BIM: Leveraging Integration

Modeling a Confederated BIM at LAX's New Tom Bradley International Terminal

By William M. Klorman

Confederated View of Basement.

Building Information Models (BIM) and Virtual Design and Construction (VD&C) are being used at Los Angeles International Airport (LAX) to enhance design coordination, leverage interoperability, improve the quality of workmanship, reduce costs while improving predictability, and advance the construction industry. This project demonstrates new approaches and applications, strategies for improvement, cost savings, and innovation.

The Project

LAX's new Tom Bradley International Terminal (TBIT) is expanding by more than one million square feet, making it one of the most ambitious airport projects in the country. The project cost is $1.5 billion. The terminal, a composite structural concrete and structural steel design, is a 7-story building that totals more than 665,000 square feet and a baggage level footprint of roughly 158,000 square feet. It has architectural concrete towers approximately 90 feet tall with 14 new gates to accommodate the next generation of super-sized jumbo jets, including the Airbus A380 and the Boeing 787 Dreamliner. Los Angeles World Airports is the Owner. Fentress Architects is the Architect of Record and John A. Martin & Associates is the Structural Engineer of Record. Walsh Austin Joint Venture is the Construction Manager and Klorman Construction is, among other things, the Prime Structural Concrete Contractor and one of the project BIM leaders.

The project specifications require the mandatory use of BIM. In particular, the LAX project requires the creation of individual subcontractor models and a confederated model, which is defined as "*the combined model file created from the integration of current Subcontractor specific model files.*"

This results in some real-world problems with respect to ownership of the models, design liability, transfer of risk, and historic reliance on 2D drawings. A legal analysis of these problems is outside the scope of this article and no legal conclusions will be offered herein.

Officially, only 2D documents (plans and specifications) are being provided to the subcontractors for use in developing their trade-specific BIMs, which will be incorporated into the confederated construction model and relied on by all contractors. Unofficially, an architectural model (produced in Revit Architecture), a structural model (produced in Revit Structure), and a confederated Navisworks file (weekly) are being provided.

Individual subcontractors' building information models are being produced in several platforms including Tekla Structures, Revit Structure, AutoCAD MEP, CADmep, and CADduct. The individual BIMs are then exported for coordination in Navisworks, 3D.DWG and Industry Foundation Class (IFC) formats. Initial confederated clash detection, coordination, and visual geospatial reviews are done by combining all construction models in Navisworks. Klorman Construction then takes this to the next level of integration by creating the confederated model in a native platform.

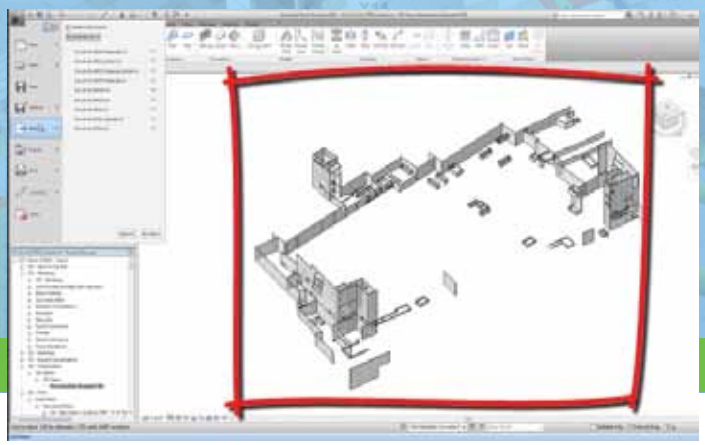
Site Logistic View of new TBIT and existing TBIT.

How It's Done

Klorman's BIMs are started from scratch using the 2D documents. RFIs are developed during creation and reviews of the anatomically correct model, and are tracked in the BIM to enhance quality control and change management. One major advantage of making the BIM the central clearing house is that it allows both the field operations team and the VDC team to ensure that all work is being performed in accordance with the latest and most up-to-date information available. The BIM is available for review by all team members 24 hours a day, 7 days a week either on the job site, in the corporate VDC office, or through a Web-based solution. This allows the BIM to become a living, evolving project record and prototype.

