AEC11415

Detail Friendly Design Models For Downstream

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Learning Objectives

- Modeling discipline and best practices
- Design and Construction team communication
- Modeling strategies for fabrication friendly models
- Cloud collaboration

Description

Design models are not typically used in the construction process. This is usually because the designers won't give up their model, and if they do they use a liability waiver releasing them from any inaccuracies. In this course, you will learn how leading structural engineering firm Thornton Tomasetti bridges the gaps between the design and construction trades helping design and construction timelines overlap by delivering an accurate, detailing and fabrication ready, model. At the end of the presentation, you will hear a discussion from the contractor's point of view: what steel detailers and fabricators expect from structural engineers to effectively collaborate and exchange model-based information.

Your AU Experts

Joshua Bradshaw *is the Design Technology Manager at Thornton Tomasetti, Inc. He comes from a background first as a steel detailer, having experience in using Tekla Structures to produce BIM models, shop drawings, DSTV files, and integration with FabTrol. Before coming to TT, Joshua was a Support Technician for Tekla, Inc. based in Atlanta, GA. His duties there, in addition to providing support, included training, creating tutorials, alpha testing, and preparing presentations for Tekla's annual user conference. At TT, he provides support, training, and customizations; he conducts a monthly internal user group for virtual construction topics and performs beta and new software testing, guiding the applications deployment of construction software firm-wide.*

Kenneth Murphy *is the Design Technology Director for Thornton Tomasetti Inc., a large multi-disciplinary Engineering firm based in New York, and is a 7 time AU speaker. Ken's subject matter expertise lies in the areas of BIM, project planning, complex modeling, Revit, AutoCAD, 3ds Max, Revit Server, and many other design related technologies. In his spare time Ken is an avid cyclist, photographer, woodworker and calligrapher.*

David Merrifield *has 50 years of experience in fabrication, engineering, erection and project management of major projects across the United States and in several foreign countries. He joined Alpha Fabrication Services in 1995 as President which has recently become SteelFab Texas, an AISC*

Certified Steel Fabricator. He is a Board member of the Nation Institute of Detailing and chairman of the Quality Procedures Committee. He is Vice President of the Texas Structural Steel Institute serving as chairman of the BIM and Technology committee, and a member of the AGC's BIM Forum, serving as co-chair of the LOD structure group. David is active in promoting BIM from the steel construction viewpoint at AGC, NISD, AISC, individual contractor, engineering and architectural firms.

Introduction

Who is Thornton Tomasetti?

Thornton Tomasetti is a global engineering firm with more than 1,200 engineers, architects, and professionals in 38 offices with projects in 54 countries.

Our Practices

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Construction Engineering

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Share and Deliver the model

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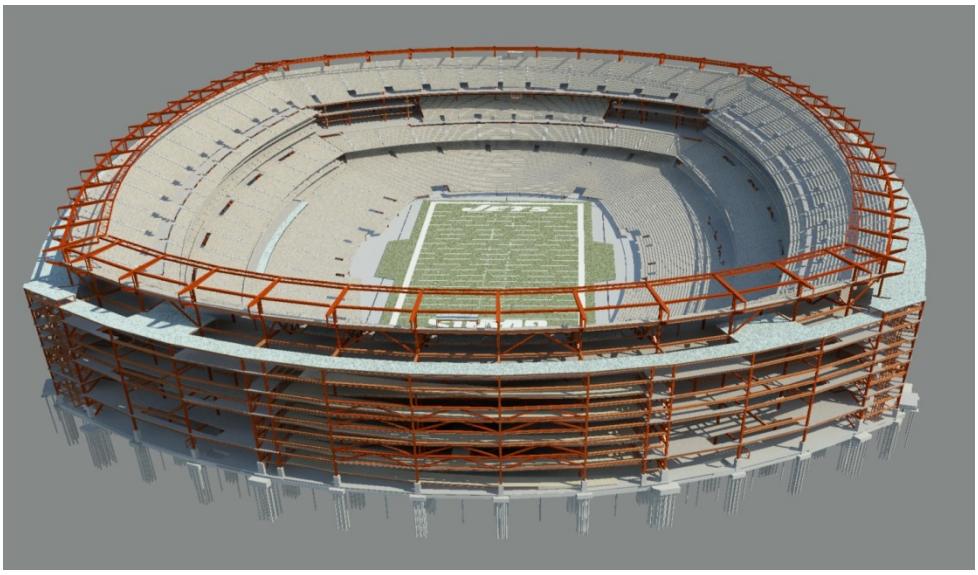
Advantages

