Detail Friendly Design Modeling for Downstream

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Class summary

Design models are not typically used in the construction process. This is 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 contractors point of view: what steel detailing firms expect from structural engineers to effectively collaborate and exchange model-based information.

Key learning objectives

At the end of this class, you will be able to:

- Understand modeling discipline and best practices
- Effectively and efficiently communicate between the design and construction teams
- Understand what is needed for an effective strategy to produce fabrication friendly models
- Understand how cloud model hosting services help expedite your deliverables and enhance collaboration

Agenda

Introduction
Case studies
Methods
Contractors Perspective
Q&A

Introduction

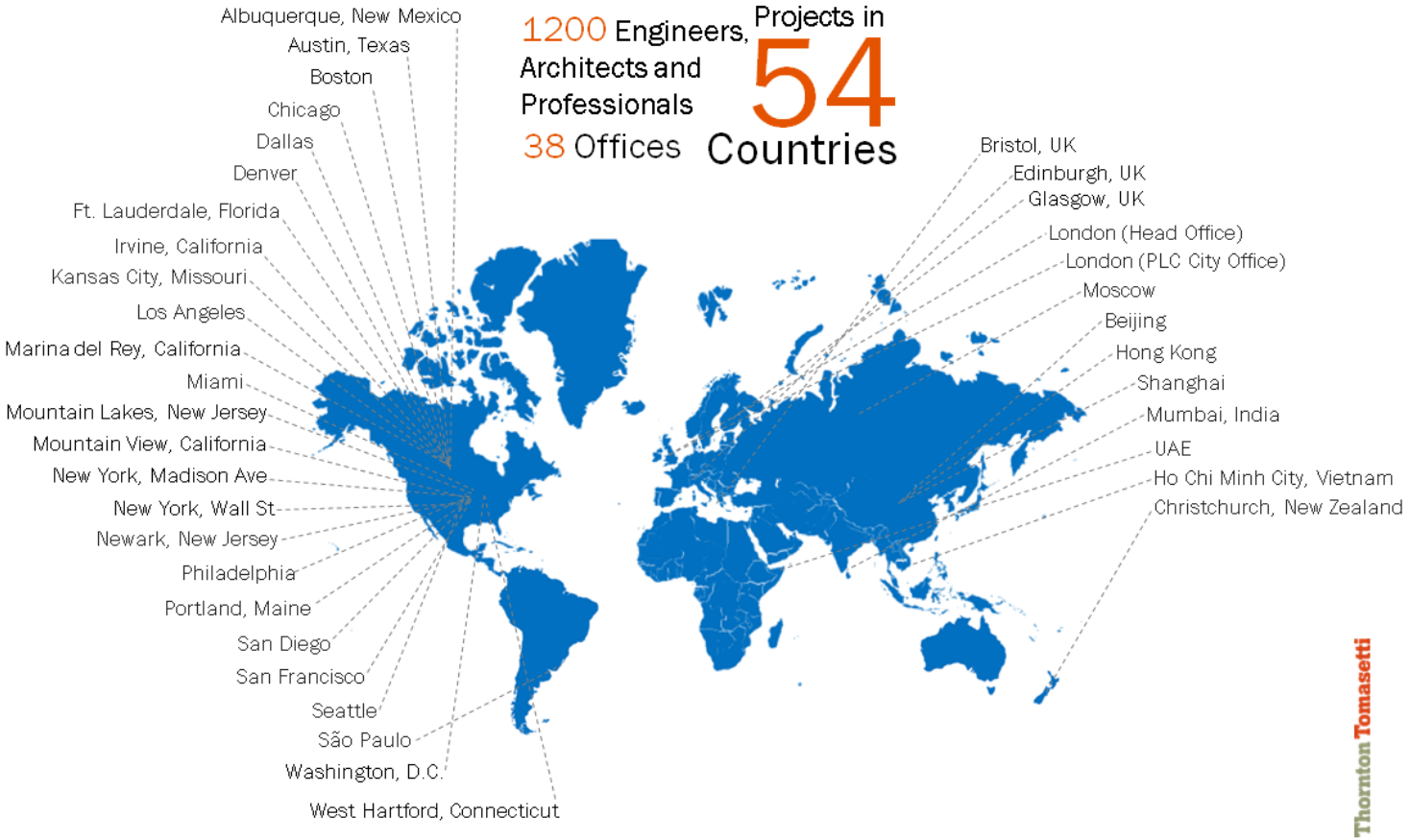
Our Locations

5 Continents

1200 Engineers, Architects and Professionals

38 Offices

Projects in 54 Countries

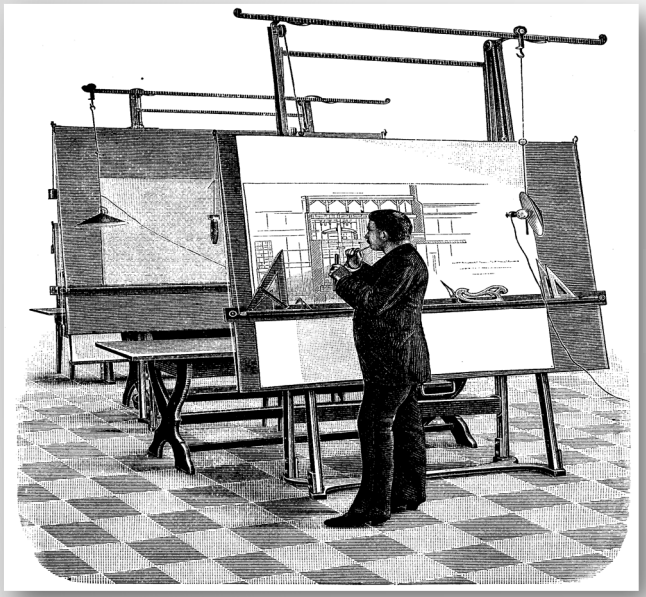


Thornton Tomasetti

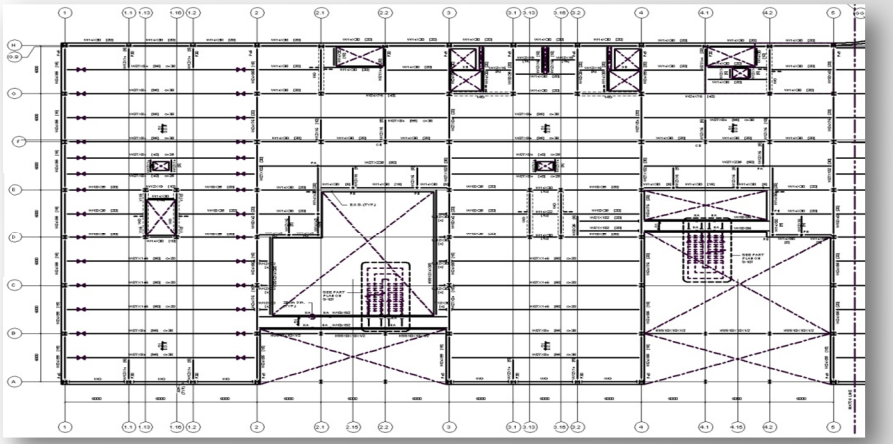
Our Practices

Thornton Tomasetti

The Great Transition…



Hand Drafting



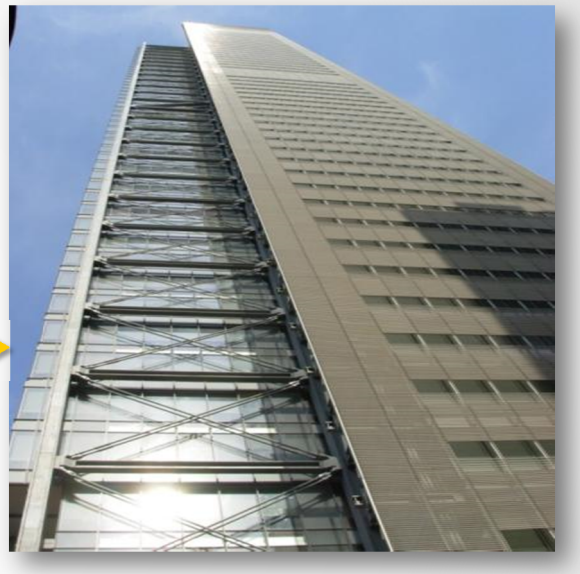
Computer Aided Drafting

How much of an Improvement?

The Great Transition…

One Liberty Place
(1987)
60 Drawings

New York Times
(2007)
140 Drawings



Hand Drafting

Computer Aided Drafting

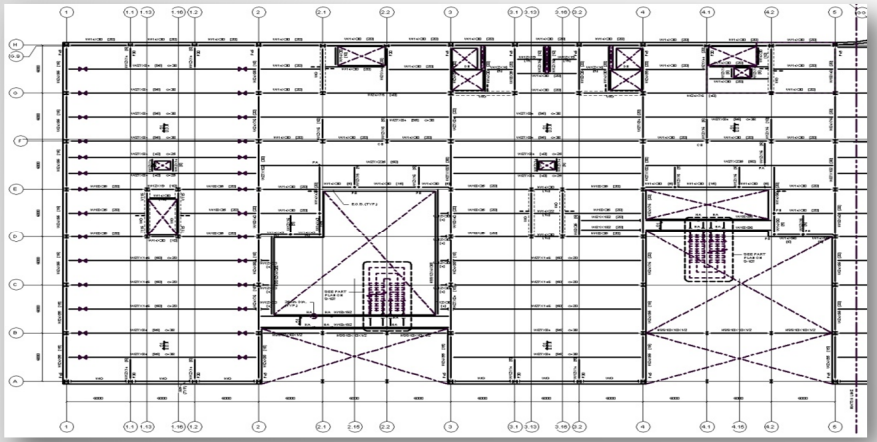
True Progress?

The Great Transition…

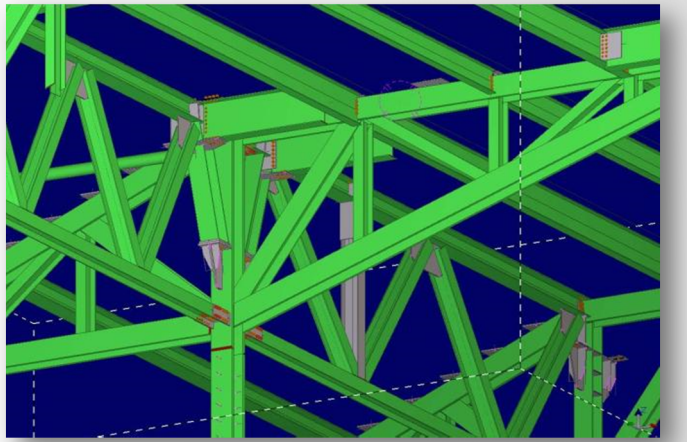
Better or Worse?

- Dimensional Information
- Clarity of Design Intent
- ½ Size Drawings
- Coordination Efforts
- Claims, Extras & RFIs

The Great Transition…



Computer Aided Drafting



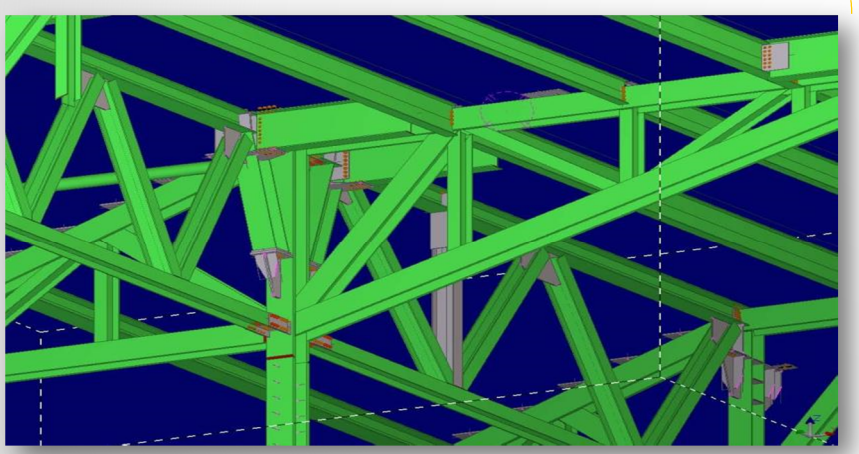
Building Information Modeling

Improvement!

The Great Transition…

If a Shared Model isn't the Deliverable…

All of this…



Might as well be…

This

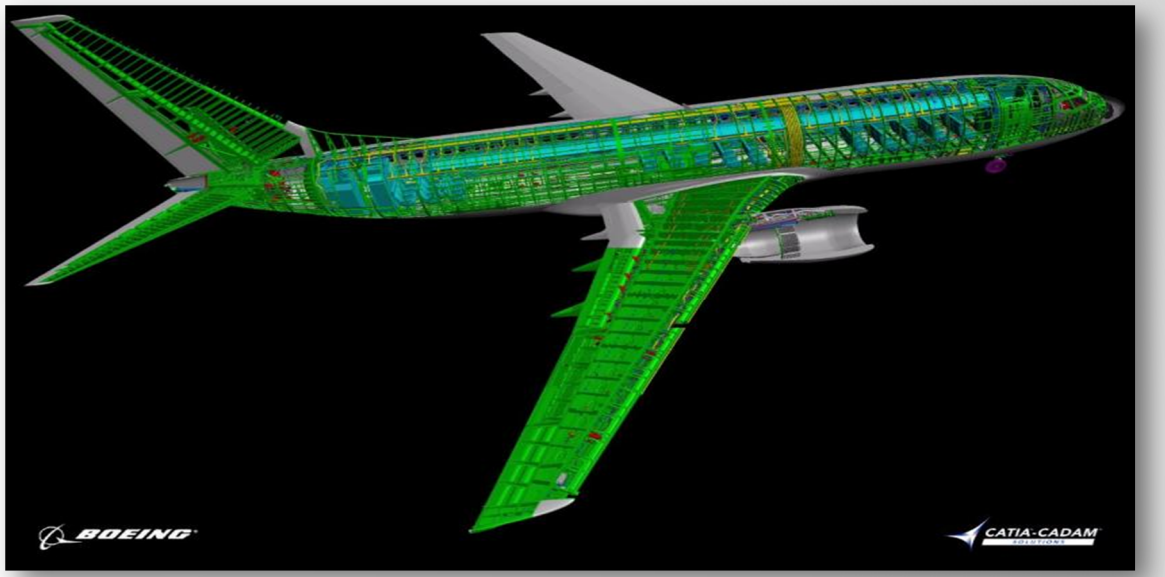
Share & Deliver: We can do it!

- **Boeing 777**

  First 100% computer

  Designed aircraft

  (CATIA, 1993)

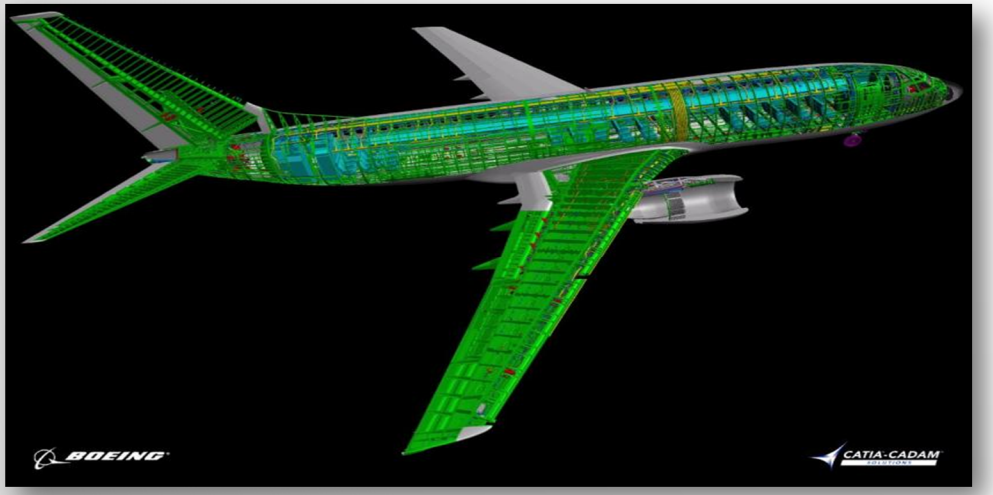


- Eliminated 3000+ assembly interfaces (No physical prototyping)
- 90% reduction in engineering change requests (6000 to 600)
- 50% reduction in cycle time for engineering change requests
- 90% reduction in material rework
- 50x improvement in assembly tolerances for fuselage

Share & Deliver: We can do it!

When a model isn't shared and delivered….

This…



can end up coming out looking like…

this…

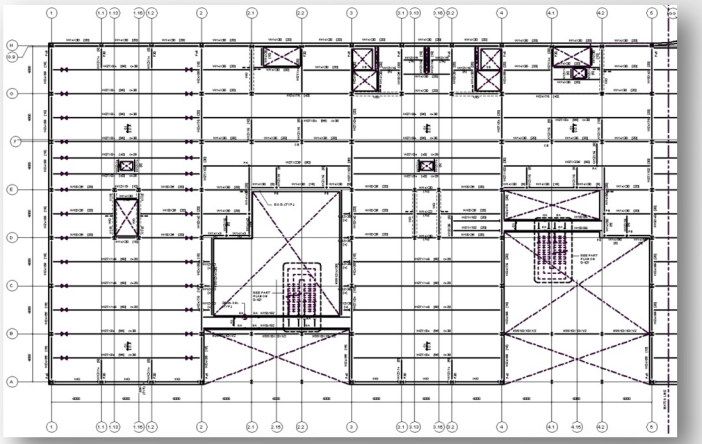
Share & Deliver: We can do it!

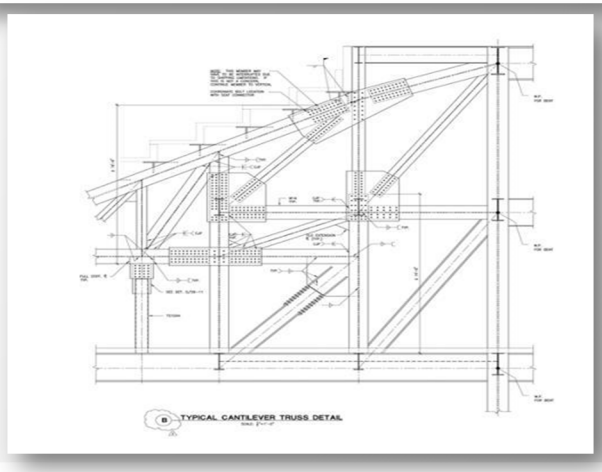
"Insanity is doing the same thing over and over again and expecting different results."
-Albert Einstein

- Designers have always been "smart"
- Designers have always "shared"
- Designers have always designed in 3D

but then…

- We don't share
- We deliver in 2D
- We deliver it "dumb"





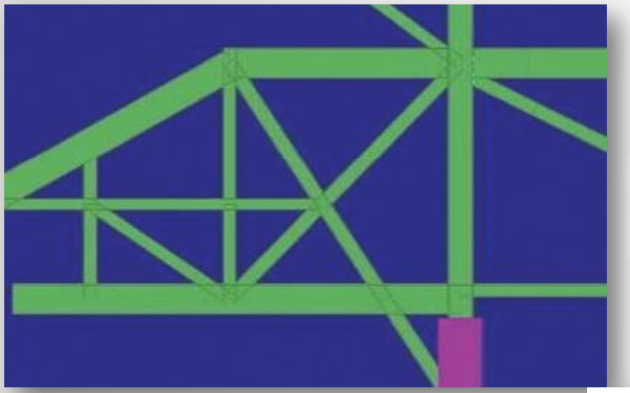
Share & Deliver: We can do it!

Lost in translation
We're smart, our deliverable…
not so much.

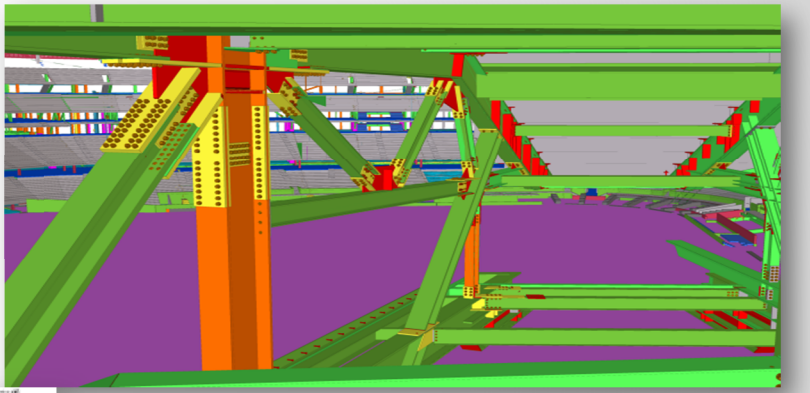
- How big can that gusset plate be?
- How does that duct get past that beam?
- How can I splice those bars?
- How many tons? Cubic yards?
- Where is *that* beam?
- Are you 100% done?

Share & Deliver: We can do it!