The following is to help illustrate how important and convenient this way of tracking and maintaining the project record is: On site, a crew prepares to lay out a new area of the project. The entire layout is done with the use of robotic total stations (RTS). In order for the layout engineer to begin, he/she must first obtain the control point file generated from the project BIM. Prior to beginning his/her double-check and closeouts, the layout engineer would ask, "*Is the layout file current through RFI-X?*" The BIM can be quickly checked to confirm that it is, and the actual RFI-X can be viewed by clicking on the user-defined attribute under the RFI Manager.

RFI Color Coding in BIM.



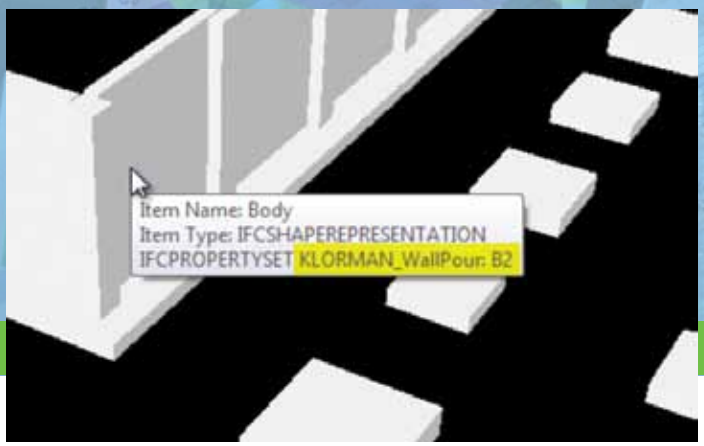
Owner's Model being exported via IFC 2x3.

This information and confirmation exchange is completed in a matter of seconds and allows all project stakeholders to save time, reduce duplication of work, reduce costs, increase communication, and ensure quality control.

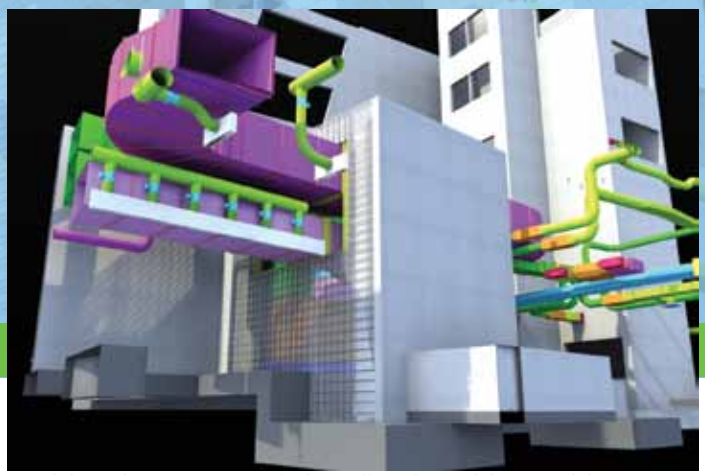
The Owner's models have been produced in Revit, but Klorman's selected platform for the majority of this project is Tekla Structures. In order to reap advantages from using the Owner's model for comparative analysis and reference, the Owner's model must be brought into the Klorman native BIM platform. To do this, we open the Owner's models in Revit and then, using filters, export the various model portions and components via the IFC 2x3 schema. We can now leverage the information contained in the Owner's model through interoperability.