Schedule Savings and Certainty



MEADOWLANDS STADIUM, EAST RUTHERFORD, NEW JERSEY

Meadowlands Stadium

The Advanced Delivery Approach allowed for open communication between the design and construction teams enabling the project steel to be procured, fabricated, and erected on time with minimal change order cost impact and no schedule impact. Project schedule savings of 4 months plus.

HUDSON YARDS, NEW YORK CITY, NEW YORK (IMAGE COURTESY RELATED)

Hudson Yards

Traditional delivery schedule with the fabricator designing the connections and starting the detailing was not even possible given the Owner's schedule – only option was to utilize TT CE Services to get procurement and fabrication underway earlier – a savings of a minimum of 6 months up front.

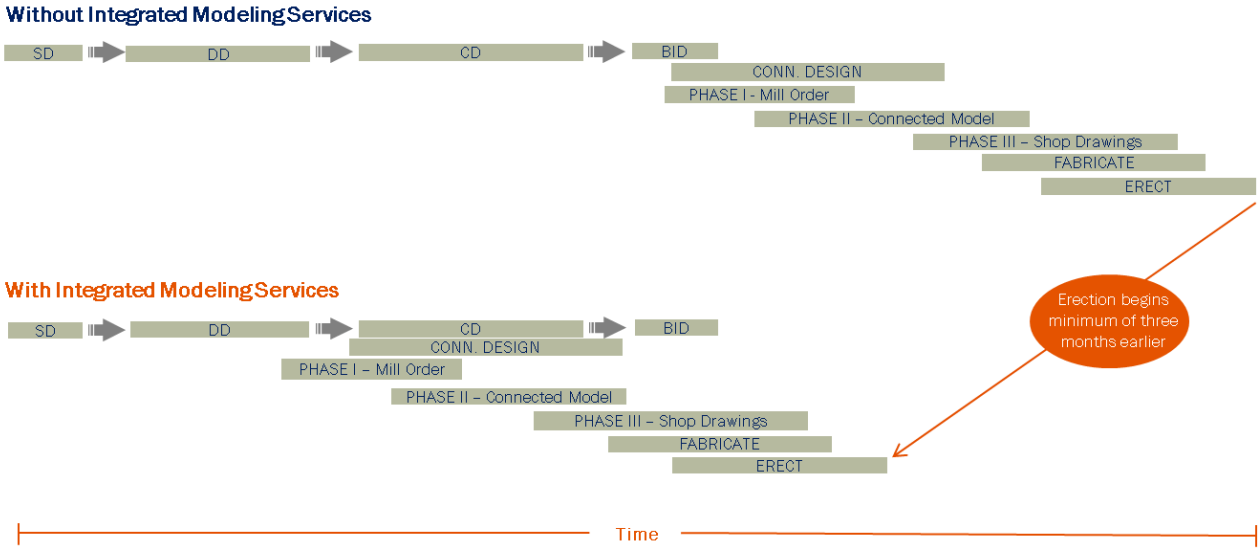


FIGURE 1: CONSTRUCTION TIMELINE INTEGRATED MODELING REDUCES POTENTIAL FOR DELAY

Cost Certainty

CATHEDRAL OF HOPE, DALLAS, TEXAS

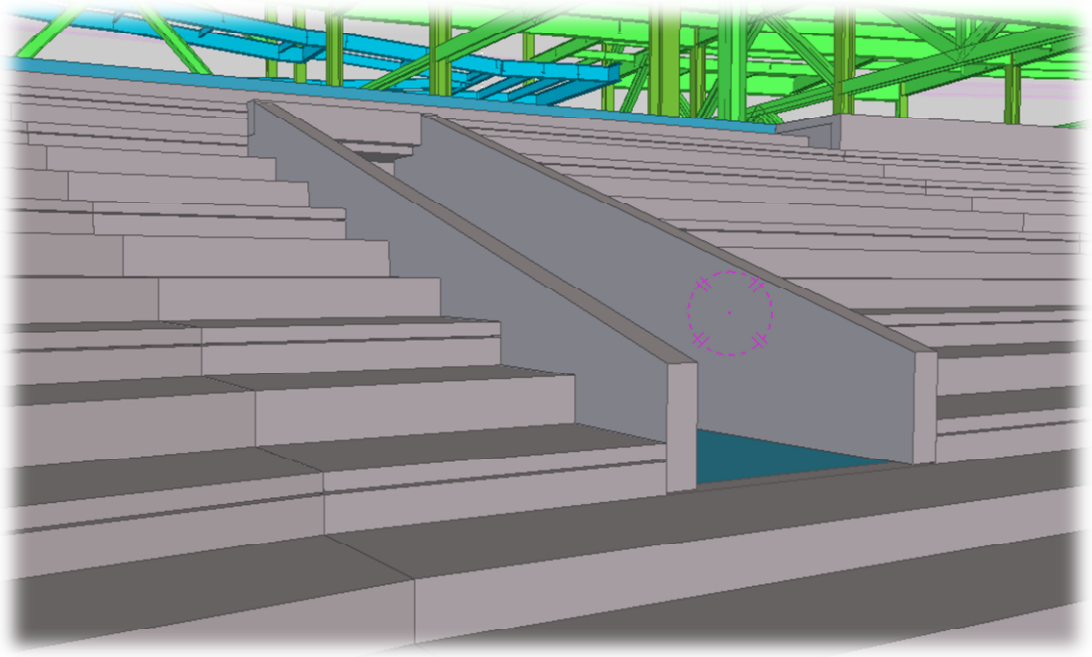
Cathedral of Hope