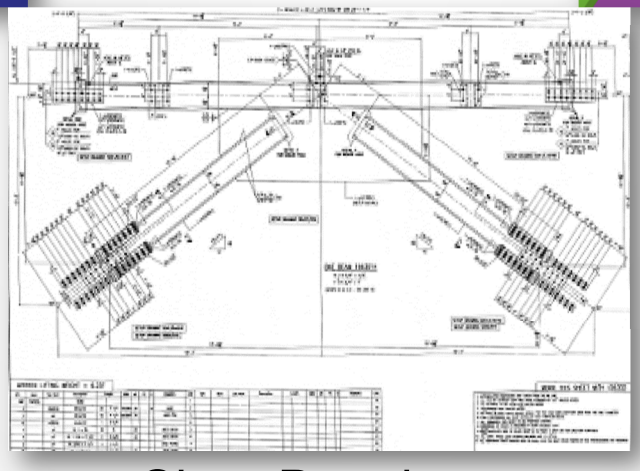
Stop the insanity!



Mill Order Member Model



Full Connections & Embedded Information



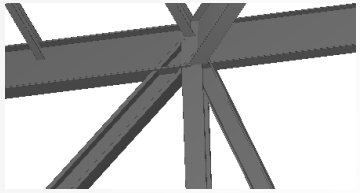
Shop Drawings

Share & Deliver: We can do it!

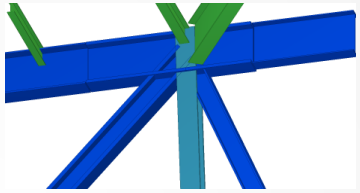
Design Intent Workflow:

SD

DD



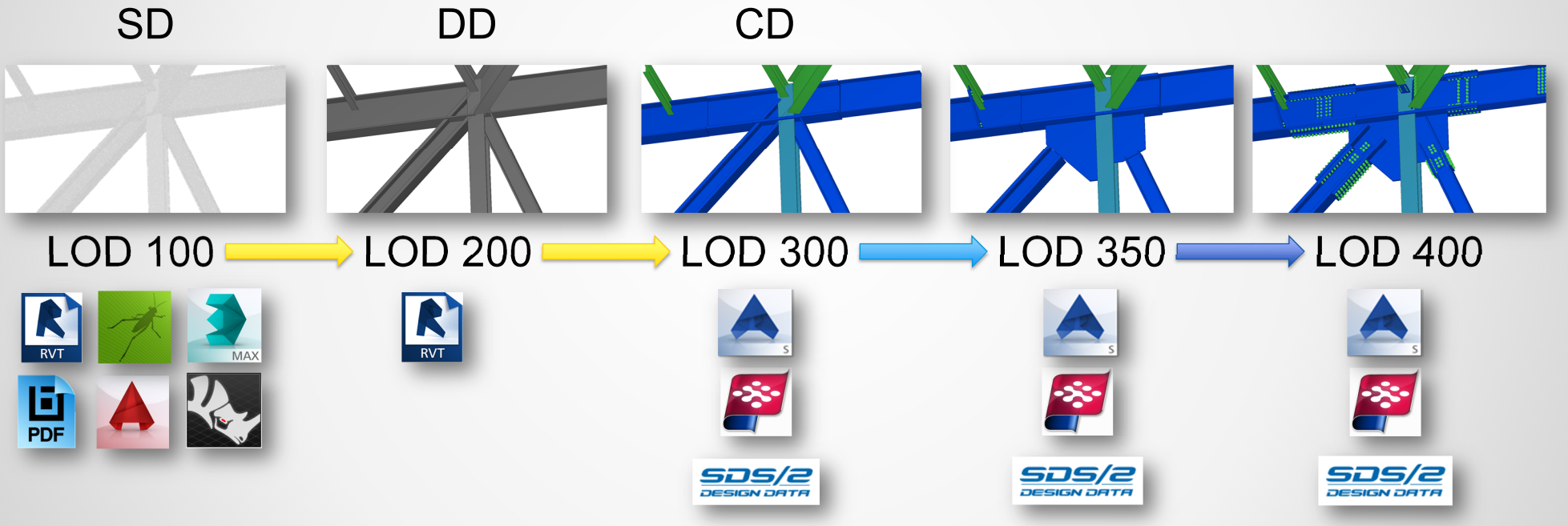
CD



LOD 100 → LOD 200 → LOD 300 →

Share & Deliver: We can do it!

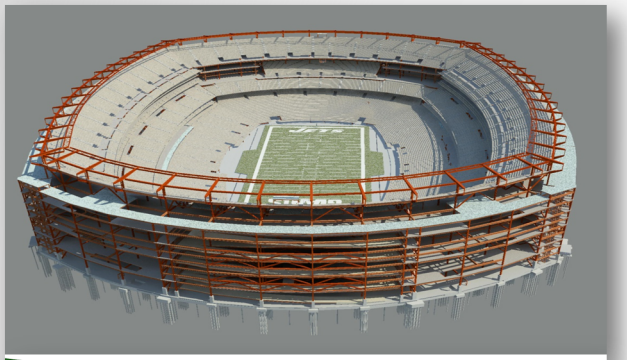
Advanced Delivery Approach:

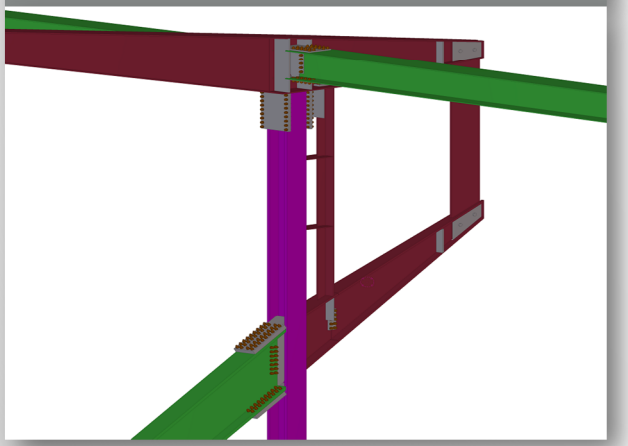


Advantages

Schedule Savings & Certainty

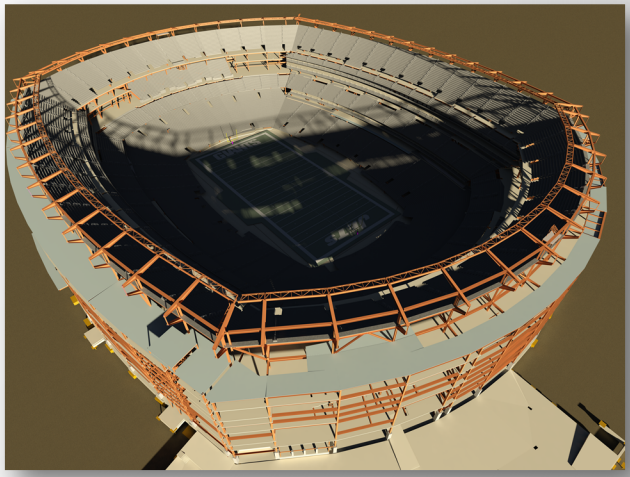
New Meadowlands Stadium, East Rutherford, New Jersey





- Design-Build, Design/Assist
- Ahead of schedule (3-6 Months)
- Model accuracy (What you see is what you get/want)
- Means and methods

Everybody wins!



Schedule Savings & Certainty

10 Hudson Yards, New York, New York

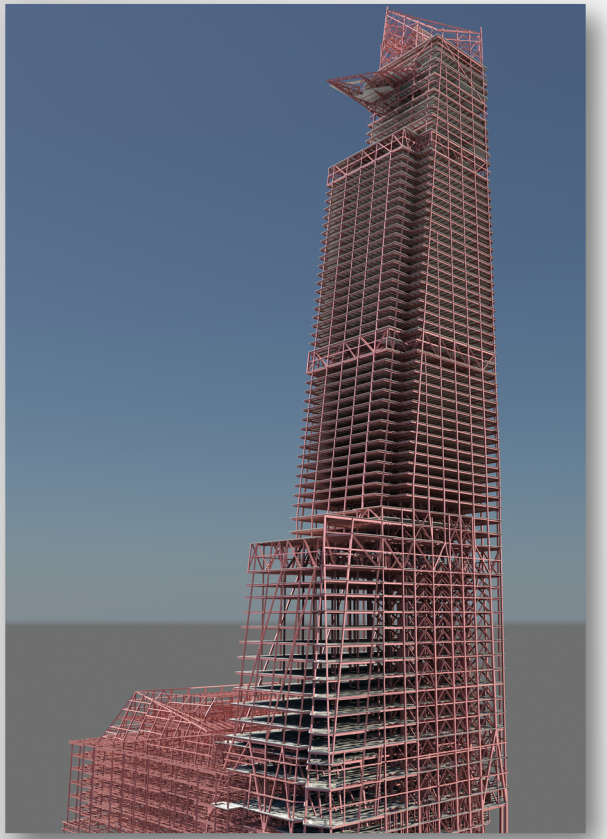


Image courtesy Related

Schedule Savings & Certainty

With Advanced Delivery Approach…

SD → DD → CD → Bid

Connection Design Consulting -

Preliminary Input -

Connection Design

Phase I

Mill Order

Phase II

Phase III

Fabrication

Erect

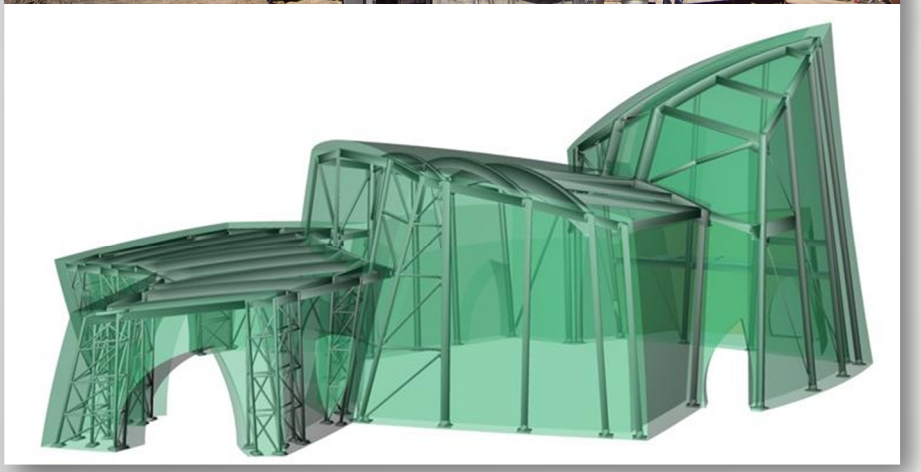
Steel detailing begins in the design phase, shortening the schedule

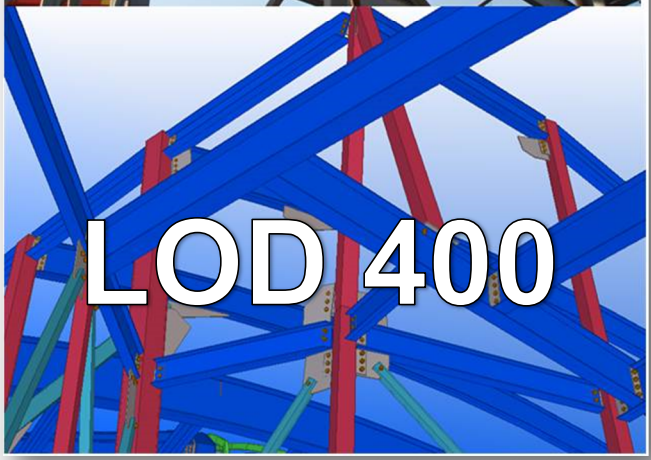
- Potential Delay

Minimum 3 months savings

Cost Certainty

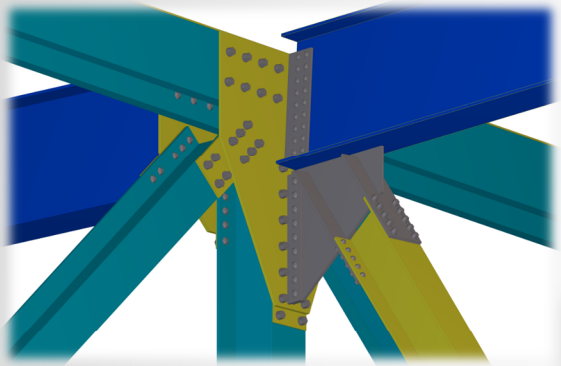
Cathedral of Hope, Dallas, Texas

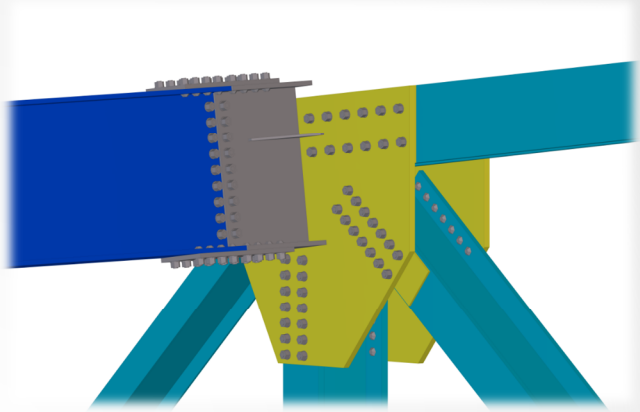


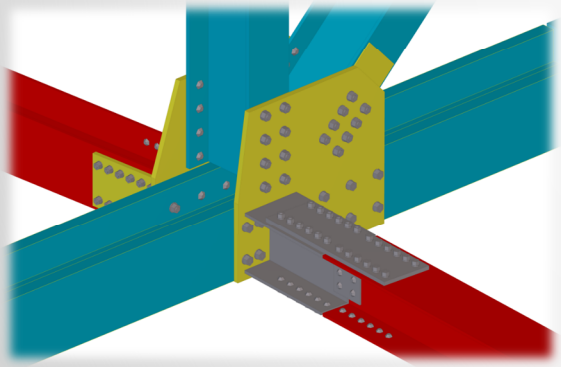


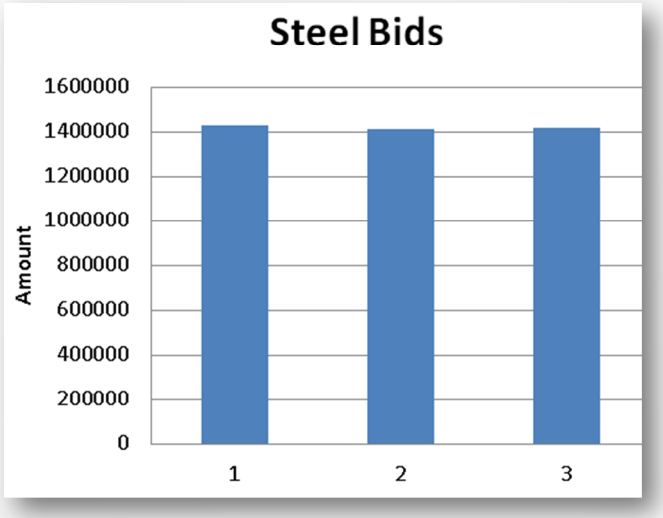
Cost Certainty

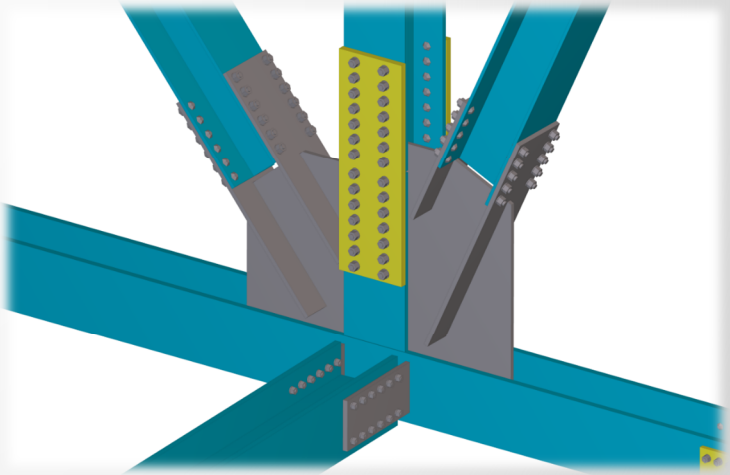
Data Center, Undisclosed Location





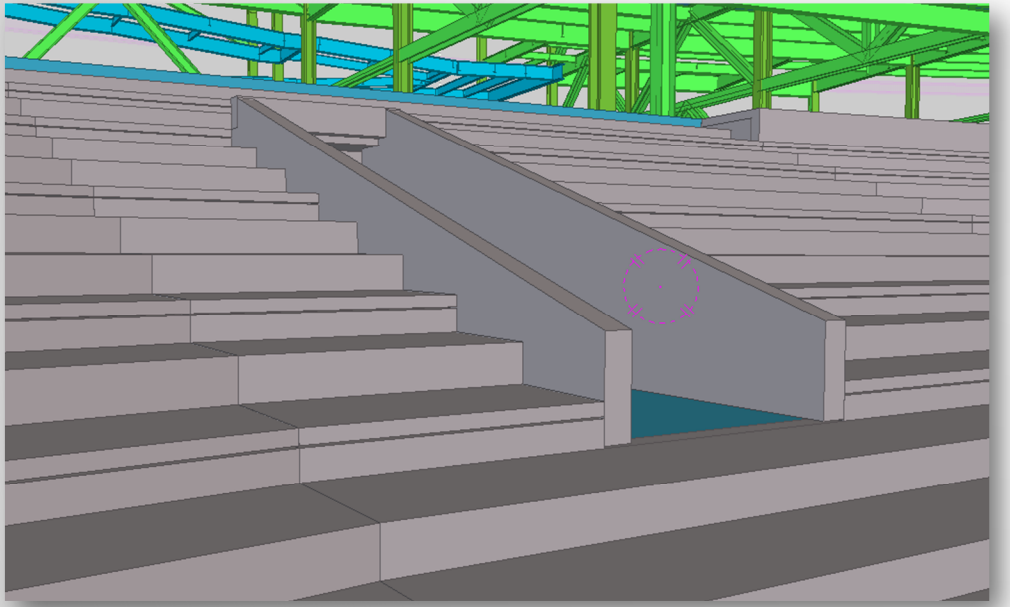


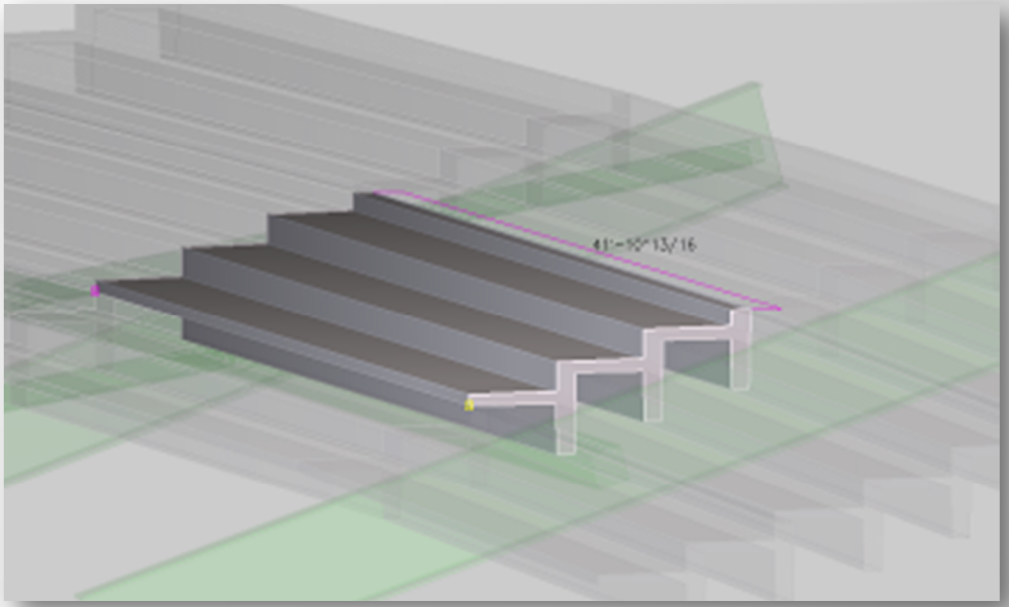




Increased Trade Coordination

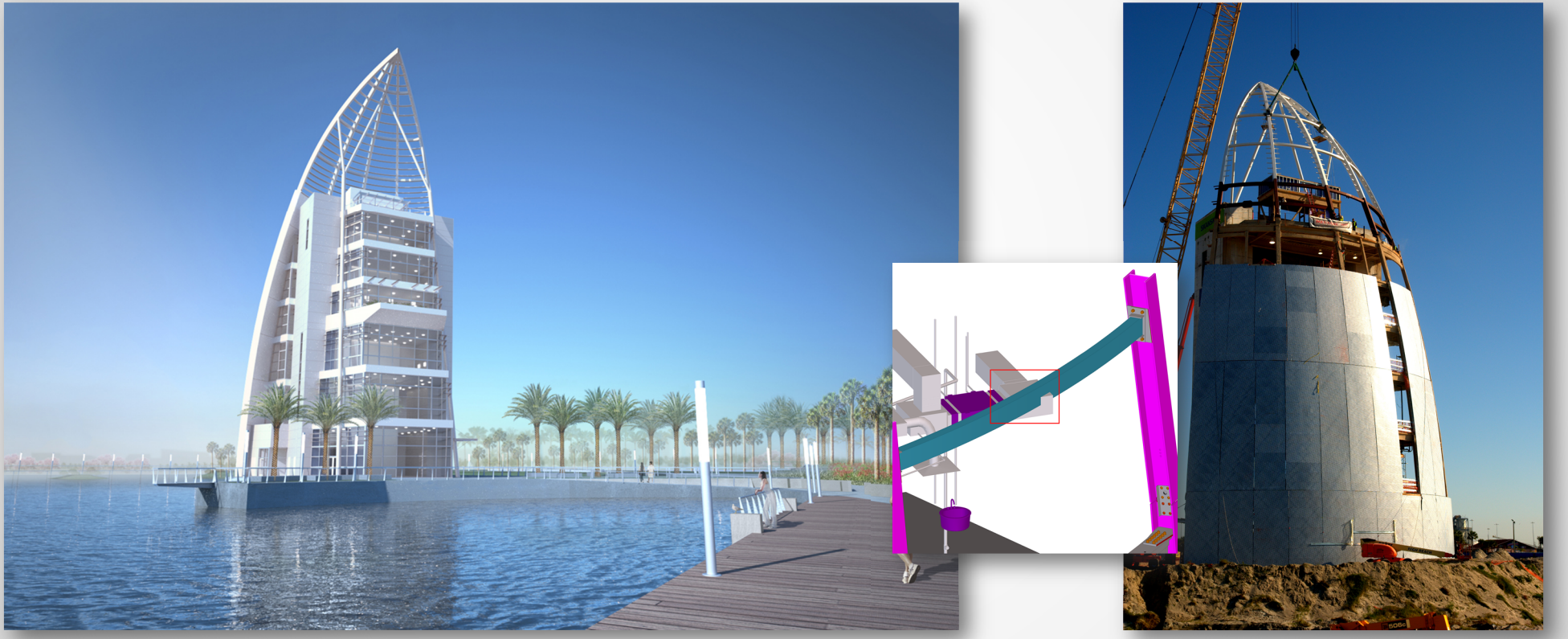
New Meadowlands Stadium, East Rutherford, New Jersey





