ASSET_type	SFO_Manufacturer	Name of Manufacturer per approved Submittal	Daikin
	SFO_ModelNumber	Model Number from Manufacturer and per approved Submittal	FTXSO9LVJU
	SFO_Capacity	Capacity of equipment (as applicable)	9000 BTU
	SFO_AssetWeight	Weight of the equipment	20 pounds
	SFO_ExpectedLife	Usable life as specified in equipment cutsheet	N/A
	SFO_O&MManual	O&M Manual for equipment	www.daikin.com
	SFO_PartsList	Parts List for equipment	www.daikin.com
	SFO_AssetType	Equipment, Facility, Vehicles, Infrastructure, Sewer, Electric Structure	Equipment
	SFO_ReplacementCost	Unit Cost of equipment	$2,000

TABLES[3]	ATTRIBUTE READABLE NAME	DESCRIPTION	EXAMPLE
ASSET_instance	SFO_SerialNumber	Serial Number as specified by Manufacturer	E003350
	SFO_ModelYear	Year of equipment model	2015
	SFO_AssetHeight	Height of the equipment at which it is installed	8'6"
	SFO_Barcode	As applicable	N/A
	SFO_RFID	As applicable	N/A
	SFO_SubmittalItem	Link to Submittal PDF or similar	www.abc.com
	SFO_CommisioningReport	Link to Commissioning Report or similar	N/A
WARRANTY_type	SFO_WarrantySpecSection	Link to warranty specification or similar	
	SFO_WarrantyGuarantorParts	Name of warranty for parts	Daikin
	SFO_WarrantyDurationParts	Duration of warranty for parts	10 years
	SFO_WarrantyGuarantorLabor	Name of warranty for labor	Brady Air Conditioner
	SFO_WarrantyDurationLabor	Duration of warranty for labor	2 years
	SFO_WarrantyDescription	Description of warranty	labor and parts
WARRANTY_instance	SFO_InstallDate	Date of installation of equipment	4/20/2016
	SFO_WarrantyStartDate	Date of warranty start	5/1/2016
	SFO_WarrantyEndDate	Date of warranty end	5/1/2018
SPECIFICATIONS_type	SFO_SustainabilityPerformanceSpec	URL to PDF, specify location of document as applicable	
	SFO_AccessibilityPerformanceSpec	URL to PDF, specify location of document as applicable	
	SFO_CodePerformanceSpec	URL to PDF, specify location of document as applicable	
FACILITY ASSET ATTRIBUTES [5]			
MOTOR_type	SFO_NumberofMotors	Number of motors	1
	SFO_MotorManufacturer	Manufacturer of motor	Daikin
	SFO_MotorModelNo	Model number of motor	RXS09LVJU
	SFO_MotorSerialNo	Serial Number of motor	E004287
	SFO_ShaftSize	Motor shaft size	N/A
	SFO_Frame	Frame size of motor	N/A
	SFO_FramePartNumber	Part Number of frame	N/A
	SFO_Starter	Starter	N/A
	SFO_FuelType	Type of fuel for motor	N/A
	SFO_PulleySize	Size of pulley of motor	N/A
	SFO_FanRPM	RPM for fan of motor	N/A
MECH-PARTS_type	SFO_DriveType	Drive types for motor: Belt, Chain, Flex-coupling, Direct	Direct
	SFO_DriveBeltSize	Belt size of motor	N/A
	SFO_DriveBeltQuantity	Quantity	N/A
	SFO_DriveBeltPartNumber	Part Number	N/A
	SFO_FilterSize	Type of filter (can be more than one type)	Washable
	SFO_FilterQuantity	Quantity	2
	SFO_FilterPartNumber	Part Number (separate line item, if different)	N/A
	SFO_Lubricant	Lubricant type	N/A
	SFO_Refrigerant	Refrigerant type	R410A