Initial steel bids came in on a design drawing set bid package only from 3 bidders with a bid spread of nearly 100% (the high bidder was twice that of the low bidder with the third in the middle of the two). The project was re-bid with the delivery of providing full connection design and a Phase II model delivery – the resulting bids came in within a 10% spread between high and low bidders.

Data Center

Delivery of a connected BIM model showing completely designed connections and modeling of connections to show complexity/construction considerations resulted in a spread of steel bids being within 1% of each other.

Increased Trade Coordination



NEW MEADOWLANDS STADIUM, EAST RUTHERFORD, NEW JERSEY: PRECAST MODELING

Meadowlands Stadium

Skanska also hired TT to parametric model the structural precast on the project. This eliminated all clashes between steel and precast interfaces between trades (only clash was a single seating unit which was actually cast incorrectly, which was fairly easily resolved in the field).

PORT CANAVERAL WELCOME CENTER, CAPE CANAVERAL, FLORIDA

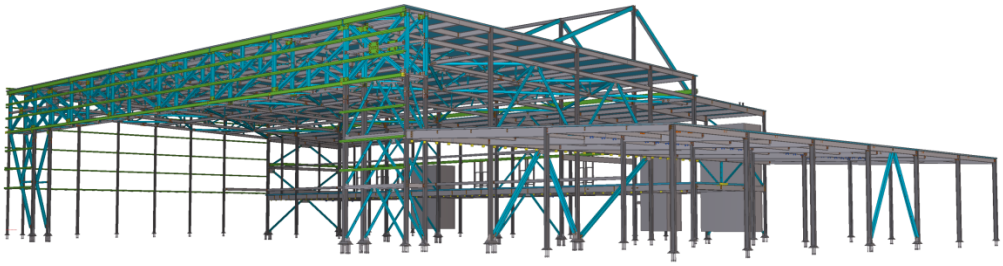
Port Canaveral Welcome Center

TT used MEP design models to assist with coordination of steel to pipes, ducts, and conduits. This allowed faster resolution of trade clashes and avoided potential field fit-up issues.