Increased Trade Coordination

Port Canaveral Welcome Center, Cape Canaveral, Florida



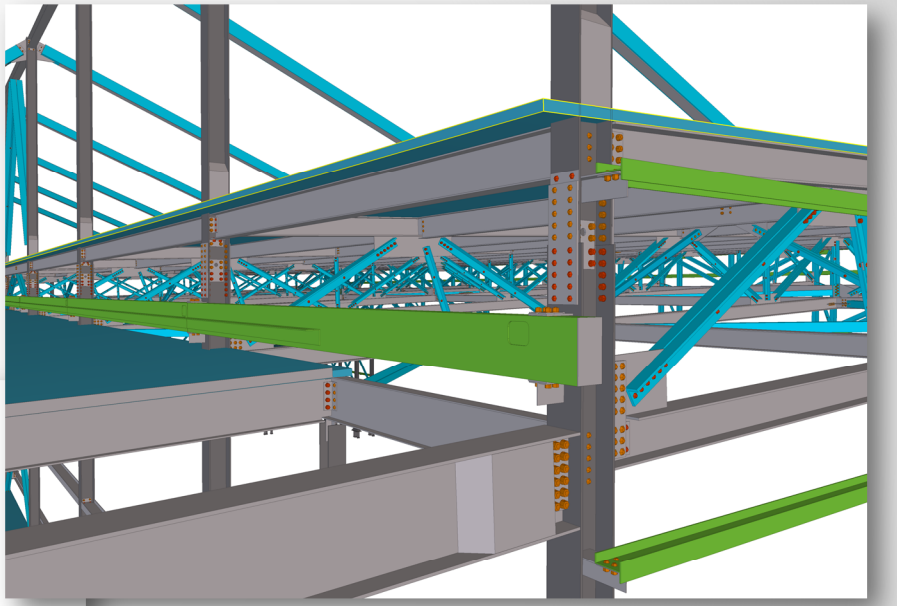
Reduction in RFIs

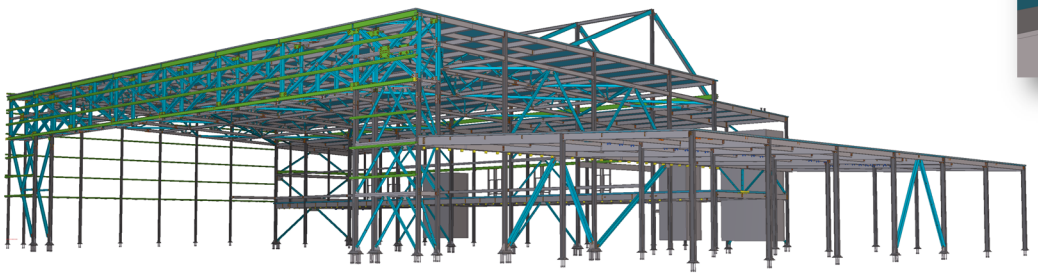
Port Canaveral Welcome Center, Cape Canaveral, Florida

Reduction in RFIs

Quantico Hangar, Quantico Marine Corps Base

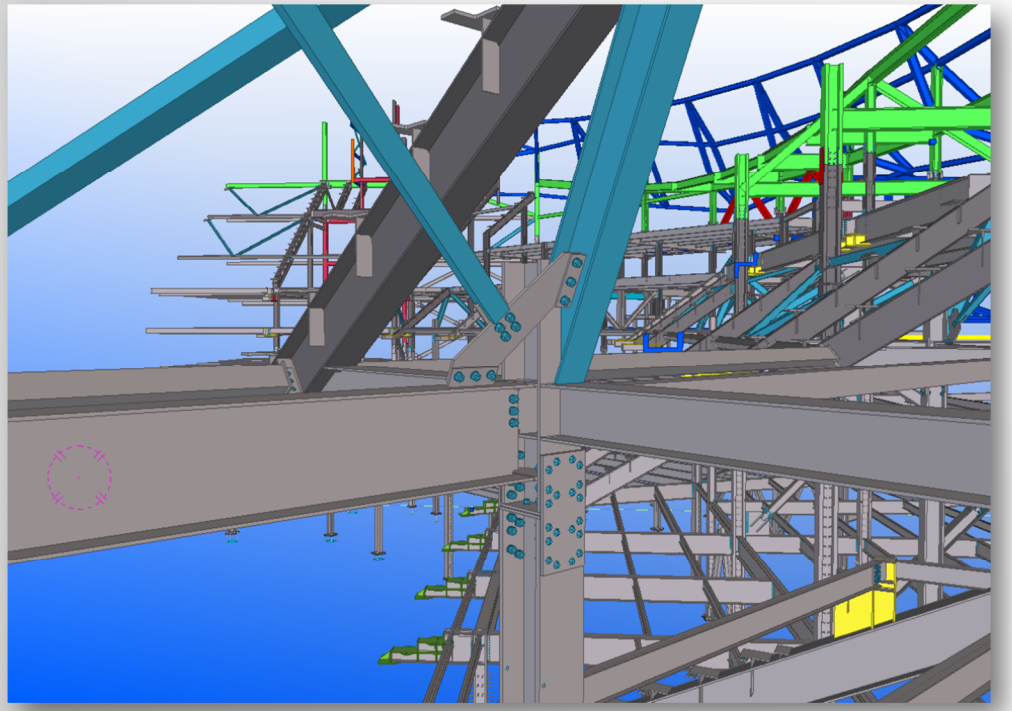
- 760 Tons
- Only 1 RFI!!!





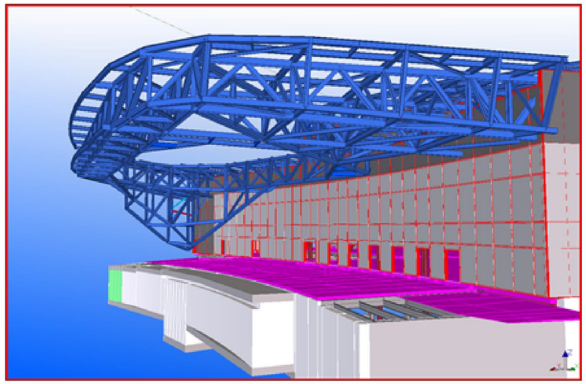
Change Order Validation or Reduction

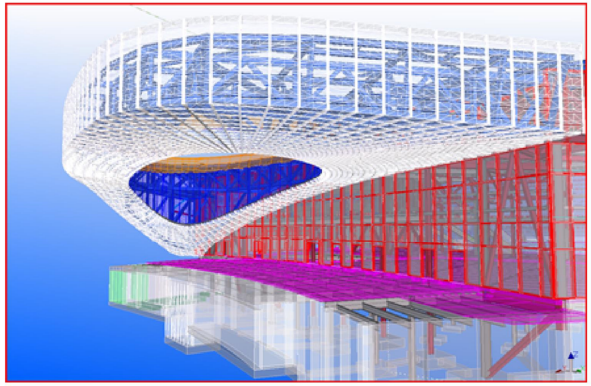
- Quantities and complexity are identified as the design progresses.

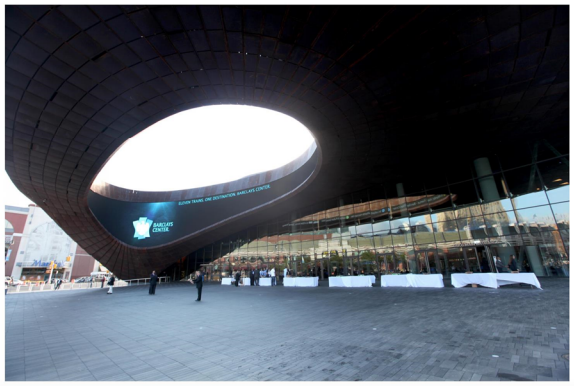


Change Order Validation or Reduction

- Once models are issued, they can be compared and quantities verified.

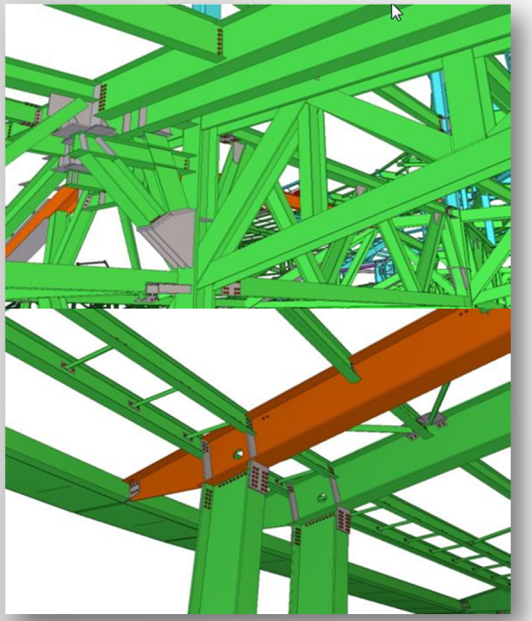


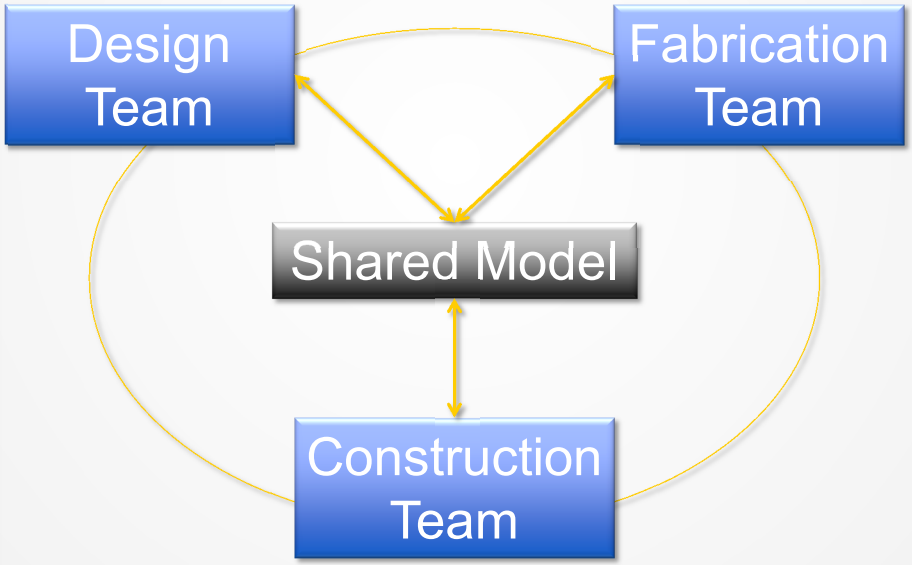




Change Order Validation or Reduction

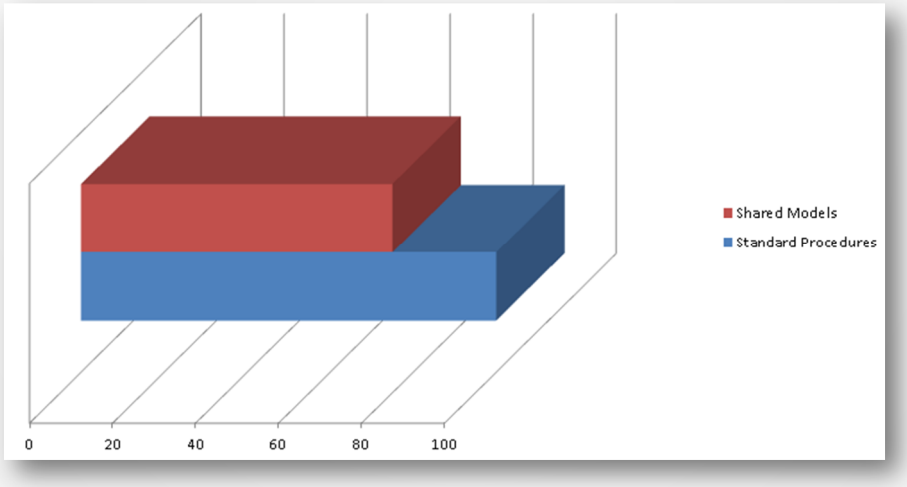
- Sharing information allows potential change orders to be identified earlier in the process.





Change Order Validation or Reduction

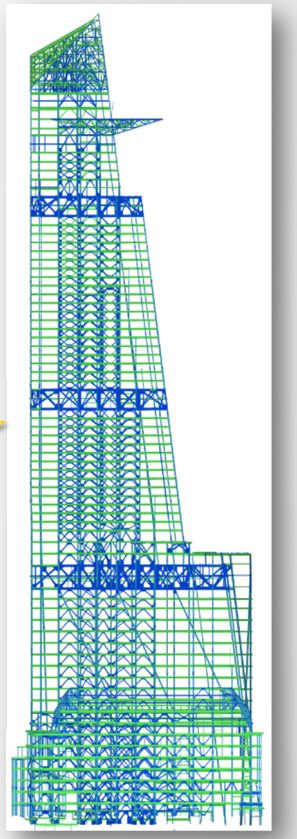
- In projects where the proper approach is implemented, change orders have been estimated by CMs to be reduced by 25%.



Change Order Validation or Reduction

This change adds over 1,000 tons!

By my calculations, it's just more than 100 tons…

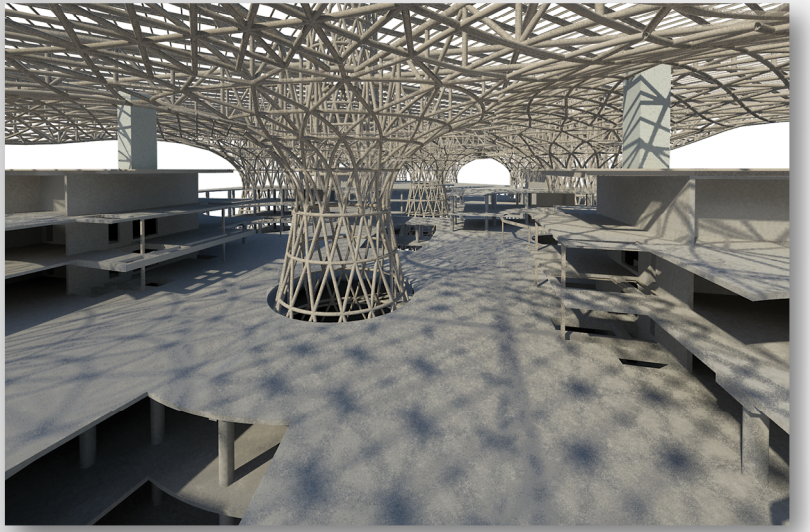


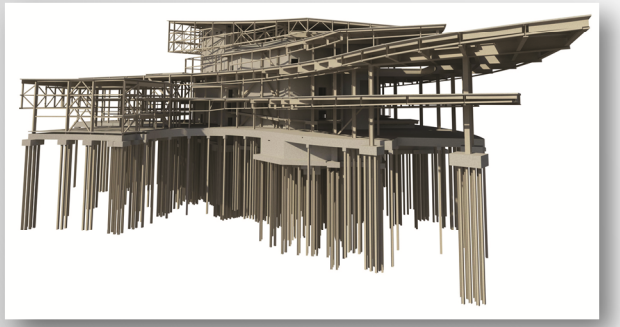
Means & Methods

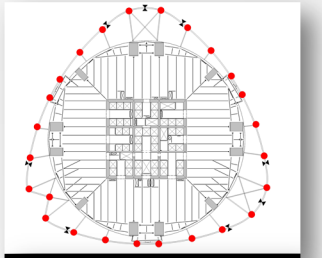
Model Discipline

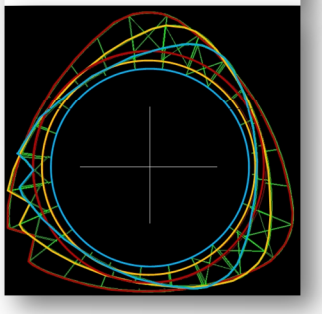
- Geometry
- Accurate shapes & material grades
- Standardize Naming Conventions
- Consistent Modeling Direction