TABLES[3]	ATTRIBUTE READABLE NAME	DESCRIPTION	EXAMPLE
ELECTRICAL_type	SFO_Size	Wire guage size	
	SFO_Control	Control system: Pressure, Float, Limit switch, Photocell, Thermostat, PLV/VFD	Thermostat
	SFO_Power	Power (HP)	
	SFO_Voltage	Voltage	208V
	SFO_Amps	Amperage	4.33A
	SFO_Phase	Phase of electrical power	1
ELEC-PANEL_instance	SFO_PanelFedBy	Panel supplying electricity	PNL17ZP12
	SFO_Circuit	Circuit	
	SFO_PanelLocation	Location of panel	CBT Room

Notes:

1. Project teams must develop strategy and technical implementation for model data collection and verification. This strategy must be identified in the project team's BIM Execution Plan.

2. Appendix C.2, EAD-Attribute Set identifies the information that the Airport cares for. This list will be updated. Project teams must contact the SFO-BIT for the latest version of this appendix prior to execution.

3. The Tables column identifies the recommended implementation as Revit schedules. The attributes are categorized as "type" and "instance" properties in Revit. Refer to Key Definitions of the BIM Guide for definitions for Revit type and instance properties.

4. Common Attributes include information that several SFO stakeholders are interested in. Project teams must deliver this information digitally for all building components, and as applicable, include the data in BIM for facility assets identified in specification document 01 78 23.23: Equipment Inventory Spreadsheet.

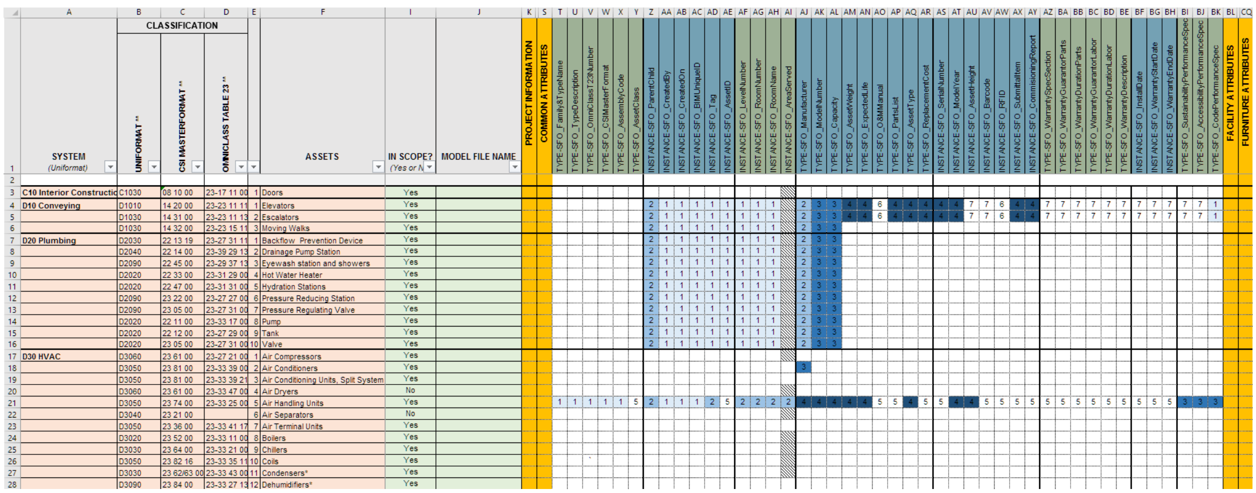
5. Facility Asset Attributes include additional information required by SFO Facility Scheduling and Maintenance. Project teams must include the data in BIM for facility assets per specification document 01 78 23.23: Equipment Inventory Spreadsheet.

6. Refer to Element Attribute Dictionary - Naming Conventions for Family and Type Name

Appendix C: Element Attribute Dictionary

C.3 Data Views (for data collection)

The Airport will partner with the project teams to develop the Data View Definitions matrix (see Figure C.3.1). The matrix defines the scope, who authors data, when it is available (i.e. the DVD milestone), and in which model the data will be finally added. The DVD milestones can correspond with project milestones, coordination schedules or submittal schedules; as determined by the project team and agreed upon by the Airport (see Figure C.3.2).