Reduction in RFI's

Port Canaveral Welcome Center

TT CE Services were utilized to not only design the structural steel connections, but also deliver a Tekla model as well as the shop drawings – resulting in less than 10 steel related RFI's on the project.



QUANTICO HANGAR, QUANTICO MARINE CORPS BASE

Quantico Hangar

Due to the collaborative nature of utilizing CE Services, there was only a single RFI on a 760 ton project. Without CE services, the anticipated count of RFI's would have been expected to much greater. By having weekly coordination meetings throughout the development of the design and model, formal RFI's are reduced 60-70% resulting in OAC processing time and also schedule benefits.

Reducing or Validation Change Orders

By preparing and utilizing a BIM model throughout the design and construction process, quantities and complexity are identified as the design progresses. Once a model is issued, changes can be tracked and compared as well as quantities verified. Since all information is shared, utilizing a collaborative design/construction approach, potential change orders are identified earlier in the process and discussions on the necessity of the change is discussed and evaluated prior to implementing, thus leading to reduced change orders. Since no two projects run completely independent approaches, this is difficult to measure, however in projects where the proper approach is implemented, change orders have been estimated by CM's to be reduced by 25%.

Case in point: Steel contractor submitted a change order stating an increase in tonnage of over 1000 tons – evaluating the Tekla model between bid time and when this claim was made showed that tonnage actually only increased by a little over 100 tons.

Means & Methods

Model Discipline

Model discipline is one of the most important aspects of creating a highly accurate and consistent deliverable. Without good established methods, with consideration of the construction trades, your efforts could be entirely unusable by contractors.

Geometry

The single most important item of a 3D model is to have accurate geometry. In cases where the design model will be used downstream for detailing and fabrication, extreme care must be exercised in order to maintain integrity of the deliverable. All endpoints must be exactly on grid intersections, lines, or at the centerline of their supporting framing.