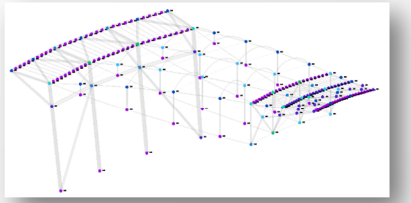
Geometry

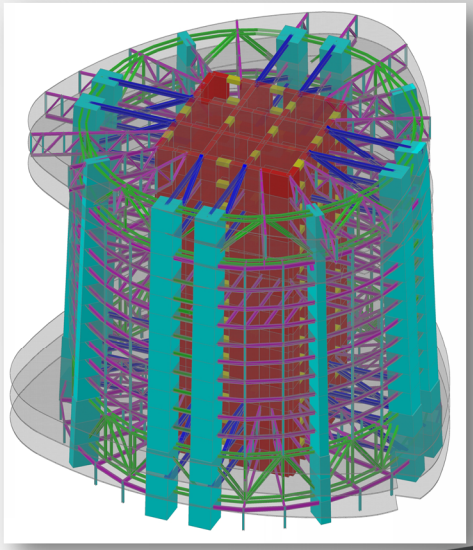


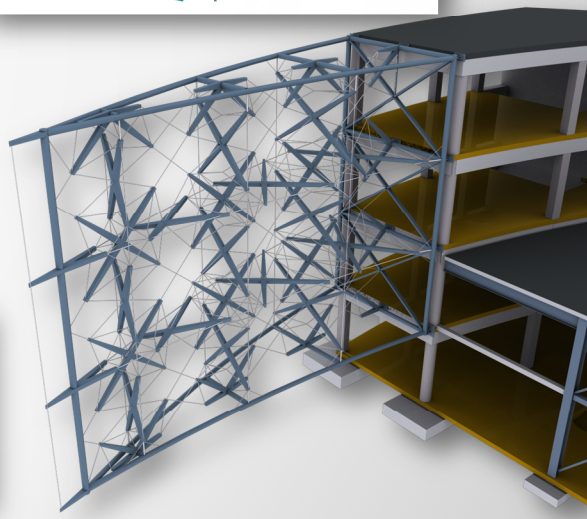






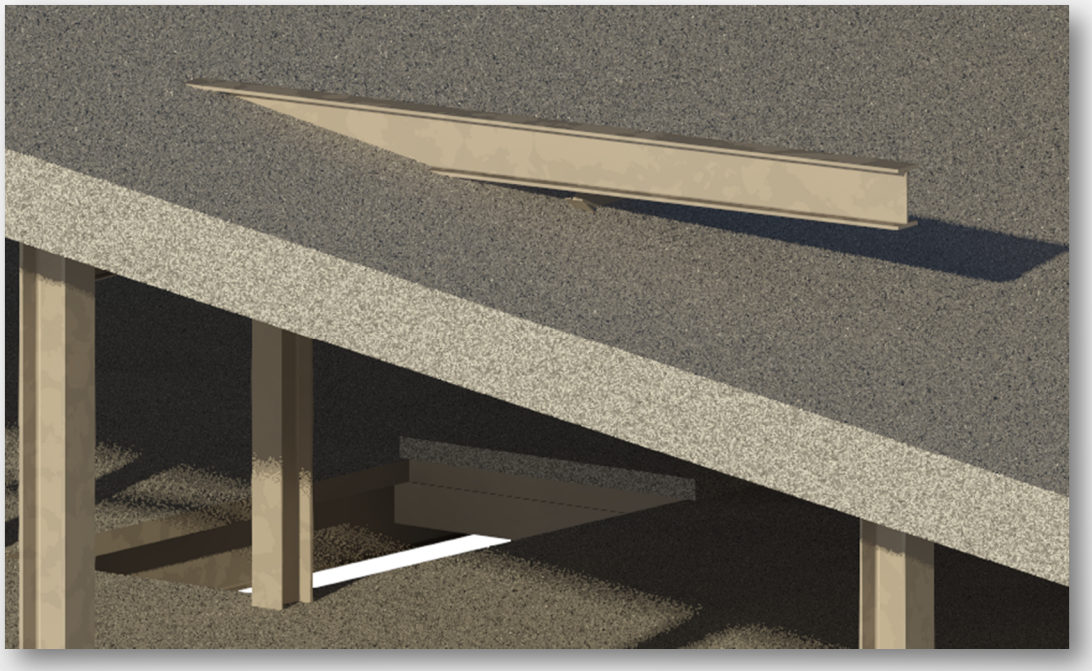




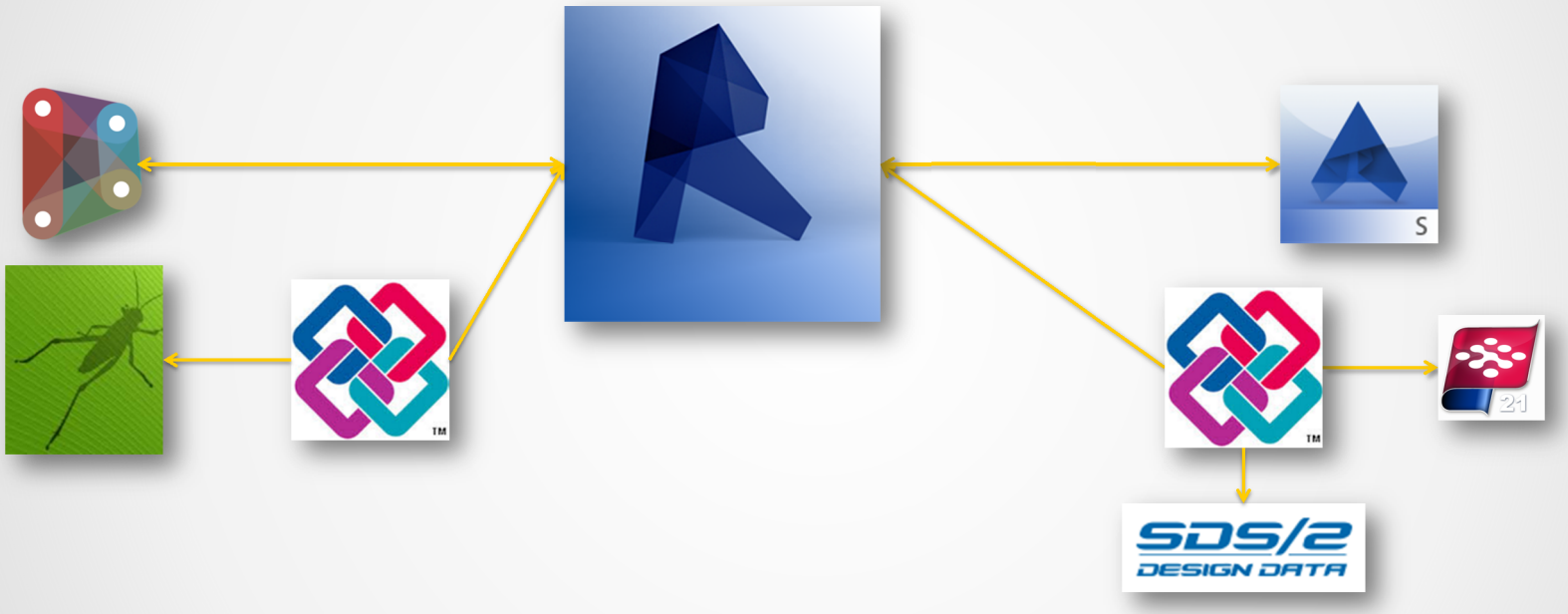


Geometry

"If you don't have time to do it right, when will you have time to do it over?" – John Wooden, Head Coach UCLA

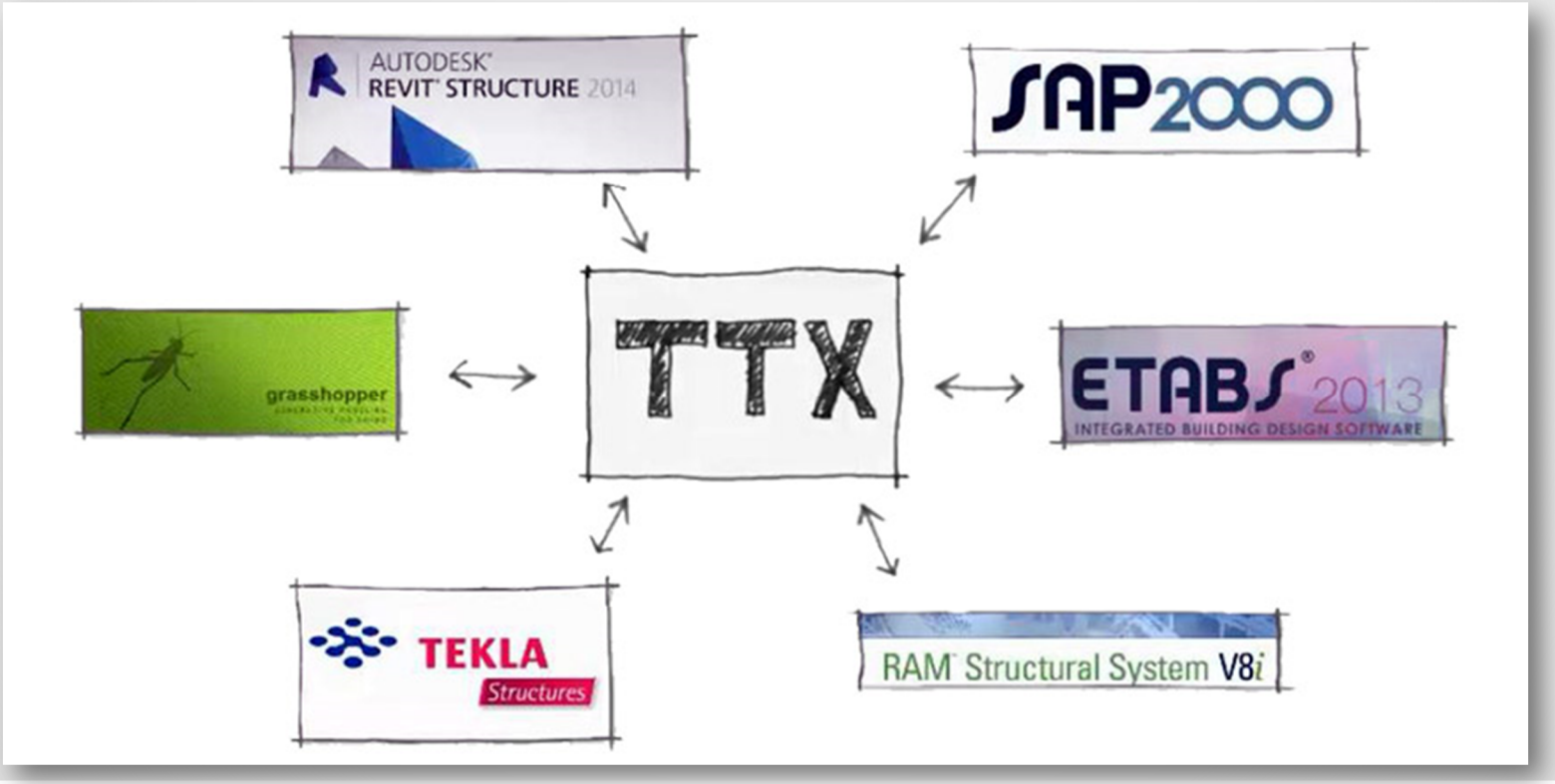


Geometry



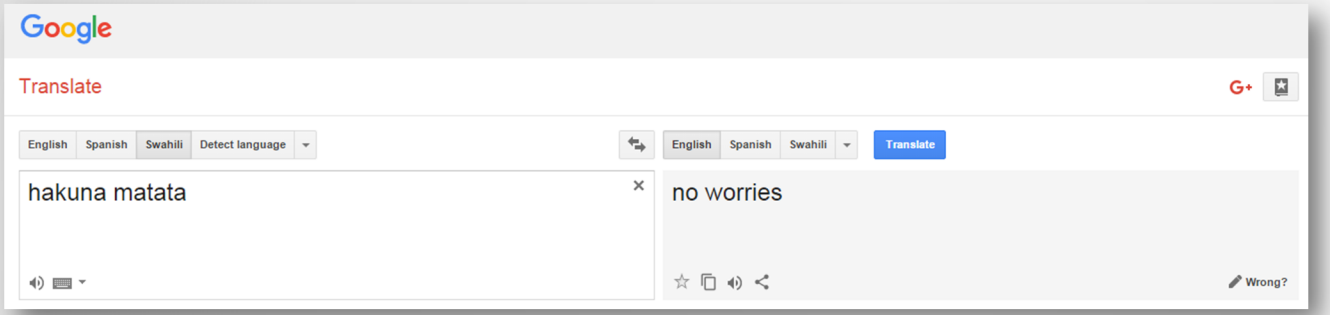
Geometry

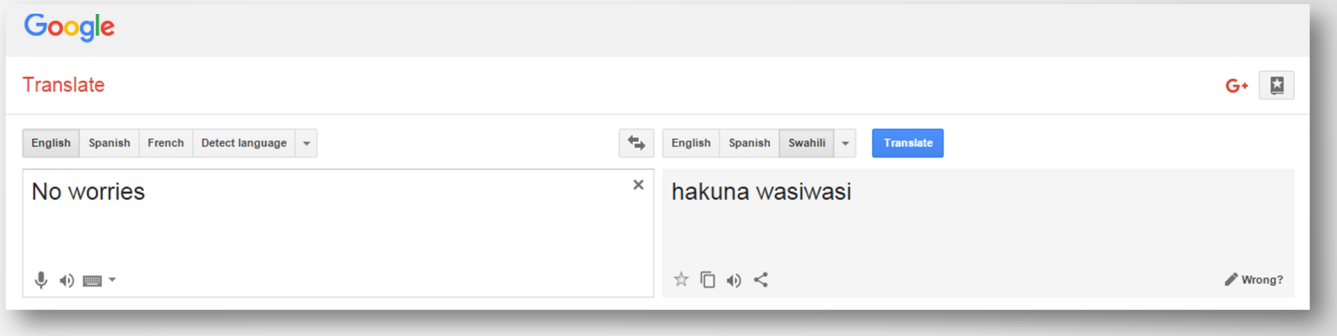
- core.thorntontomasetti.com/interoperability/