	SYSTEM (Uniformat)	UNIFORMAT	CSI MASTERFORMAT	OMNICLASS TABLE 23		ASSETS	IN SCOPE? (Yes or N	MODEL FILE NAME
2								
3	C10 Interior Constructio	C1030	08 10 00	23-17 11 00	1	Doors	Yes	
4	D10 Conveying	D1010	14 20 00	23-23 11 11	1	Elevators	Yes	
5		D1030	14 31 00	23-23 11 13	2	Escalators	Yes	
6		D1030	14 32 00	23-23 15 11	3	Moving Walks	Yes	
7	D20 Plumbing	D2030	22 13 19	23-27 31 11	1	Backflow Prevention Device	Yes	
8		D2040	22 14 00	23-39 29 13	2	Drainage Pump Station	Yes	
9		D2090	22 45 00	23-29 37 13	3	Eyewash station and showers	Yes	
10		D2020	22 33 00	23-31 29 00	4	Hot Water Heater	Yes	
11		D2020	22 47 00	23-31 31 00	5	Hydration Stations	Yes	
12		D2090	23 22 00	23-27 27 00	6	Pressure Reducing Station	Yes	
13		D2090	23 05 00	23-27 31 00	7	Pressure Regulating Valve	Yes	
14		D2020	22 11 00	23-33 17 00	8	Pump	Yes	
15		D2020	22 12 00	23-27 29 00	9	Tank	Yes	
16		D2020	23 05 00	23-27 31 00	10	Valve	Yes	
17	D30 HVAC	D3060	23 61 00	23-27 21 00	1	Air Compressors	Yes	
18		D3050	23 81 00	23-33 39 00	2	Air Conditioners	Yes	
19		D3050	23 81 00	23-33 39 21	3	Air Conditioning Units, Split System	Yes	
20		D3060	23 61 00	23-33 47 00	4	Air Dryers	No	
21		D3050	23 74 00	23-33 25 00	5	Air Handling Units	Yes	
22		D3040	23 21 00		6	Air Separators	No	
23		D3050	23 36 00	23-33 41 17	7	Air Terminal Units	Yes	
24		D3020	23 52 00	23-33 11 00	8	Boilers	Yes	
25		D3030	23 64 00	23-33 21 00	9	Chillers	Yes	
26		D3050	23 82 16	23-33 35 11	10	Coils	Yes	
27		D3030	23 62/63 00	23-33 43 00	11	Condensers*	Yes	
28		D3090	23 84 00	23-33 27 13	12	Dehumidifiers*	Yes	