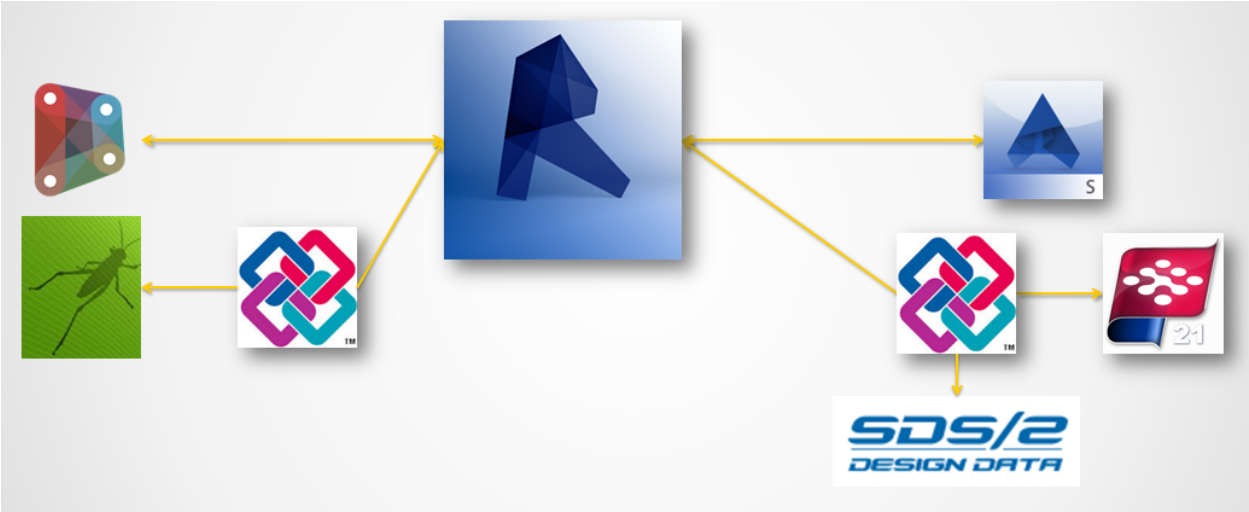


FIGURE 1: OUT-OF-THE-BOX SOFTWARE TRANSLATION

Since most design documentation software are not efficient in creating construction models, some type of translation is usually necessary. All BIM programs should have a built-in coordination language, such as IFC. However, some vendors offer direct translators between their platforms, such as the bi-direction link from Revit to Advance Steel. (See Figure 1).

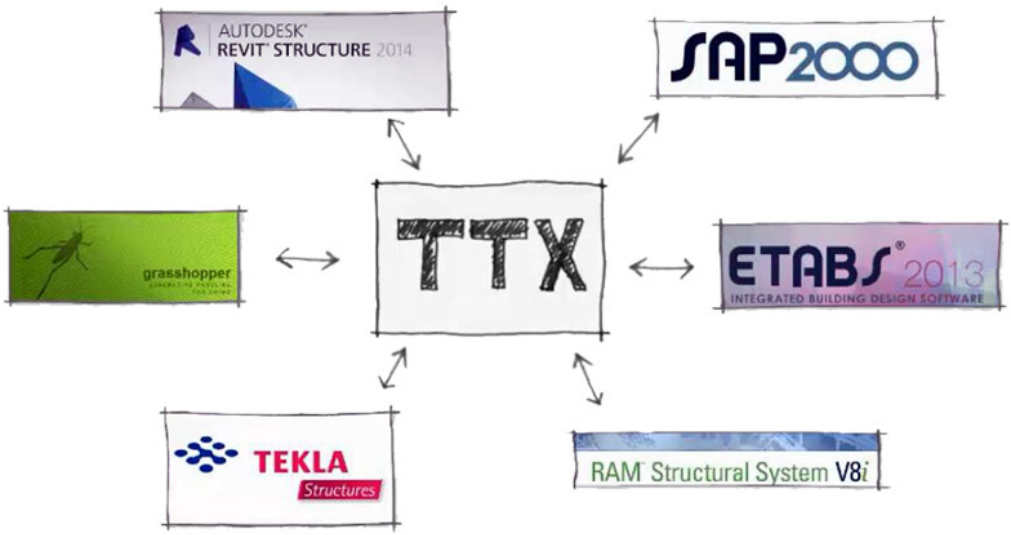


FIGURE 2: CUSTOM TRANSLATION TOOLS

Several companies, like TT, have developed their own translation tools utilizing a given program's API (Application Programming Interface). (See Figure 2.)