Geometry

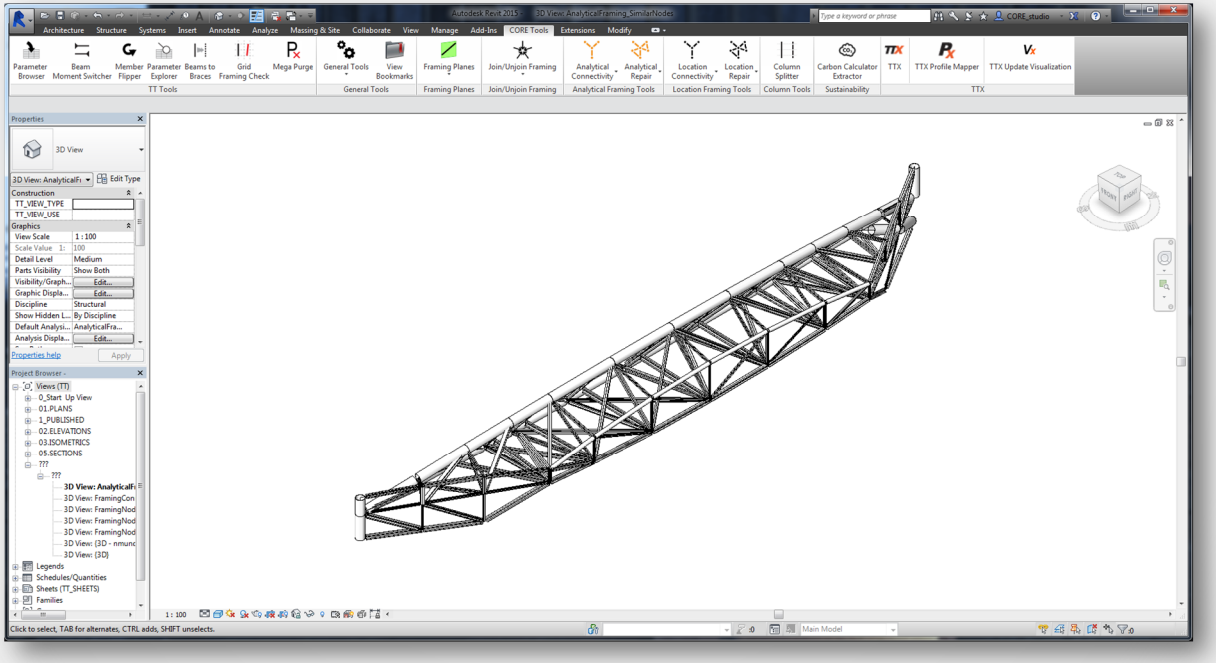
- Lost in Translation





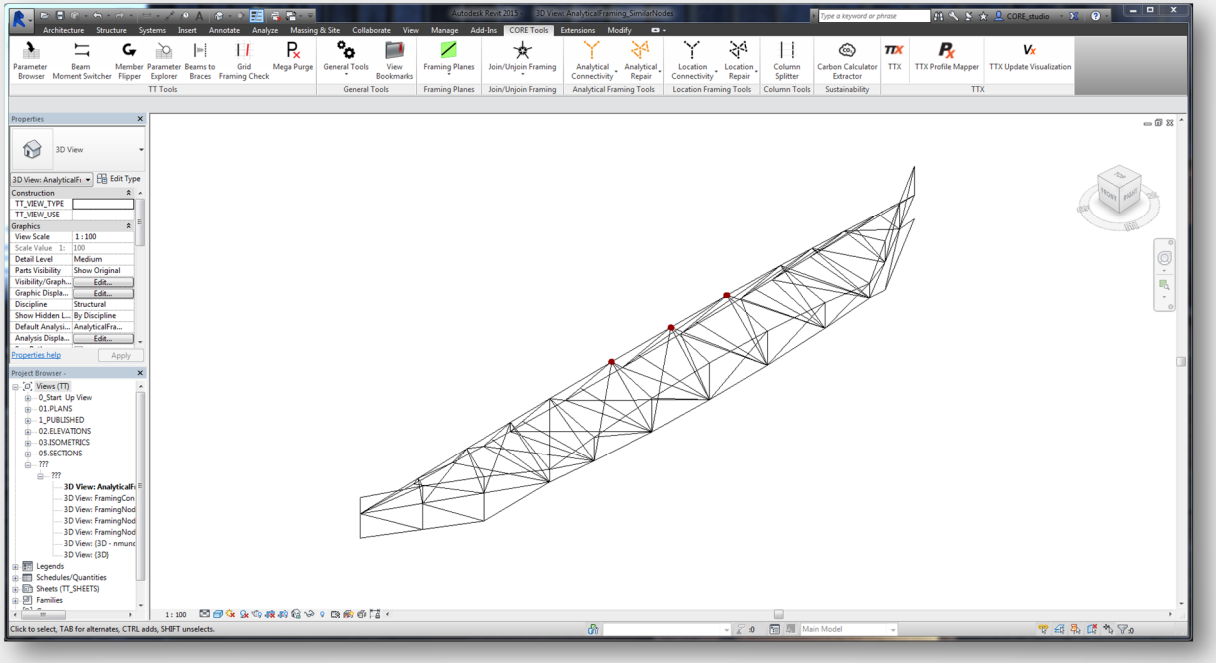
Geometry

- Correcting Geometry



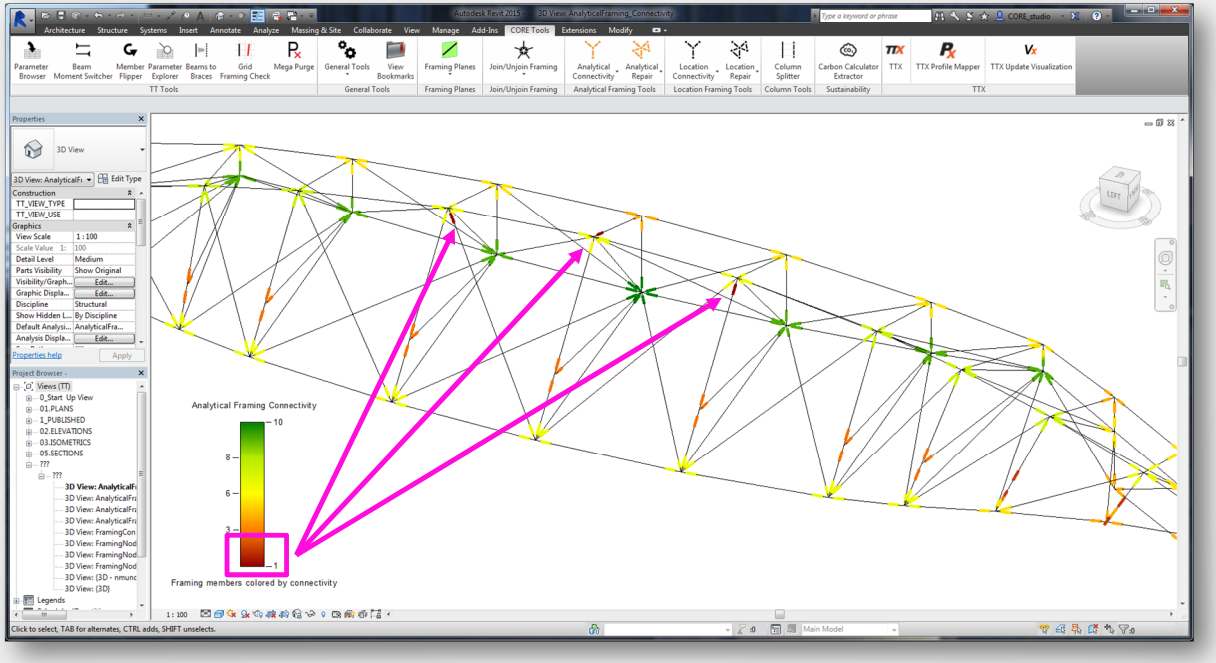
Geometry

- 3 similar nodes



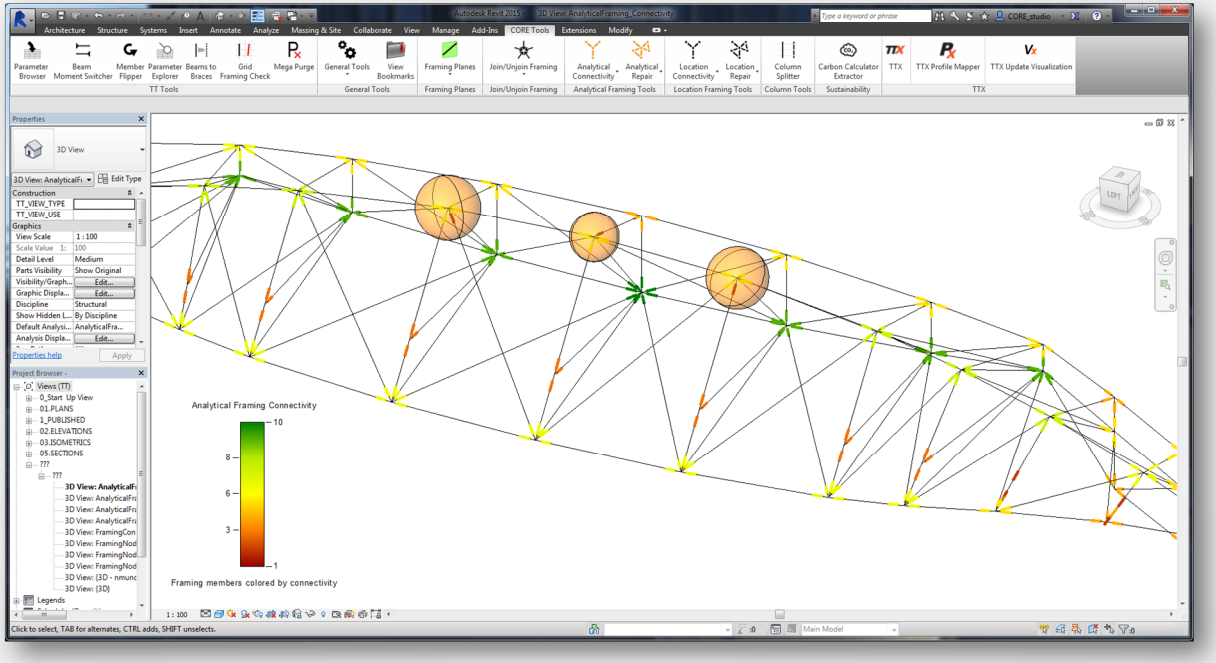
Geometry

- 3 Naked Nodes



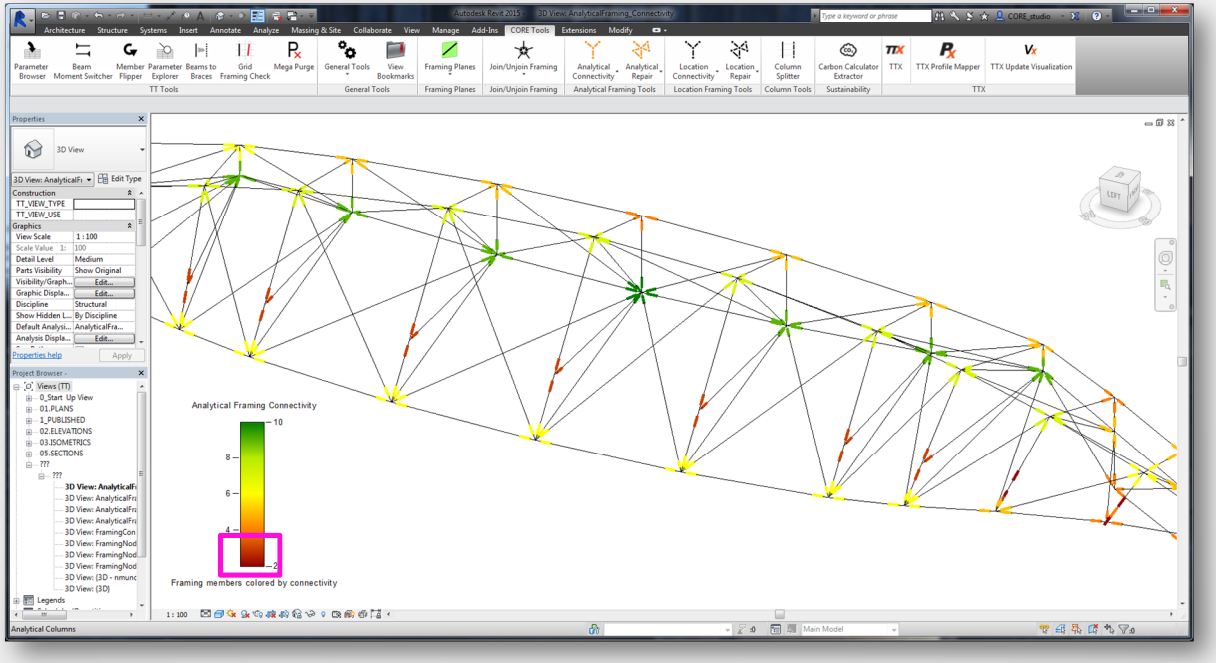
Geometry

- Connectivity Repair



Geometry

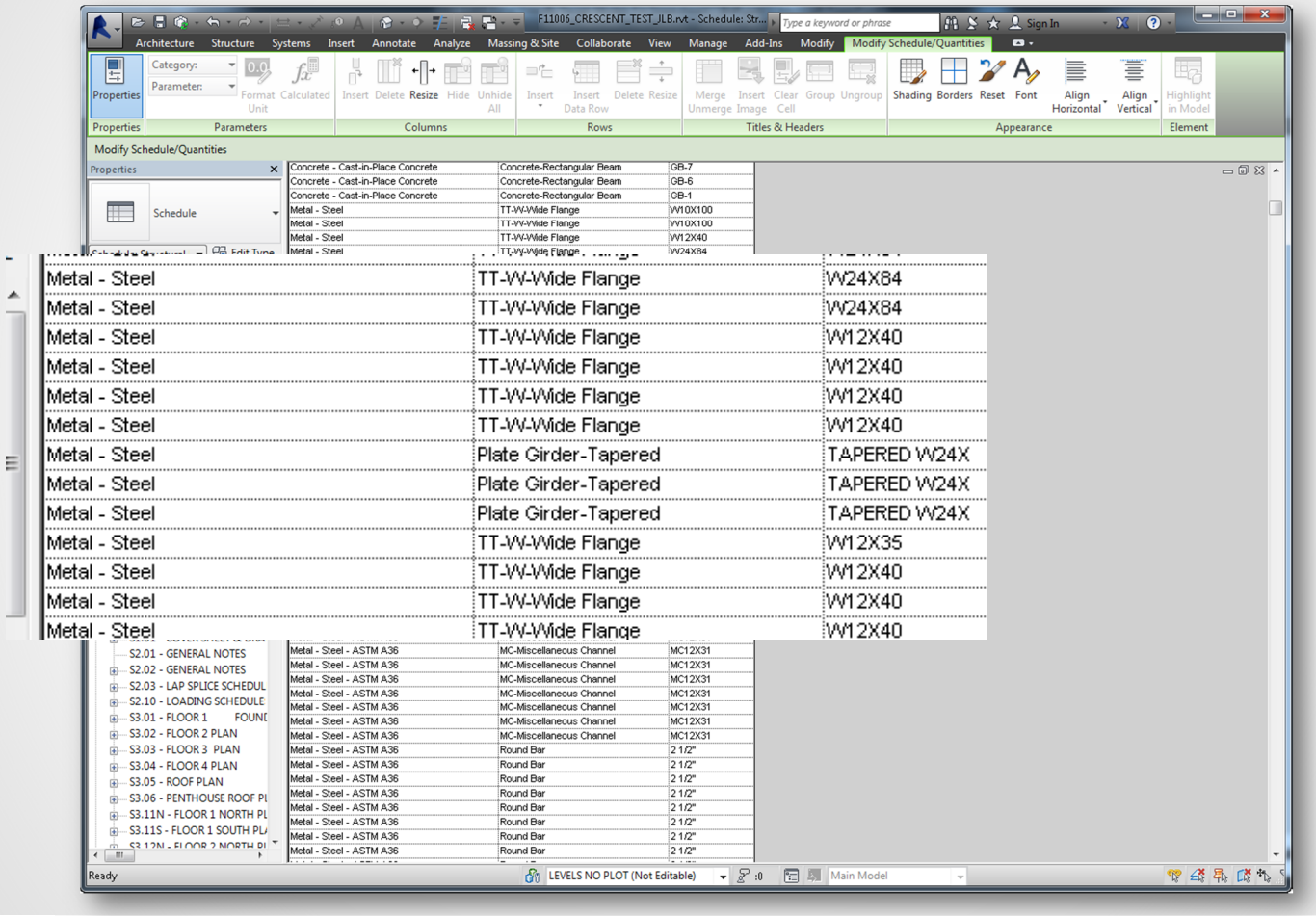
- Connectivity Repair



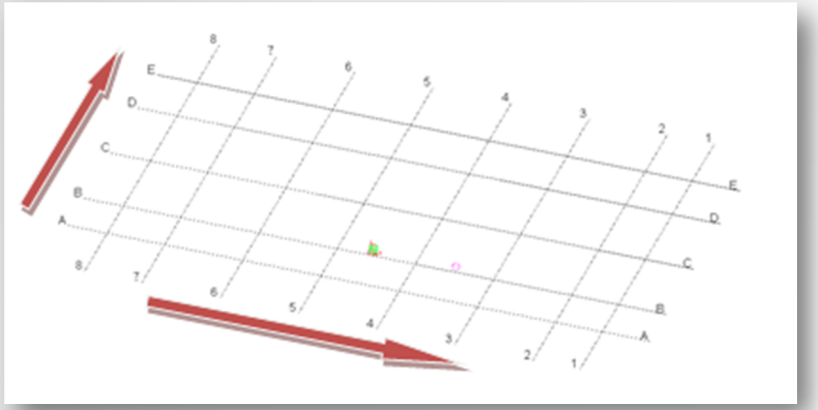
Standardize Naming Conventions

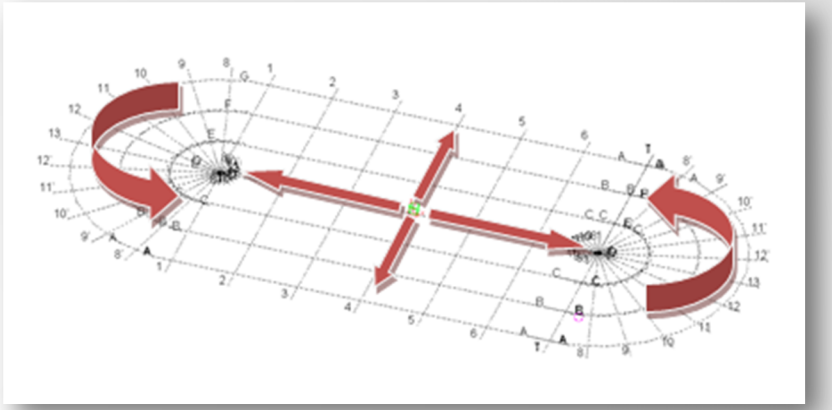
	Name	Assembly Prefix	Class	Description	Suggested Method
PRIMARY STEEL	BEAM	B	3	Used for infill framing	Beam
	GIRDER	B	3	Main structural beam supporting other members	
	JOIST	J	11	Pre-fabricated joist members made of multiple elements	
	JOIST GIRDER	J	14	Pre-fabricated joist girder members made of multiple elements	
	BRIDGING	M	5	Joist bridging	
	RAKER	B	3	Sloping seating support members	
	COLUMN	C	*	Vertical supporting element that originate at the foundation	Column *Use Class 7 for W shapes, Class 9 for pipe, Class 12 for HSS
	XCOLUMN	C	*	Crusiform column	
	POST	C	*	Vertical supporting element that are supported from below	
	HANGER	C	*	Vertical supporting element that are supported from above	
	TRUSS	T	8	All members of a truss assembly including top and bottom chord	Beam
	HORIZONTAL BRACE	D	4	All bracing elements that do not drastically change in elevation	
	VERTICAL BRACE	D	4	All bracing that the start and end points drastically change in elevation	
	STRINGER	S	10	Main support for stairs and ramp framing	
	GIRT	M	10	Door frame, lintels, purlins, sag rods, etc.	
	GRATING	M	26		Contour Plate
	FLOOR PLATE	M	26		
	CHKD PLATE	M	26		
	PLATE BEAM	PB	3	Members that are a combination of plate elements whose final profile resembles that of a rolled shape.	Cross Plate Profile (S33)
	PLATE BRACE	PD	4		
	PLATE GIRDER	PG	3		
	PLATE COLUMN	PC	7		
	PLATE RAKER	PB	3		
	BUILTUP BEAM	BB	3	Members that are a combination of a rolled shape and cover plates.	Beam
	BUILTUP BRACE	BD	4		
	BUILTUP GIRDER	BG	3		
	BUILTUP COLUMN	BC	7		
	BUILTUP RAKER	BB	3		

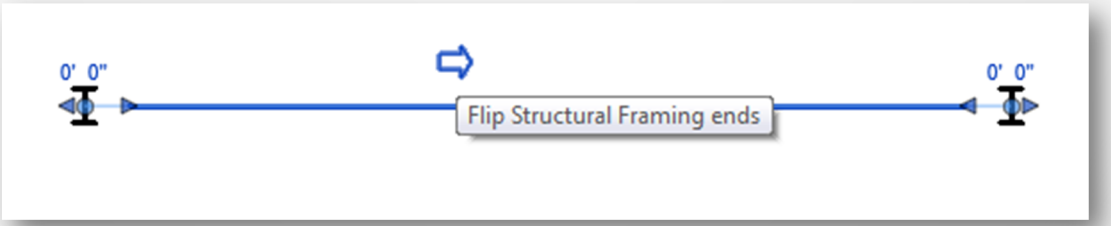
Accurate shapes & material grades



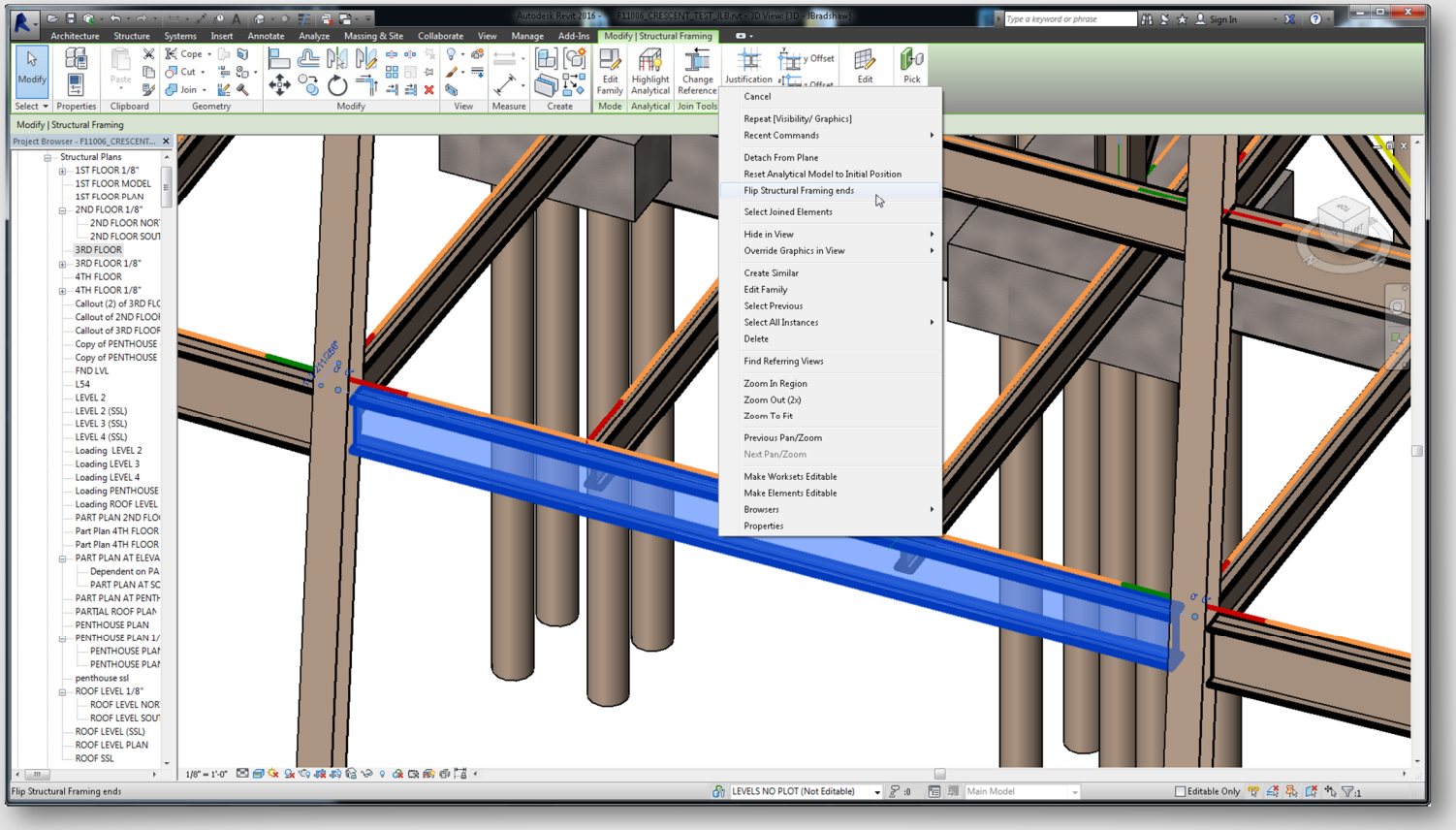
Consistent Modeling Direction







Consistent Modeling Direction



Design and Construction team communication

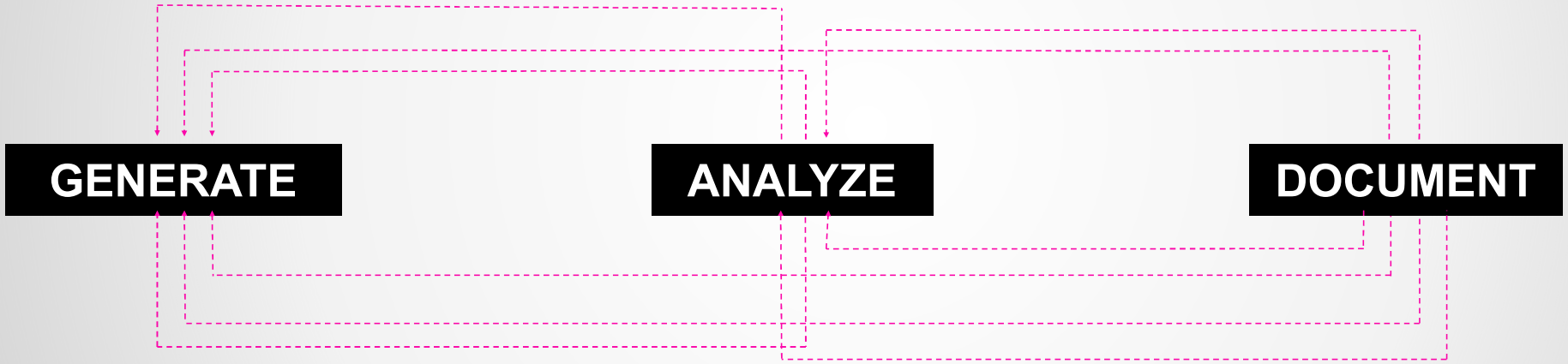
- Object ownership
- Status of objects
- In model comments
- Change management