Figure C.3.1. Sample of DVD Matrix

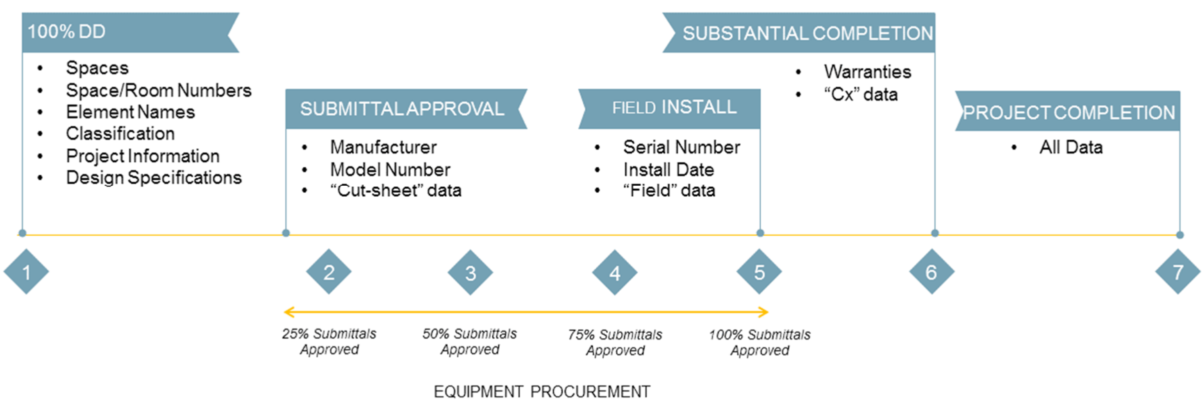


Figure C.3.2. Examples for DVD Milestones

Appendix D – Coordinate System Setup

Background

San Francisco International Airport employs a local coordinate system, SFO-B. The SFO-B coordinate system, both horizontally and vertically, is defined by Record of Survey #2925 (Vol. 43 of LLS Maps, Pages 44-45, San Mateo County Records). SFO-B establishes the horizontal axis (x-axis) as the centerline of Runway 10L-28R. Axes (x and y) are parallel and perpendicular to the centerlines of this runway. Vertical (z coordinates) coordinates shall be based on the North American Vertical Datum of 1988 (NAVD88). The origin of SFO-B is located 180 feet left of the threshold of Runway 10L on center.

Setup

Models and drawings submitted to the Airport shall reference the SFO-B coordinate system (x, y, and z coordinates). The following files are available to coordinate the origin of the project files with the SFO-B coordinate system:

1. SFO Base Map (.dwg file)
2. Adjacent Control Points (.dwg file)
3. SFO-B Origin Marker (.rfa and .dwg files)

The SFO Base Map includes the SFO-B Origin Marker and functions as the overall site plan of SFO's buildings. The original design axes of the terminal buildings in the map serve as references for existing gridlines.

The Adjacent Control Points file from the SFO Chief Surveyor includes the latest horizontal and vertical location of control points closest to the project. It is important to request the latest file at the start of each project, because the SFO Chief Surveyor regularly updates the locations of the control points.

The SFO-B Origin Marker is a 3D symbol to locate the SFO-B coordinate system origin (x, y, and z coordinates) and identify the SFO-B North orientation uniformly in all project models.

Any vertical reference other than NAVD88 (e.g. NGVD29) shall be specified to the SFO Chief Surveyor when requesting the latest version of the Adjacent Control Points file, if required for regulatory purposes.

The following steps outline the prerequisites of the proper project coordinate system setup:

1. Request the latest version of the SFO Base Map and the SFO-B Origin Marker from the SFO BIM Integration Team.
2. Request the latest version of the Adjacent Control Points file from the SFO Chief Surveyor (through SFO PM) for the project's work area.
3. Coordinate the survey of the project's work area based on the Adjacent Control Points file. Coordination should include:
    a. Existing building footprints
    b. Tie-in points
    c. Vertical elevations of exiting adjacent floors
    d. Existing adjacent or tie-in grid lines
4. Review the survey results with the SFO Chief Surveyor.
5. Update the project BIM authoring tool's coordinate system based on the survey. Figures 01 and 02 illustrate this step.

Documentation

All design discipline and trade partner models shall include the correctly positioned SFO-B Origin Marker. The project-specific process of coordinate system alignment between design disciplines and trade partners must be documented in the project's BIM Execution Plan. The process of coordinating with other active, adjacent SFO projects must be documented in the project's BIM Execution Plan as well, if applicable. The documentation must include the date of when the SFO Base Map and the Adjacent Control Points files were received.