One of the advantages of using IFC as opposed to 3D.DWG or other formats is the increased amount of information that can be captured and modified to transmit specific information to other users of the BIM, including fabricators, erectors , designers, inspection & testing, tolerances, fit-up and facilities management. The concept and practice of using the BIM to transfer intelligence beyond just geospatial representations, in a file type that can be used by various software platforms, is very important and paramount to the future of BIM/VDC. The following is one example of how very simple information captured in the IFC file can increase the understanding and use of the BIM. All contractors provide a Navisworks-compatible file for use during the BIM coordination meetings, which are held in a large room with a minimum of two projectors to view the confederated representation and constraint log. Klorman's concrete work is not only a major scope item, but a critical step in the sequence of construction to ensure on-time delivery of various elements. One such element is the basement retaining wall (28.67 feet) and the specific areas that will be cast. When viewing the Navisworks file and hovering the cursor over an element, information about that element will pop up. In order to ensure that all coordinating contractors can easily locate a specific wall – not only in the BIM but also in related scheduling, procurement and inspection operations – Klorman was able to have the identifying wall names and pour information "pop-up" when hovered over. This seemingly simple information allowed for detailed discussions regarding schedule, quantities, and interfaces with other trades, inspection demands, and quality requirements on the fly. Additionally, large amounts of technical information can be captured in the IFC file and, when provided to a specific user, transferred to a specific workflow.

4D sequencing is the animation of the BIM in sequence with the project schedule. This produces a visual workflow of the various elements and provides a fantastic visual presentation of the scheduled work progression expectations. This type of communication tool allows for all project participants to understand quickly and "see" the



IFC information for up & down stream.



Confederated BIM in native platform allows for modification of the structure in exact locations and avoids delays.

schedule regardless of their sophistication for reading and interpreting schedules in diagrammatic form. Here, a schedule for area castings was produced by Klorman as a deliverable and to help better analyze the interaction between the substructure and superstructure.

Advantages of a Native Platform

Although this Project's specifications required the confederated model to be viewed in Navisworks, a confederated model maintained in a native BIM platform is far more useful and superior. This is not to say that a viewer like Navisworks is not a good solution, but viewers are limited and in many circumstances are simple representations that do not allow for manipulation of the BIM itself to resolve issues. In most cases, users are restricted to taking a snap shot of the area and forwarding it to the affected project participants to await their responses.

Confederated BIM in a native platform is better for a number of reasons:

- Extract accurate quantities
- Quickly determine accurate locations and dimensions
- Create accurate details
- Produce construction documents based on actual, not representation
- Create and track RFIs
- Conduct constructability reviews that consider adjacent trades/work
- Address clash detection more expediently
- Spot detailing problems during BIM creation
- Better understand construction sequencing
- Study issues in the live BIM as opposed to viewing past or "as-of-date" conditions in Navisworks or other simulators

One example was a detailing issue identified where conduits were penetrating thorough a concrete wall at a construction joint. The problem was that the structural engineer had very specific detailing of the jamb and containment steel that would not allow for penetrations, especially of the magnitude indicated by both the electrical and plumbing designs. An even more critical issue was the discovery of HVAC ducts needing to penetrate a major shear wall that was not designed for large openings. Because of the native platform, Klorman was able to identify the problem before construction, modify the mild steel reinforcement and cast-in-place concrete wall forms, and provide all affected project team members with specific information while continuing with modeling and construction.

Visual coordination cannot be overlooked or undervalued. Based on an individual's experience and expertise, different things applicable to their project involvement that would not readily be apparent in viewing 2D documents become immediately obvious. Klorman has used BIM photorealistic representations on this project for various purposes, including confederated model coordination, site logistics, concrete detailing, and reinforcement detailing.

Conclusions

In this article, we have limited the discussion to a small number of uses of BIM on the LAX project site. Other uses that are being implemented include:

- Taking BIM to the Field with Robotic Total Stations for:
  - Layout
  - Quality Control
  - As-Builts
  - Tolerance Coordination & Resolutions (Fit-Up)
- Automated Fabrication Drawings for Formwork and Reinforcement
- Automated Erection Drawings for Formwork and Reinforcement
- Erection Simulations
- Location Based Management
- Lean Construction
- Sustainability Increases
- Facilities Management

By using a confederated BIM, many benefits have been realized. Clearly there have been reductions in the overall cost and time of the project, which are being shared by the Owner and the contractors. These savings have resulted while increasing quality control, communication and predictability. Visualization increases interaction, and the BIM process provides greater ability to take advantage of lean construction and enhance sustainability, resulting in positive returns on the BIM investment for all stakeholders.▪

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