Design and Construction team communication

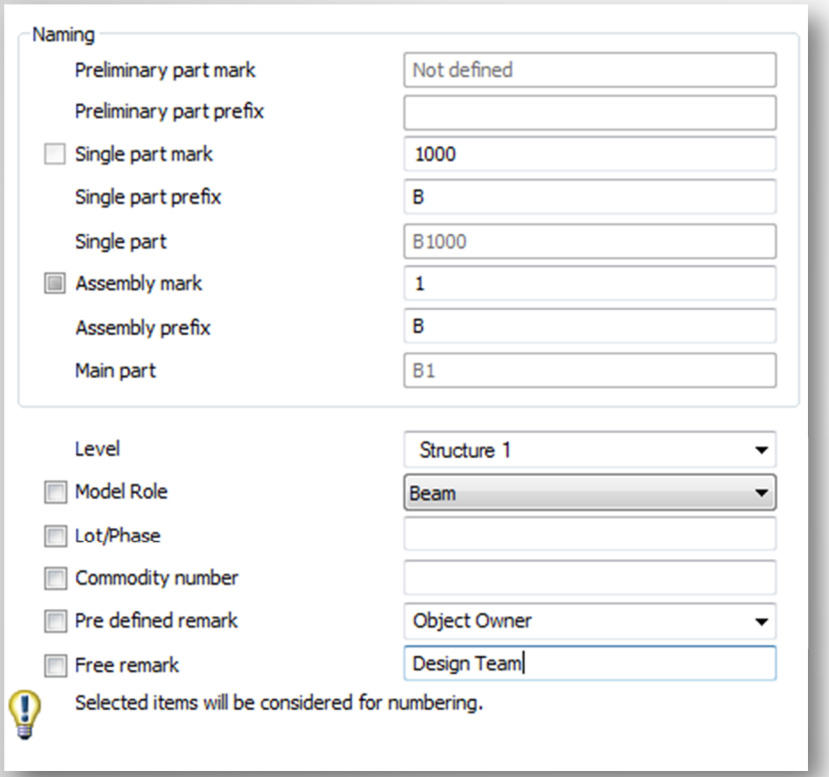
- Typical Workflow

Design and Construction team communication

- Typical Workflow

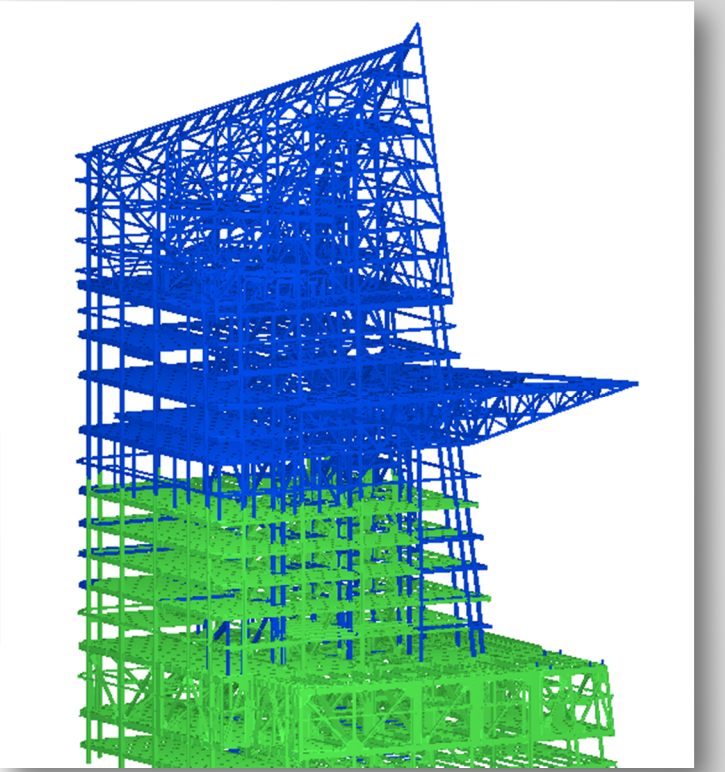


Object ownership

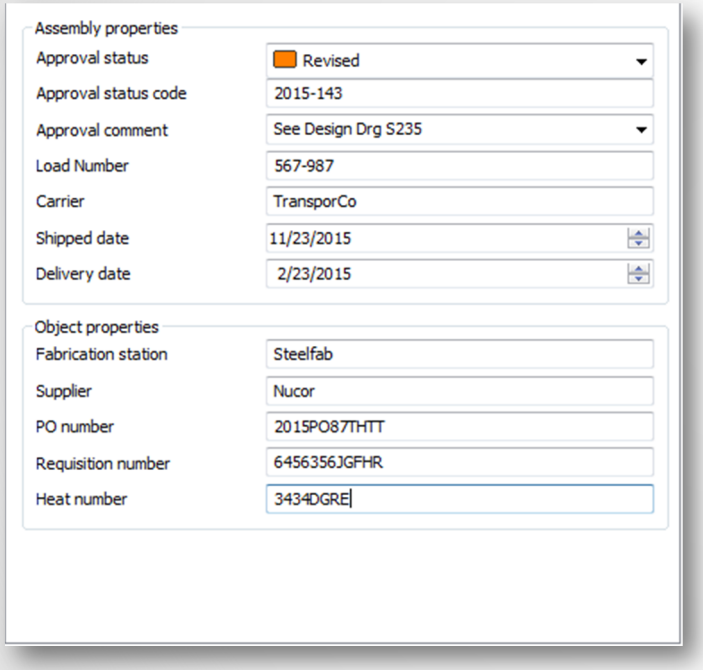


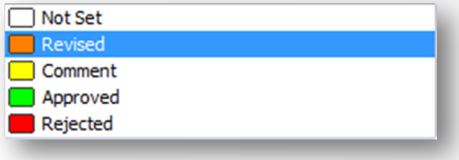
Design Team

Detailing Team



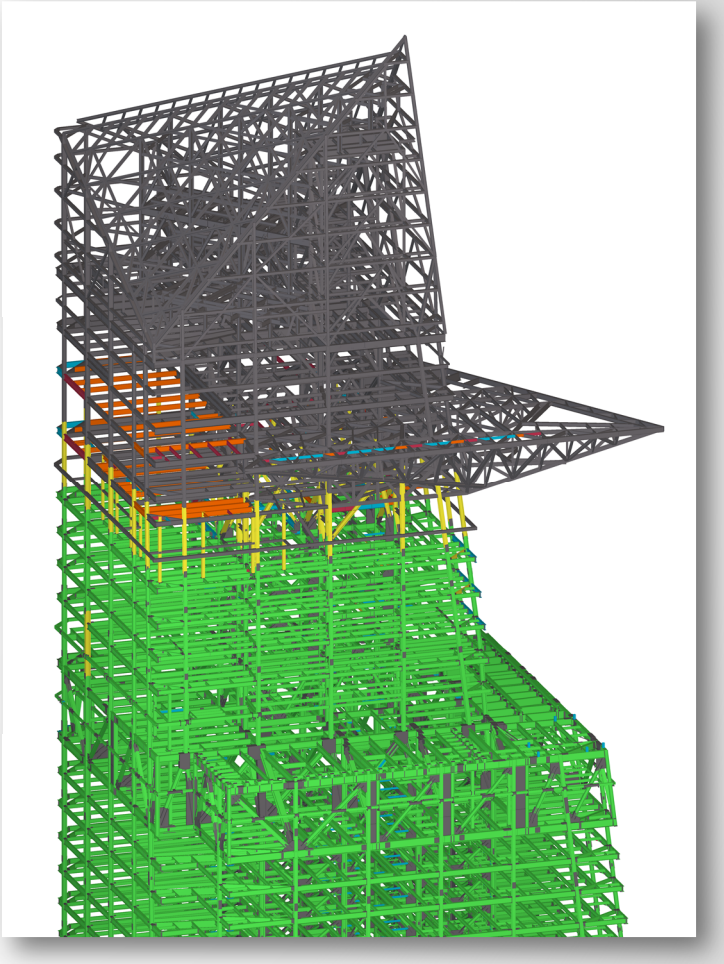
Object ownership





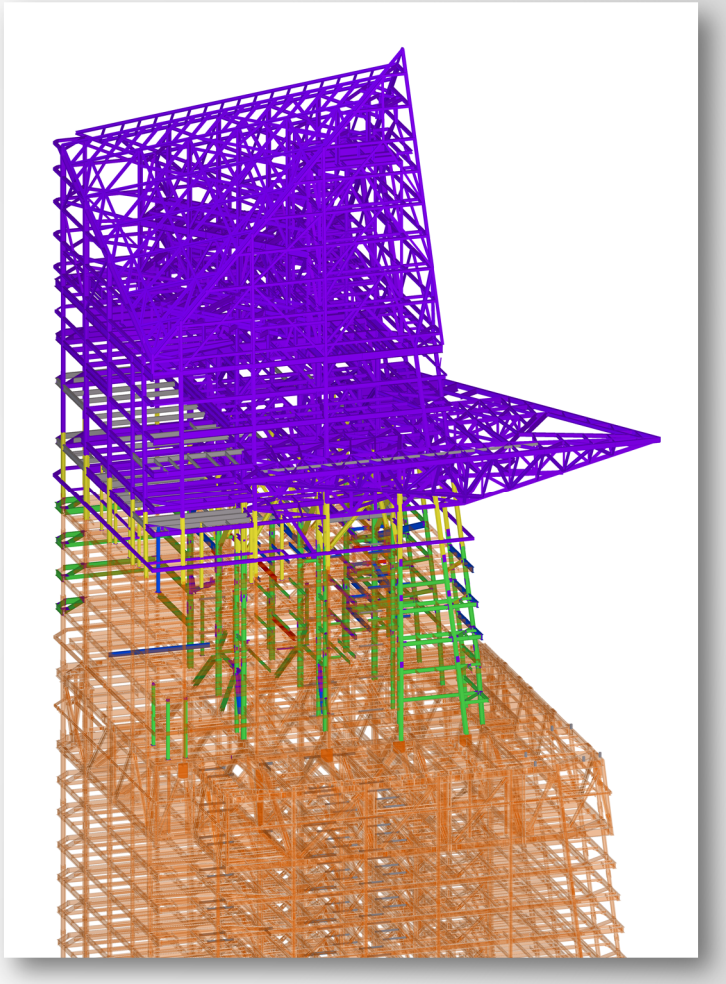
Status of objects

Object group	Color	Transparency
TTD_Both_Conn_Applied		Visible
TTD_End_Conn_Applied		Visible
TTD_Start_Conn_Applied		Visible
TTD_Both_Codes_AppId		Visible
TTD_End_Code_AppId		Visible
TTD_Start_Code_AppId		Visible
TTD_No_Codes_AppId		Visible
All	Color by class	Visible

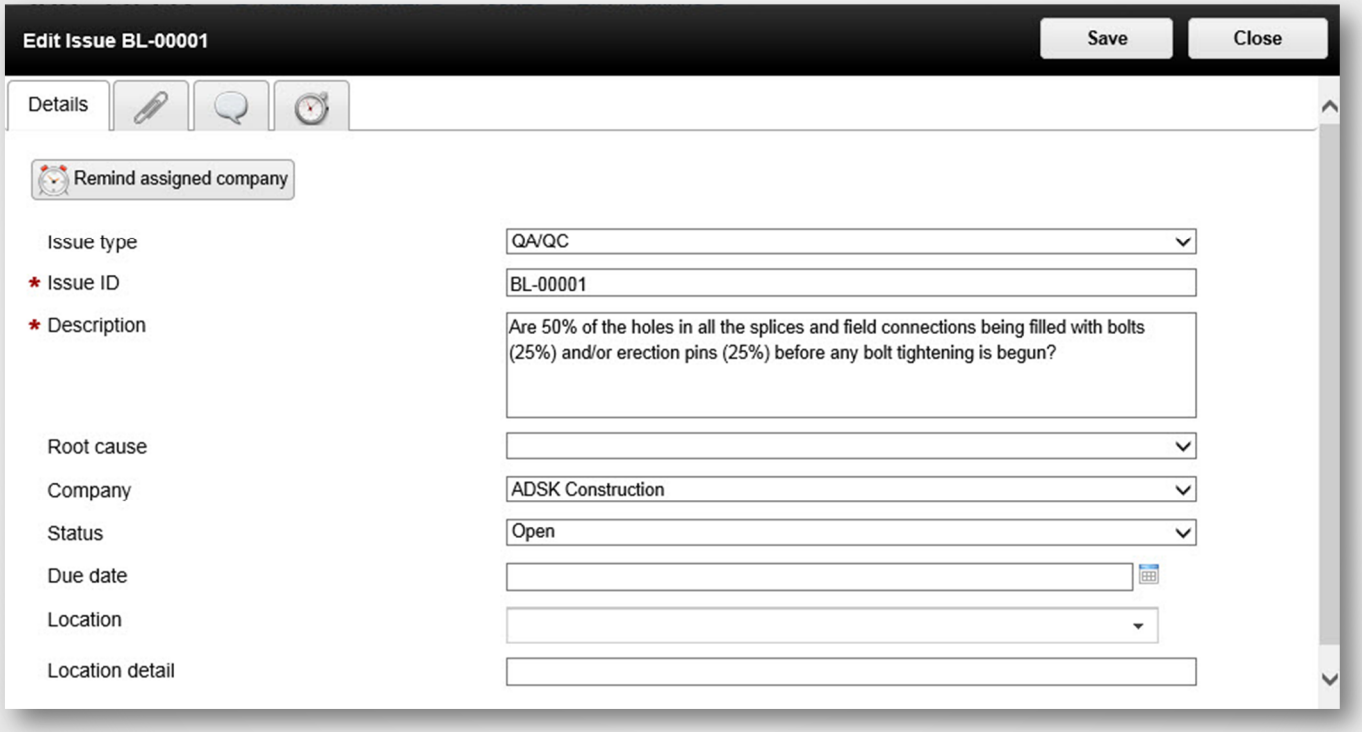


Status of objects

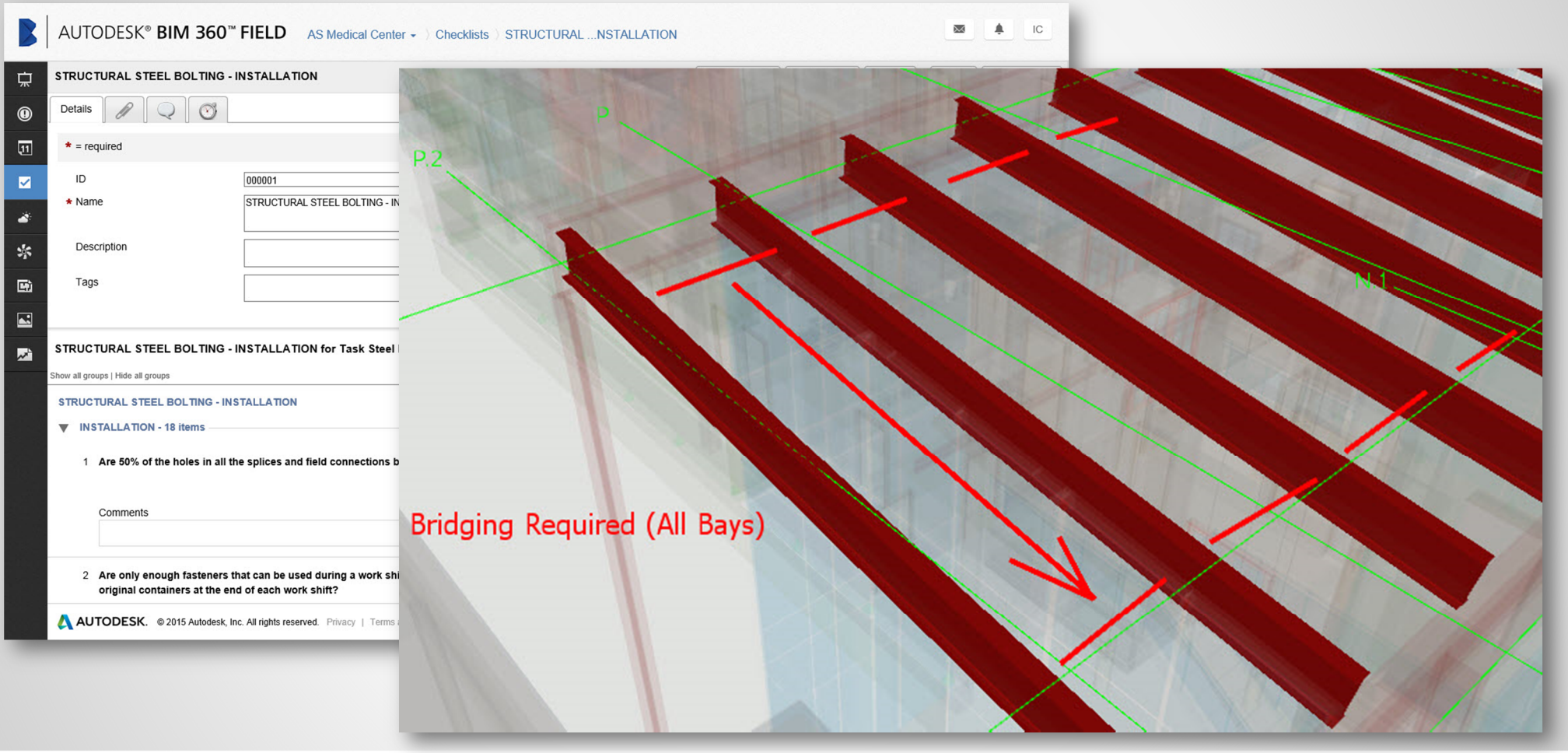
Object group	Color	Transparency
TTD_Revd_Adj_Reqd		Visible
TTD_Detailing_Ready		70% transparent
TTD_status_millorder_ready		70% transparent
TTD_status_review_required		Visible
TTD_Start_Conn_Applied		Visible
TTD_End_Conn_Applied		Visible
TTD_Both_Conn_Applied		Visible
TTD_No_Conn_Applied		Visible
TTD_Bolt_Small		Visible
TTD_Bolt_Large		Visible
All		Visible



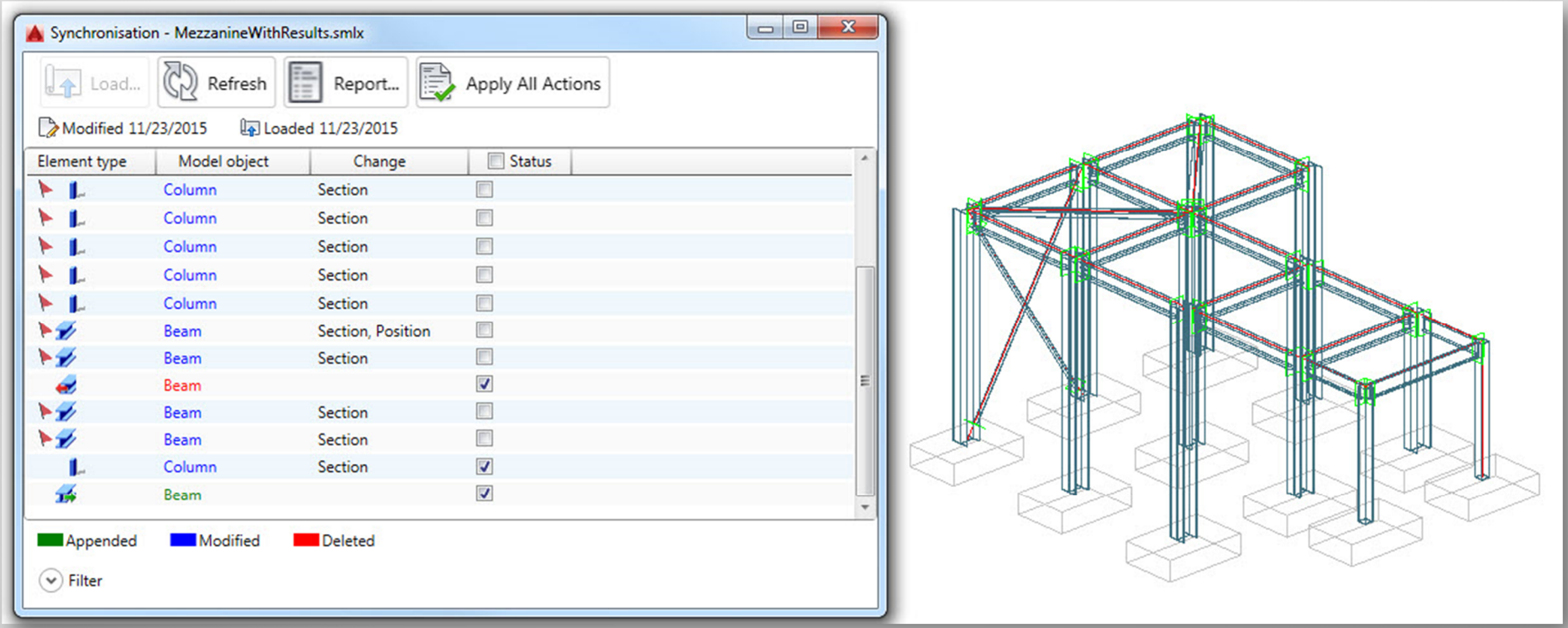
In model comments



In model comments



Change management

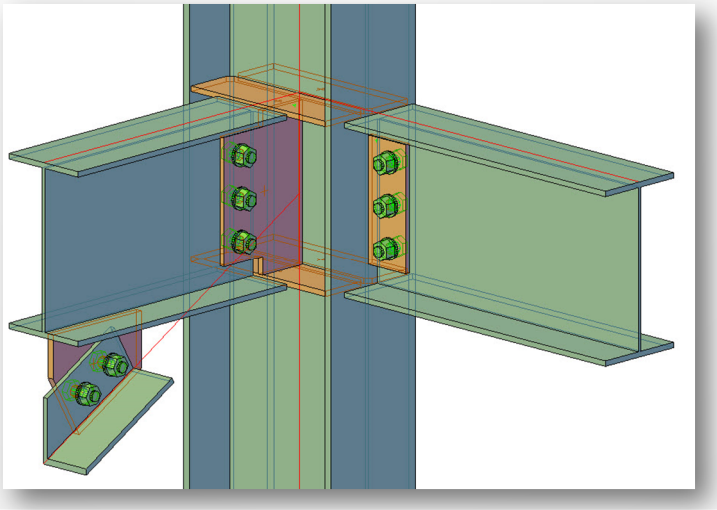


Strategies for Fabrication Friendly Models

- BIM Execution Plan/Scope - beyond standard design
- Project Trade Experts: staff or contracted

Scope - beyond standard design

- Connection Design
- Advance Bill of Materials (ABM)
- Full Connection Detailing
- Misc Steel, Shop Drawings & Erection Sheets



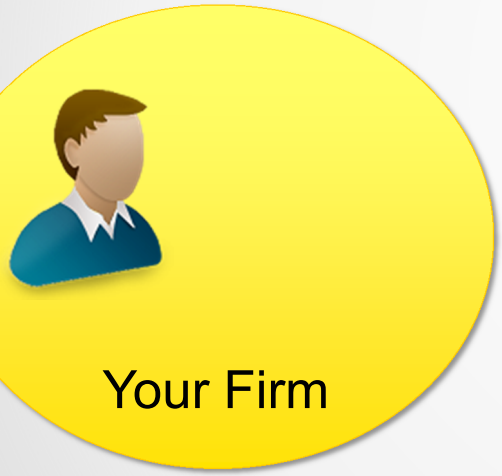
Scope - beyond standard design

Sheet Number (if applicable)	Detail Number (if applicable)	Description	Model Responsibility Matrix		
			TT	Fabricator	Comments
Phase I model scope					
		Geometrically accurate model	X		
		Accurate Member Sizes	X		
		Accurate Material designations	X		
		Contains CVN designations where required	X		
		Member provided workpoint to workpoint	X		
		Adding / Subtracting material	X	X	If connections have been started then material will be actual length. Else any material additions or subtractions for material cutting or skewed end conditions will be Fabricators responsibility to review
Phase II model scope					
Main Steel elements					
Sheet Number (if applicable)	Detail Number (if applicable)	Description	Model Responsibility Matrix		
			TT	Fabricator	Comments
		Main Structural Steel elements	X		Columns/Girders/Beams/Bracing/Frames/Built-up shapes/Girts/Trusses
		Web Penetrations	X	X	TT to model those shown on the structural drawings; All other openings (if any) by Fabricator
		Special Beam end copes	X	X	TT to model those shown on the structural drawings; All other copes non connection specific (if any) by Fabricator
		Minor / Misc Steel Members		X	Includes elevator divider beams, misc steel and any steel members not sized in the structural documents