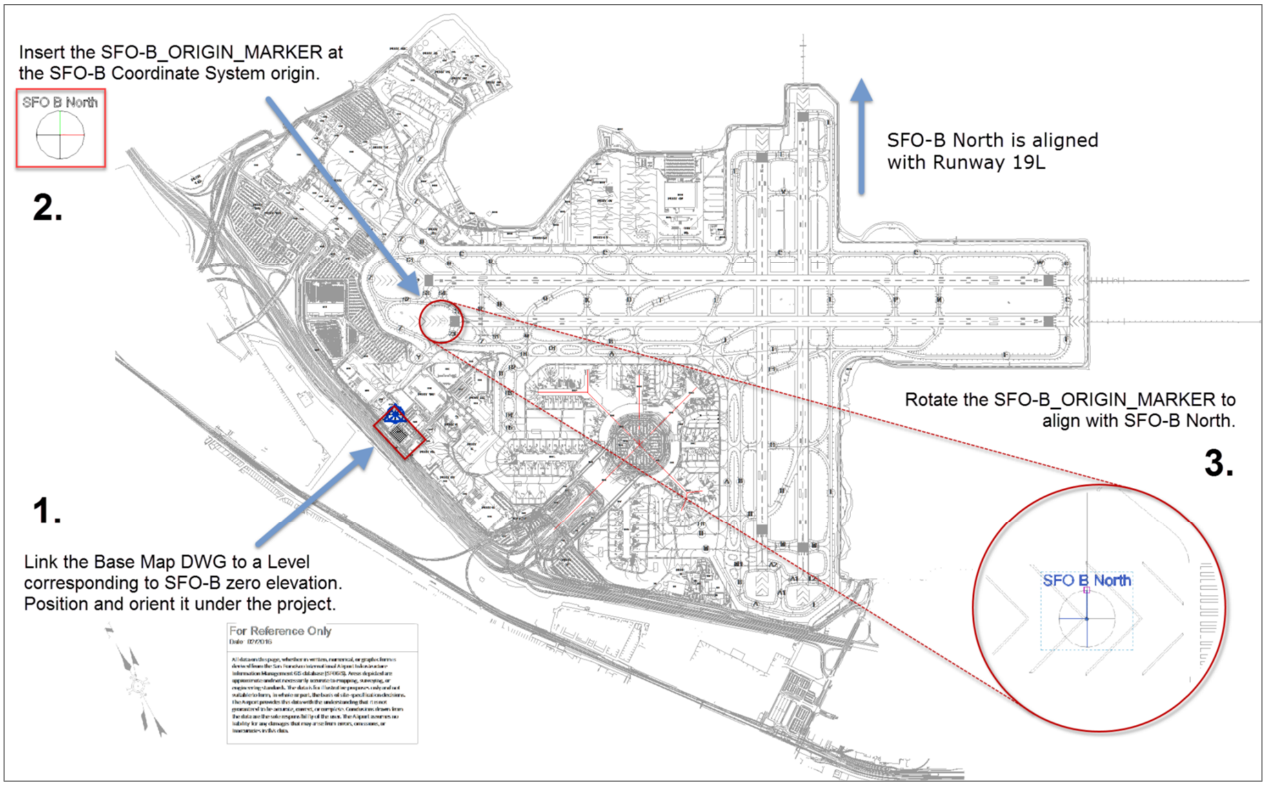


Figure 01. Link the Base Map and insert the SFO-B Origin Marker

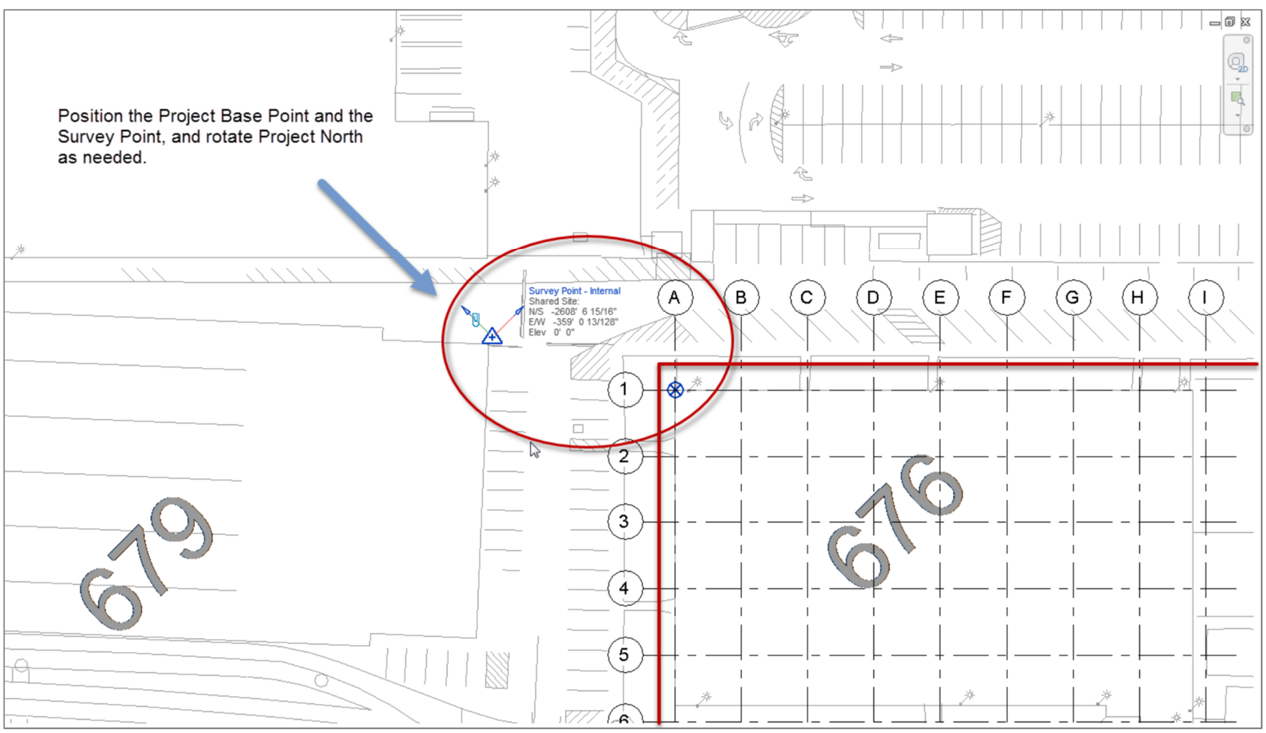


Figure 02. Update the coordinate system as needed

Change Management Log