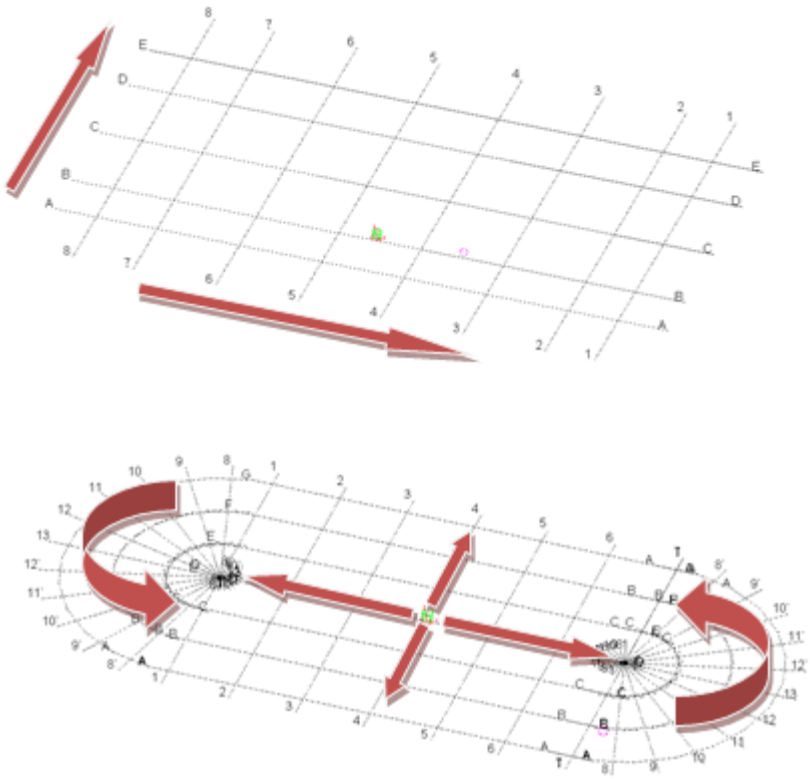
No matter which translation method (if any) is used, geometry should always undergo a rigorous QA/QC process.

Standard Naming Conventions

Naming conventions are another important part of model discipline. If the same types of members have different names, it can cause a mess for the fabricator that costs a lot of time and effort to clean up. It is best to establish an intuitive standard that is easy to interpret and conforms to most shops' standards.

Accurate Shapes & Materials

Just like naming conventions, it is important that all of your shapes and materials are not only correct, but the same syntax should be used throughout.



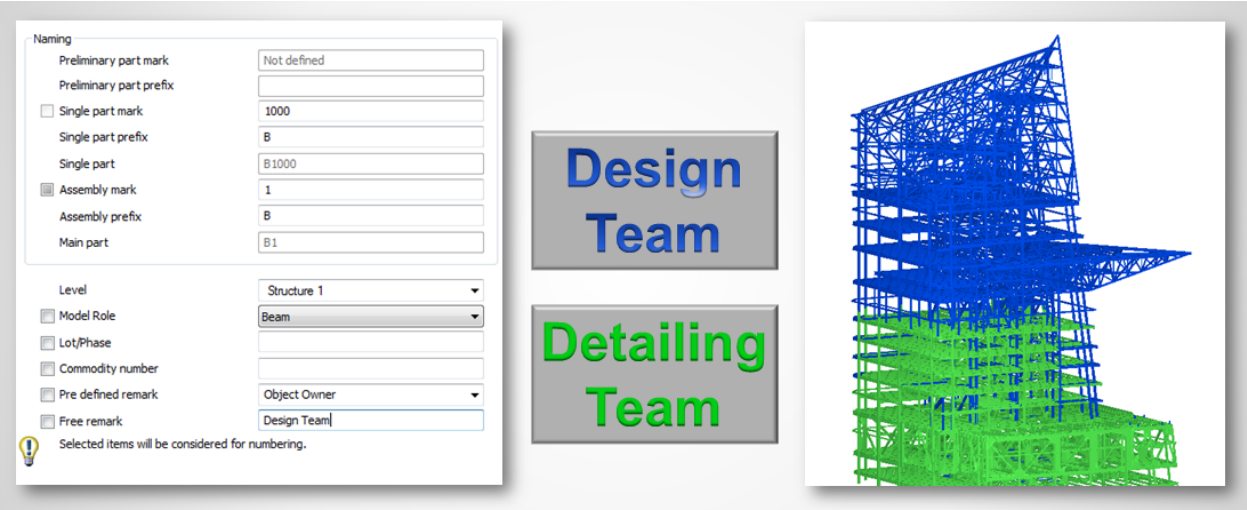
MODELING DIRECTION

Consistent Modeling Direction

Main structural members should all be modeled left to right, bottom to top. In a circular structure such as a stadium, where the origin is in the center, model outwards and counter-clockwise. The logic behind this is that shop assembly drawings are typically oriented with the start point of a member on the left side of the sheet. This way, the shop drawing front view is always looking in the same direction in relation to the building. In Revit 2016, the best way to make sure you're modeling correctly is to select the member after modeling (click) and make sure the direction arrow follows these rules. If it doesn't, you can simply click on the arrow to flip the ends.