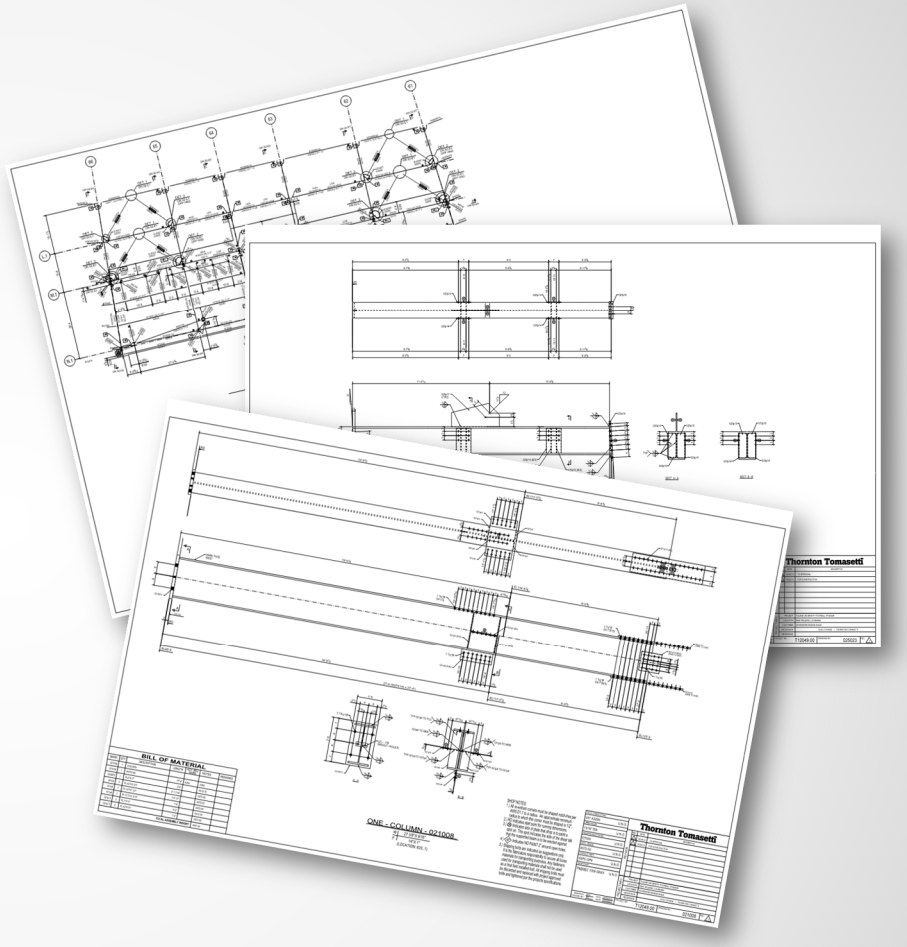
Scope - beyond standard design

Main Steel connections					
Sheet Number (if applicable)	Detail Number (if applicable)	Description	Model Responsibility Matrix		
			TT	Fabricator	Comments
		Steel Connection Material for Main Structural Steel	X		
		Copes required connecting members	X		
		Weld Sizes	X		
		Shop Weld Preps		X	
		Field Weld Preps		X	
		Field bolts	X		Tension controlled bolts. Diameters and grades as required per connection design. Fabricator will request substitution if needed due to availability or alternate tightening method.
		Shop bolts		X	All connection required bolts will be provided as field bolts
		Backing Bars		X	
		Surface preparations		X	
		Mill to bear surfaces		X	
		Column base plates	X		
		Anchor Bolts	X		
		Anchor Bolt templates		X	
		Fill plates	X		Any gaps greater than 1/16" will be filled with a single plate of the thickness equal to the gap
		Tight flange to flange plate connections/Web vertical	X		1/4" Deck plate provided at top & 1/4" Fill plate provided at bottom
		Tight flange to flange plate connections/Web horizontal	X		1/4" Fill plate provided on each flange

Project Trade Experts: staff or contracted?



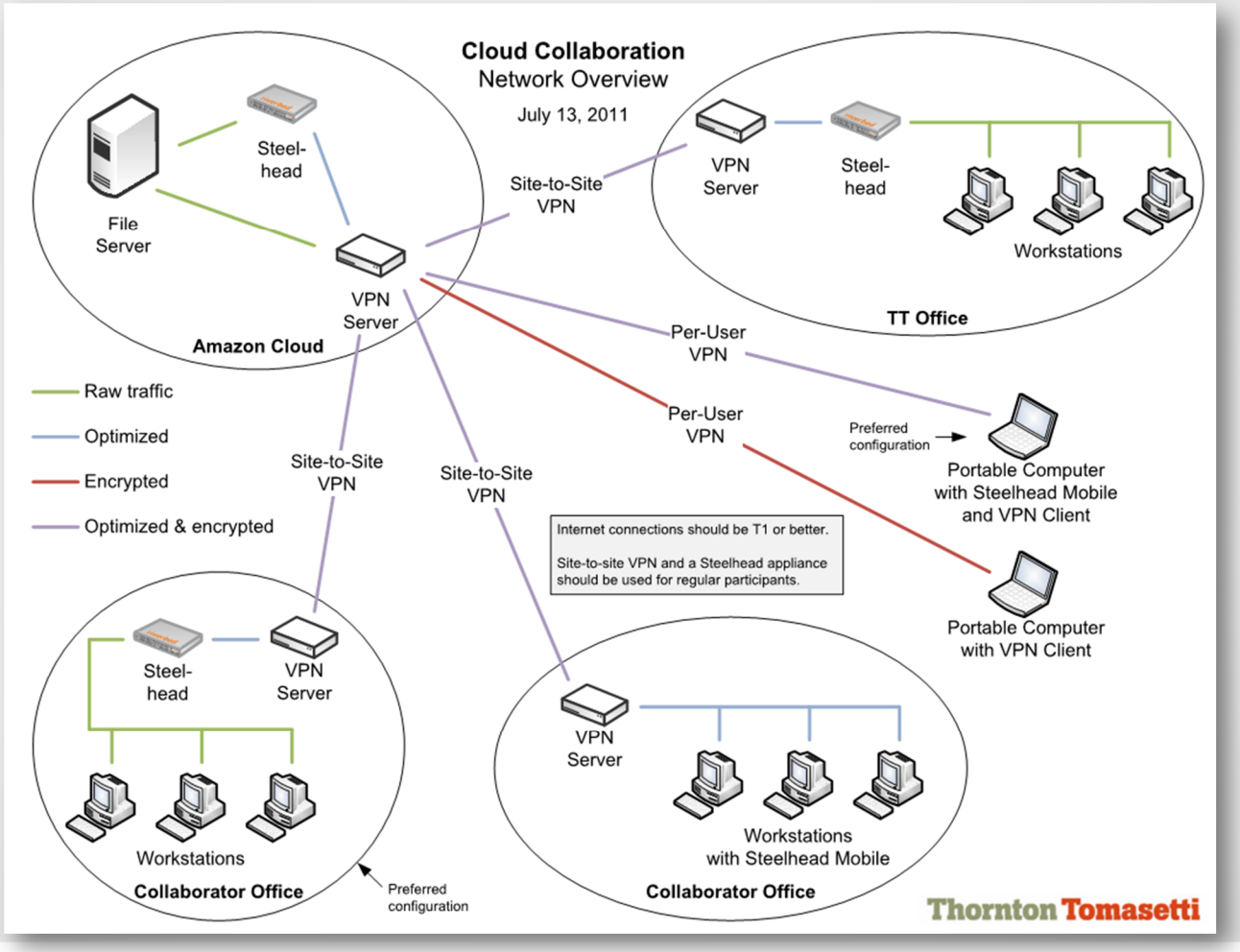
Detailer



Cloud Collaboration

- AWS/MS Azure/etc…
- Cloud NAS
- Platform Specific

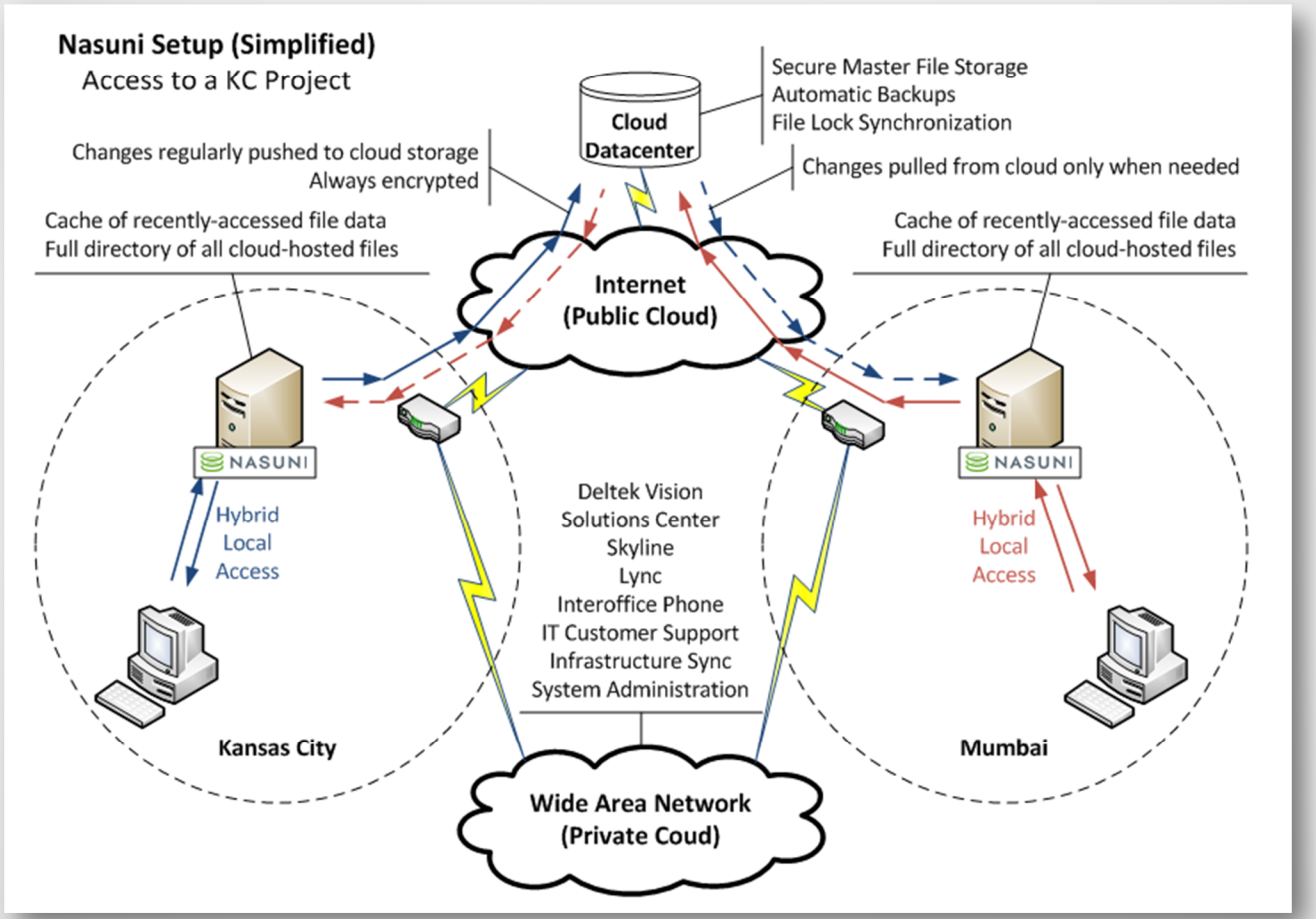
AWS/MS Azure/etc…



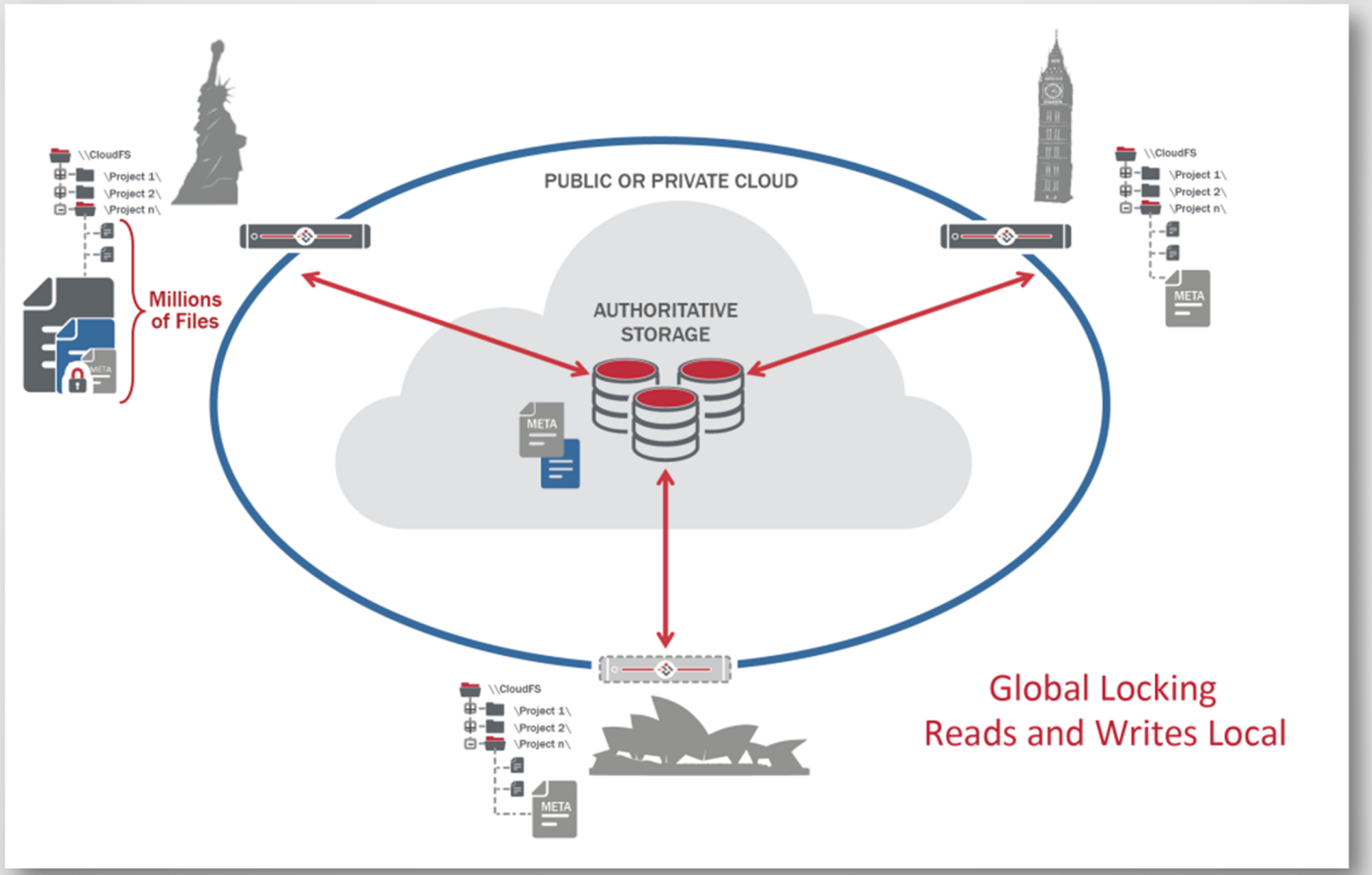
Cloud NAS

- Cloud synchronized NAS (Network-Attached Storage)
- Global File Locking
- Global Synchronization

Cloud NAS


Nasuni Setup (Simplified)
Access to a KC Project
Cloud Datacenter
Secure Master File Storage
Automatic Backups
File Lock Synchronization
Changes regularly pushed to cloud storage
Always encrypted
Changes pulled from cloud only when needed
Cache of recently-accessed file data
Full directory of all cloud-hosted files
Cache of recently-accessed file data
Full directory of all cloud-hosted files
Internet
(Public Cloud)
NASUNI
NASUNI
Hybrid
Local
Access
Hybrid
Local
Access
Deltek Vision
Solutions Center
Skyline
Lync
Interoffice Phone
IT Customer Support
Infrastructure Sync
System Administration
Kansas City
Mumbai
Wide Area Network
(Private Coud)

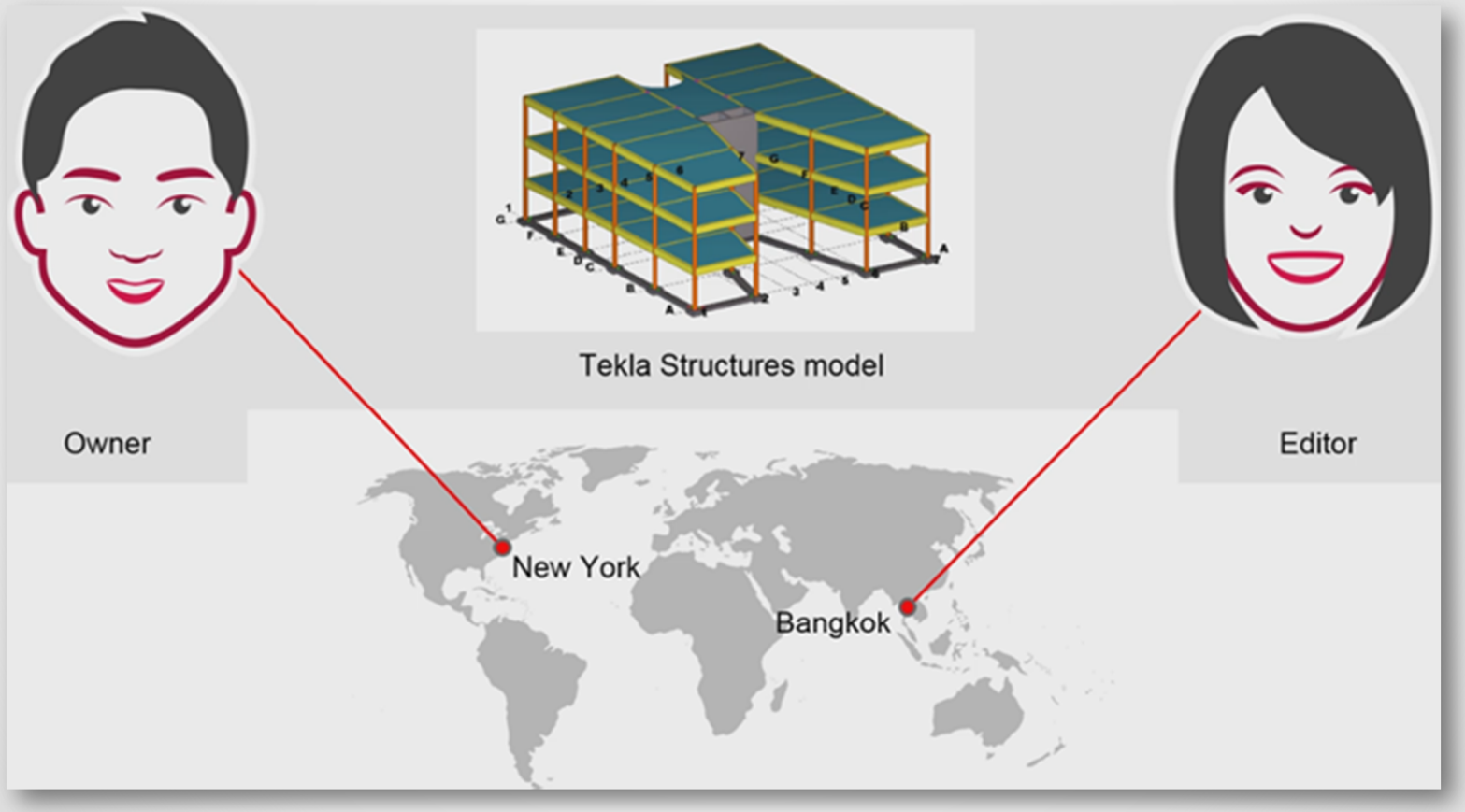
Cloud NAS


\\CloudFS
\Project 1\
\Project 2\
\Project n\
Millions of Files
META
PUBLIC OR PRIVATE CLOUD
AUTHORITATIVE STORAGE
META
\\CloudFS
\Project 1\
\Project 2\
\Project n\
META
\\CloudFS
\Project 1\
\Project 2\
\Project n\
META
Global Locking
Reads and Writes Local