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Version 1.0

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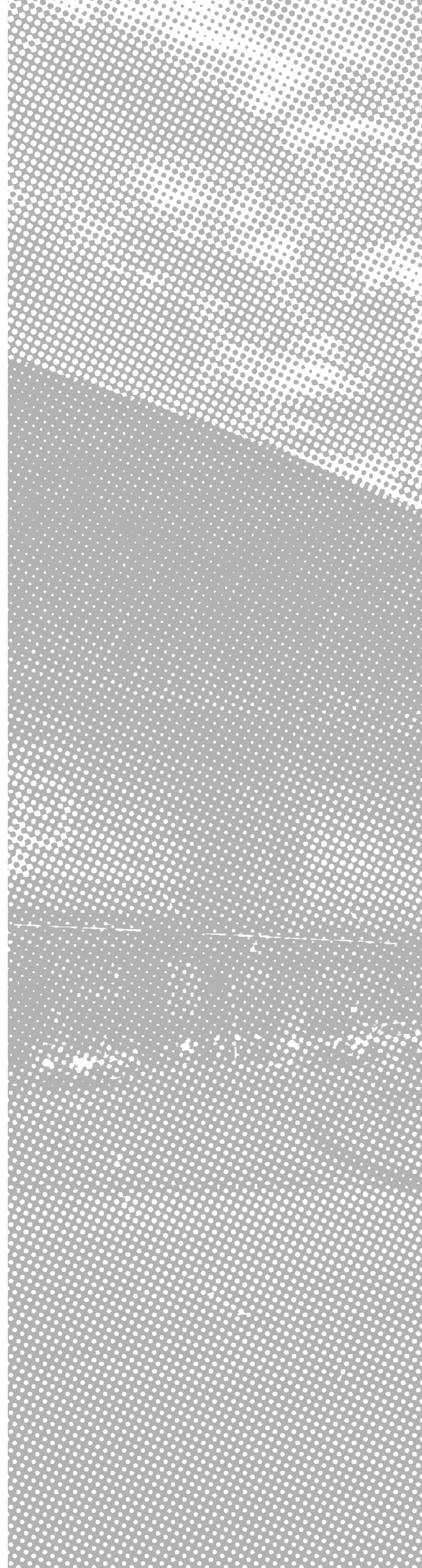

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