Design & Construction Team Communication

Communication is key to success in any industry. Nothing is different here. The design and construction teams need to be in communication with each other as early as possible. In the case where you are in the same office, this makes it very easy to implement a creative workflow, complimentary to the software you're using. When the detailing is done outside your company, it does present other challenges, but is certainly doable. In either case, it is important to write up a simple document to show how the communication system is set up. Email is a great tool, but it's best if something model-based can be used.



Object Ownership

It is important to have a clearly defined line of who owns which elements and a given point. Initially, all elements will belong to the design team. Once the design is complete, they will hand them over to a connection design team. The connection design team will review the design and accept or reject it, based on constructability. Once the connection design is complete, that team will hand off the object to the connection modeling team. When the connection modeling team has completed their part, it is handed off to the detailing team for shop drawing creation.

In Model Comments

To help facilitate a direct communication of issues pertaining to individual model elements, it is very helpful to have a method to make comments directly in the model, attached to the members involved. At TT, we've developed this in-house to work with the platforms we currently use; however, there are solutions within the Autodesk family of products that are certainly suitable.

Change Management

Model Compare for Revit is useful to compare two Revit models. There are also tools available to compare IFC files. For a good write-up on a workflow from PSU, see:
https://faculty.ist.psu.edu/wu/papers/bim-cm-icccbe-2014.pdf

Strategies for Fabrication Friendly Models

As you may have guessed, the strategy for creating a fabrication friendly model is a bit more involved than that of your typical design project. You can't do it for free. You must have a proper BIM execution plan, a scope showing what you will and will not model, and a team of experts who can deliver a quality product.

BIM Execution Plan/Scope – beyond standard design

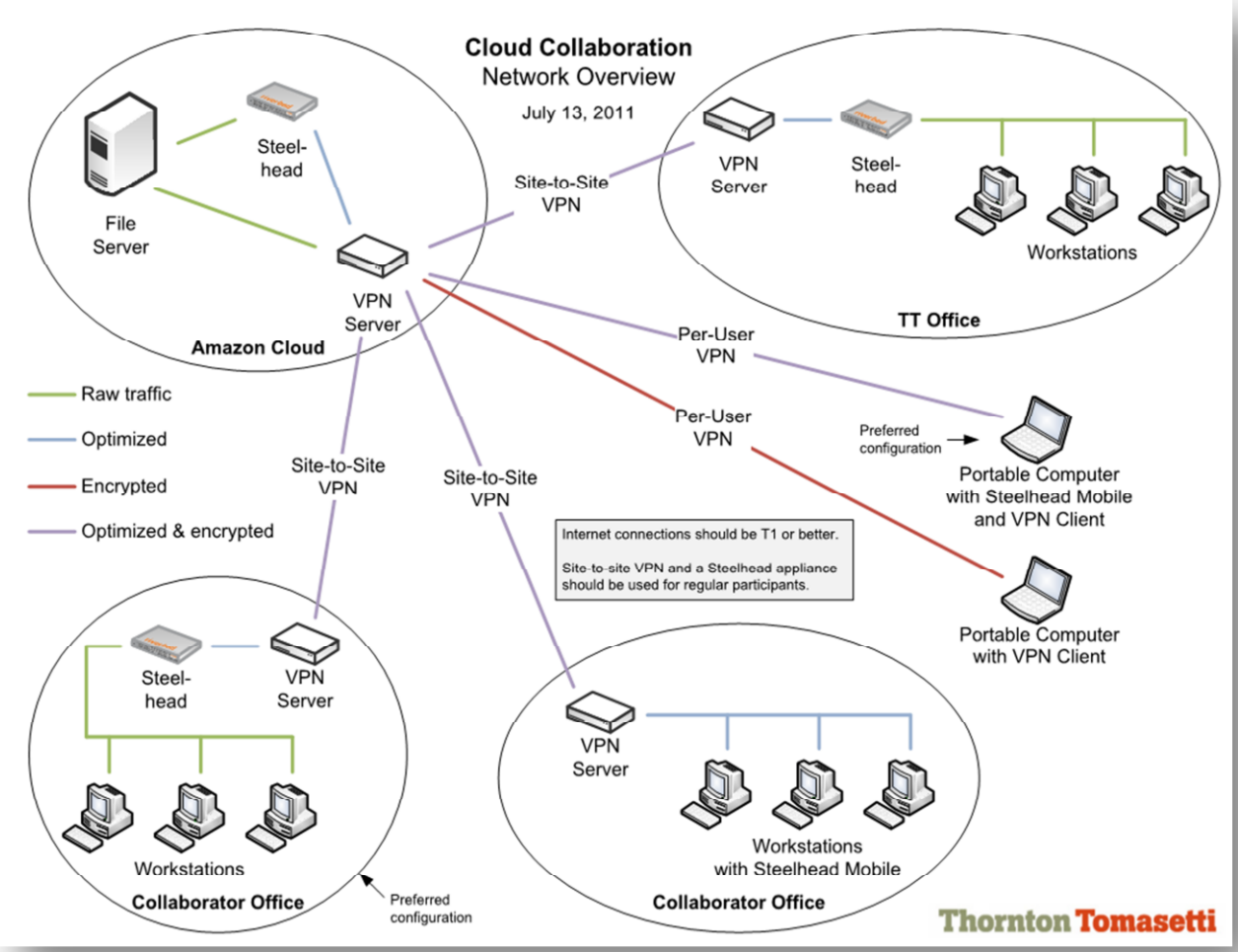
Your scope may include just connection design, where you might want to model some of the more complex connections and provide 2D sketches for the typical details. But, for the major project schedule savings, you'll want to deliver an ABM, and then possibly provide full connection modeling to the fabricator. For the shop drawings, I suggest letting the fabricator take care of that. They know how their drawings need to look, and no two fabricators want it the same way.

Project Trade Experts

Unless you have steel and/or concrete detailing experts on staff, you will need to consider where to get your expertise. It's a good idea to hire a reputable detailing firm that can collaborate closely with your team and implement any communication workflows that you've established. It would be best to find those detailers who not only have extensive experience in the type of project you're working on, but also have been involved in this type of advanced delivery method.

Cloud Collaboration

There are many definitions of collaboration on projects, even when you narrow the concept to just "cloud" collaboration. Each form of collaboration has trade-offs in performance, cost, and convenience.



AWS/MS Azure/etc.…

For our initial live-collaboration efforts, we selected a shared file server accessible to all parties, which addressed most of our concerns reasonably but did not sufficiently address performance problems. The software involved just was not built to work with many participants collaborating over a variable-performance WAN (based on bandwidth and distance constraints).

Cloud NAS (Network Attached Storage)
More recently, we've begun using a variation of this model where data is replicated between sites using newer collaboration-safe hardware. But even this has had performance challenges due to the nature of the application software involved.

Platform Specific
Some software vendors are attempting to address these challenges with their own cloud-friendly solutions, many of which perform reasonably well and significantly better than the previous versions of their tools. However, these solutions typically only work in the narrow context of the individual applications' own files, requiring a combination of independent solutions to truly collaborate on design models *and* spreadsheets *and* fabrication models.