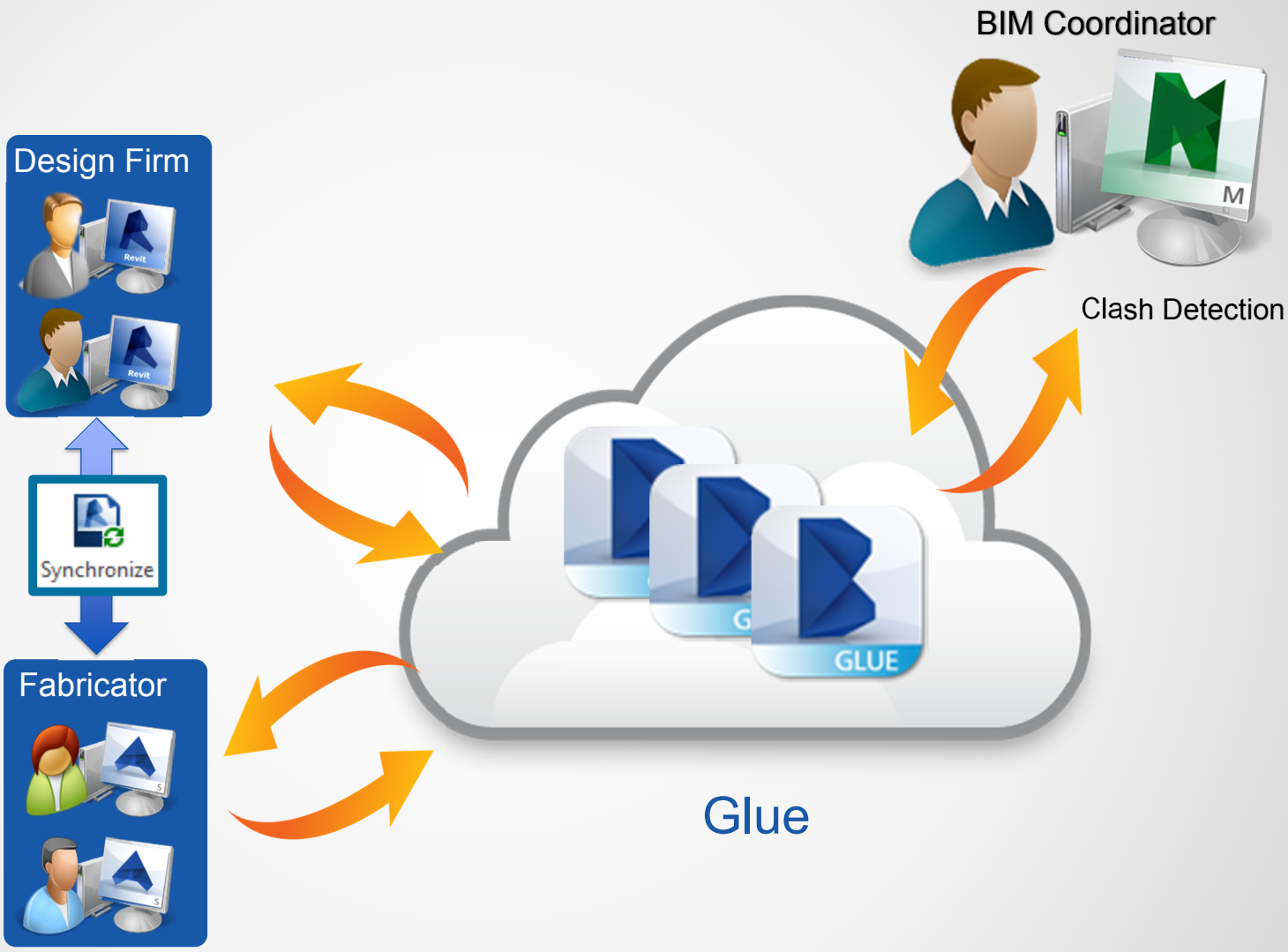
Platform Specific

- Tekla Model Sharing
- BIM 360

Tekla Model Sharing



BIM 360


BIM Coordinator
Design Firm
Revit
Revit
Clash Detection
Synchronize
Fabricator
G
GLUE
Glue

CONTRACTORS POINT OF VIEW

David Merrifield

VP Operations, SteelFab Texas

Relationships and Collaboration key to Success

FIRST BAPTIST CHURCH DALLAS, TEXAS

DFW AIRPORT TERMINAL D

AIRBUS A-380 FIRE TRAINER

GATEWAY CHURCH – SOUTHLAKE, TEXAS

SMU DINING HALL – DALLAS, TEXAS

HUNT OIL CORPORATE HEADQUARTERS – DALLAS, TEXAS

ST PAUL ST

MEDICAL EDUCATION TRAINING CAMPUS - METC – FORT SAM HOUSTON TX

TEXAS HEALTH HARRIS HOSPITAL – FORT WORTH

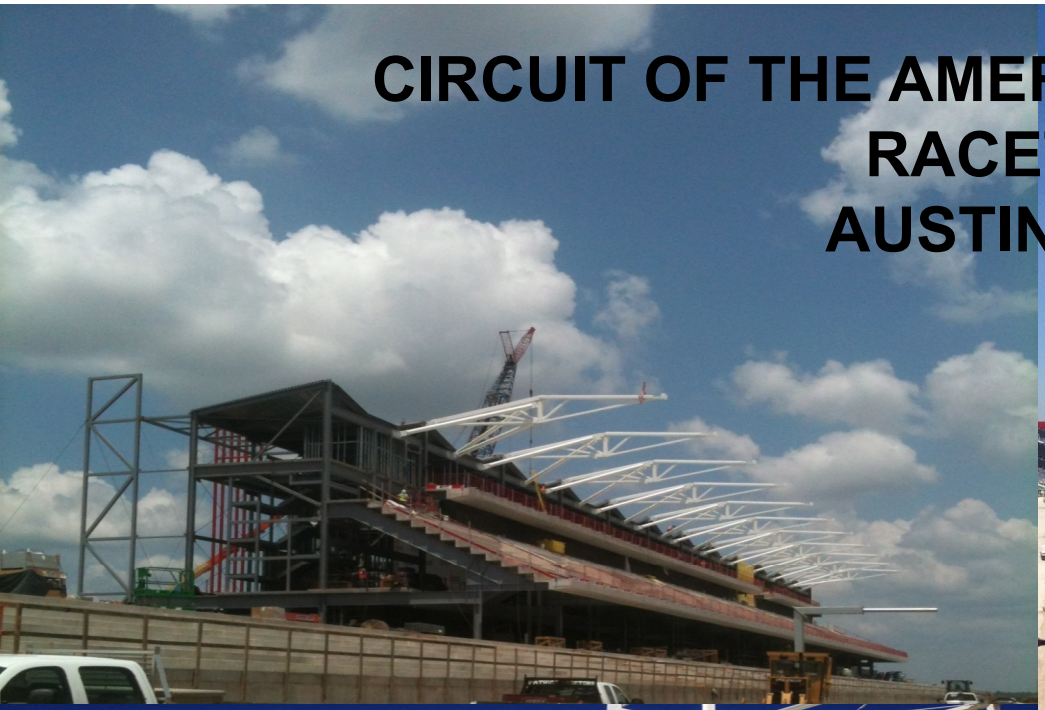
BECK

Texas Health Harris Methodist
Alliance Hospital

Print #110824797
Date: 08/24/11
Lat/Lon: 32.931092 -97.309242

Aerial Photography, Inc. 954-568-0484

CIRCUIT OF THE AMERICAS – FORMULA ONE RACETRACK
AUSTIN, TEXAS



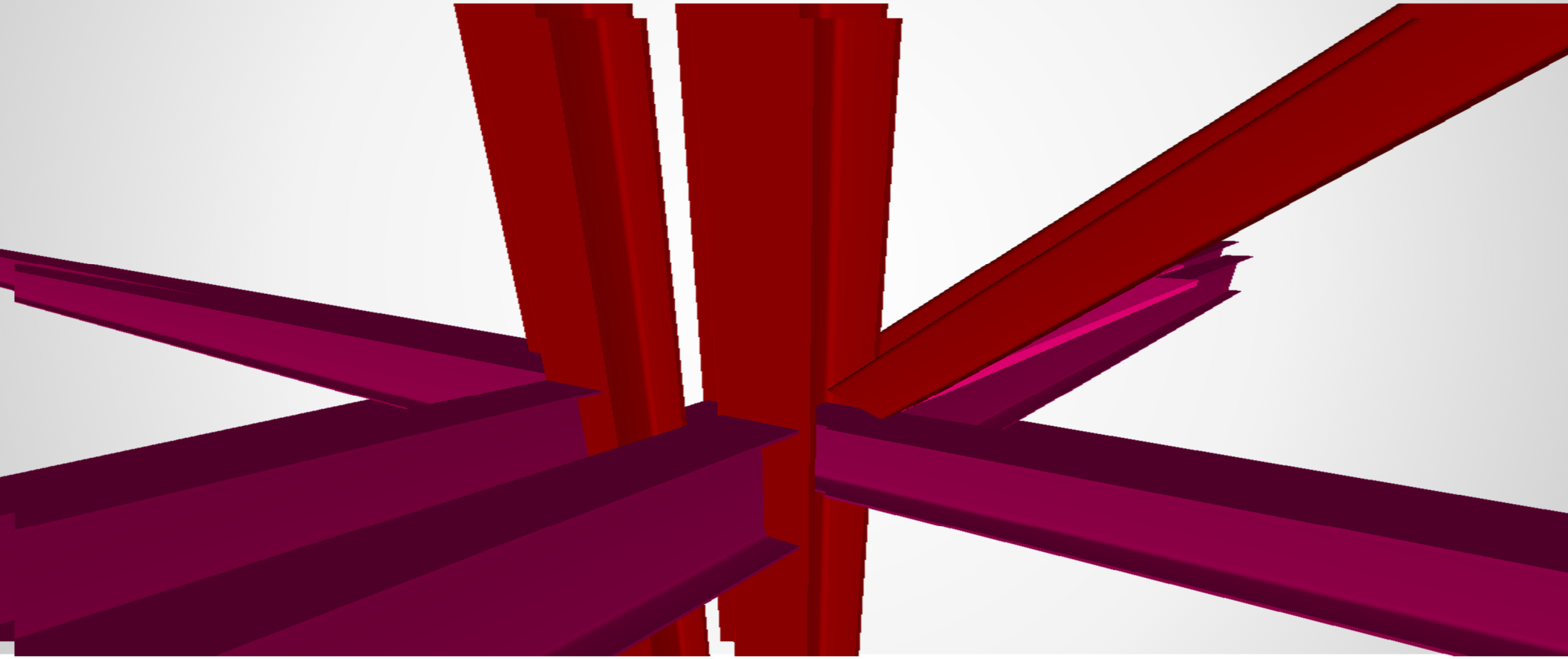
Design Model versus Fabrication Model

- **Main members – Do they meet the definition of LOD 300**

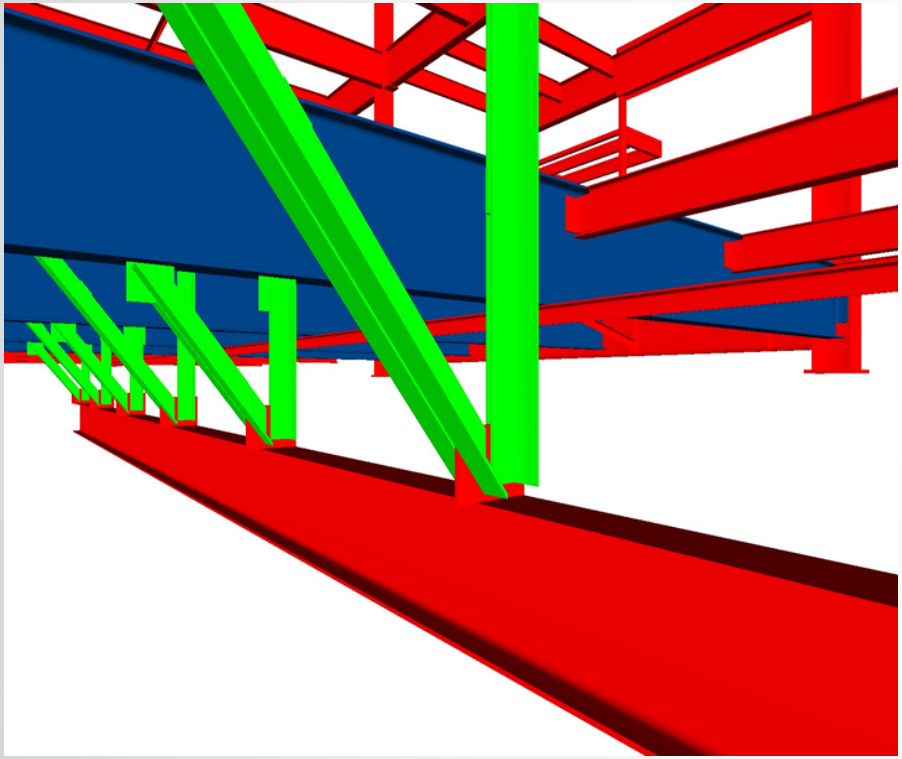
- *The Model Element is graphically represented within the Model as a specific system, object or assembly in terms of quantity, size, shape, location, and orientation. Non-graphic information may also be attached to the Model Element.*

- Bimforum interpretation: The quantity, size, shape, location, and orientation of the element as designed can be measured directly from the model without referring to non-modeled information such as notes or dimension call-outs. (From LOD Specification)

Level 300 Elements easily transferred to Fabrication Level software.



Secondary Steel Members
Treated as Generic Sections or LOD 300 Elements



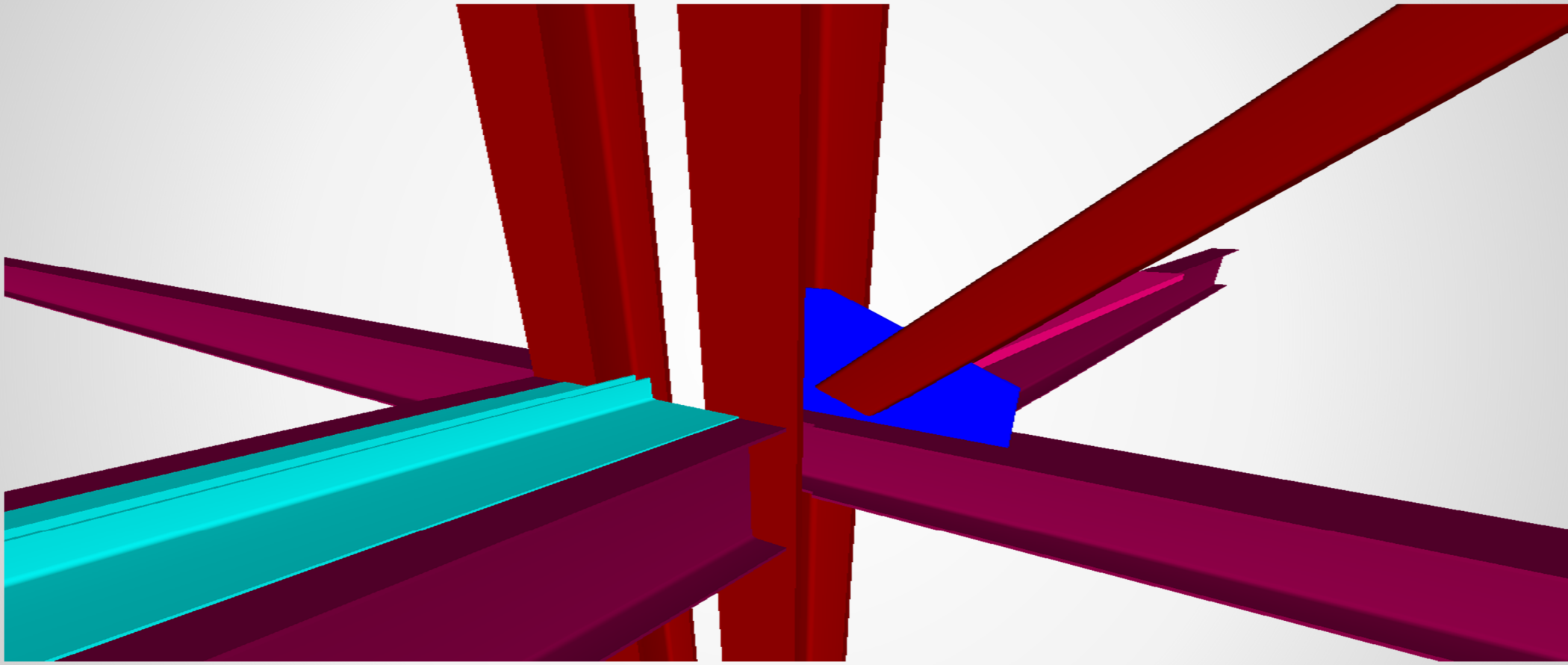
Items such as suspended supports, kickers, deck edge, brick and stone support, etc. require coordination with other trades and need to be properly located. The most expensive material per pound is not modeled as but usually treated “Typical” in design models!

Trade Coordination or LOD 350 (1st Fabrication level)

- *The Model Element is graphically represented within the Model as a specific system, object, or assembly in terms of quantity, size, shape, location, orientation, and interfaces with other building systems. Non-graphic information may also be attached to the Model Element.*

- BIMForum interpretation. Parts necessary for coordination of the element with nearby or attached elements are modeled. These parts will include such items as supports and connections.
- (From LOD Specification)

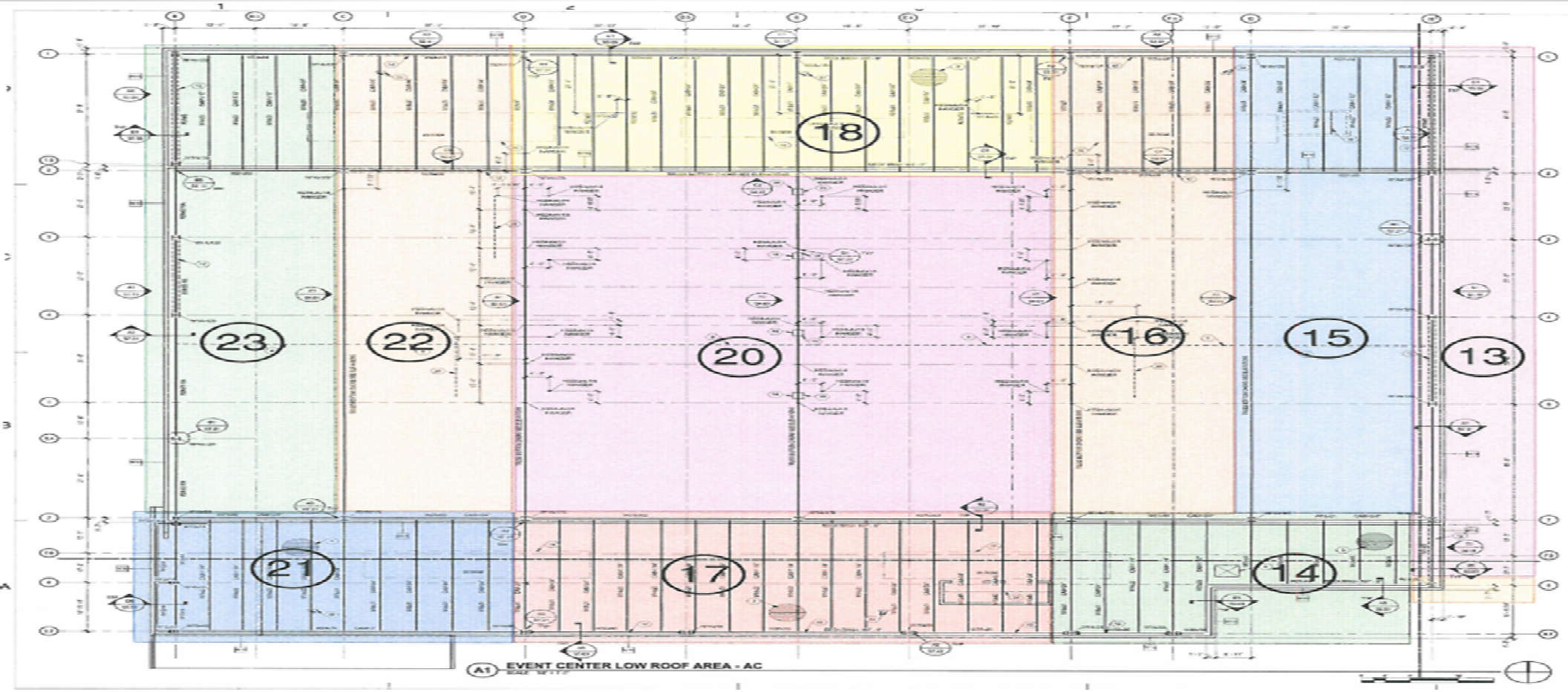
LEVEL 350 MODEL – TRADE COORDINATION



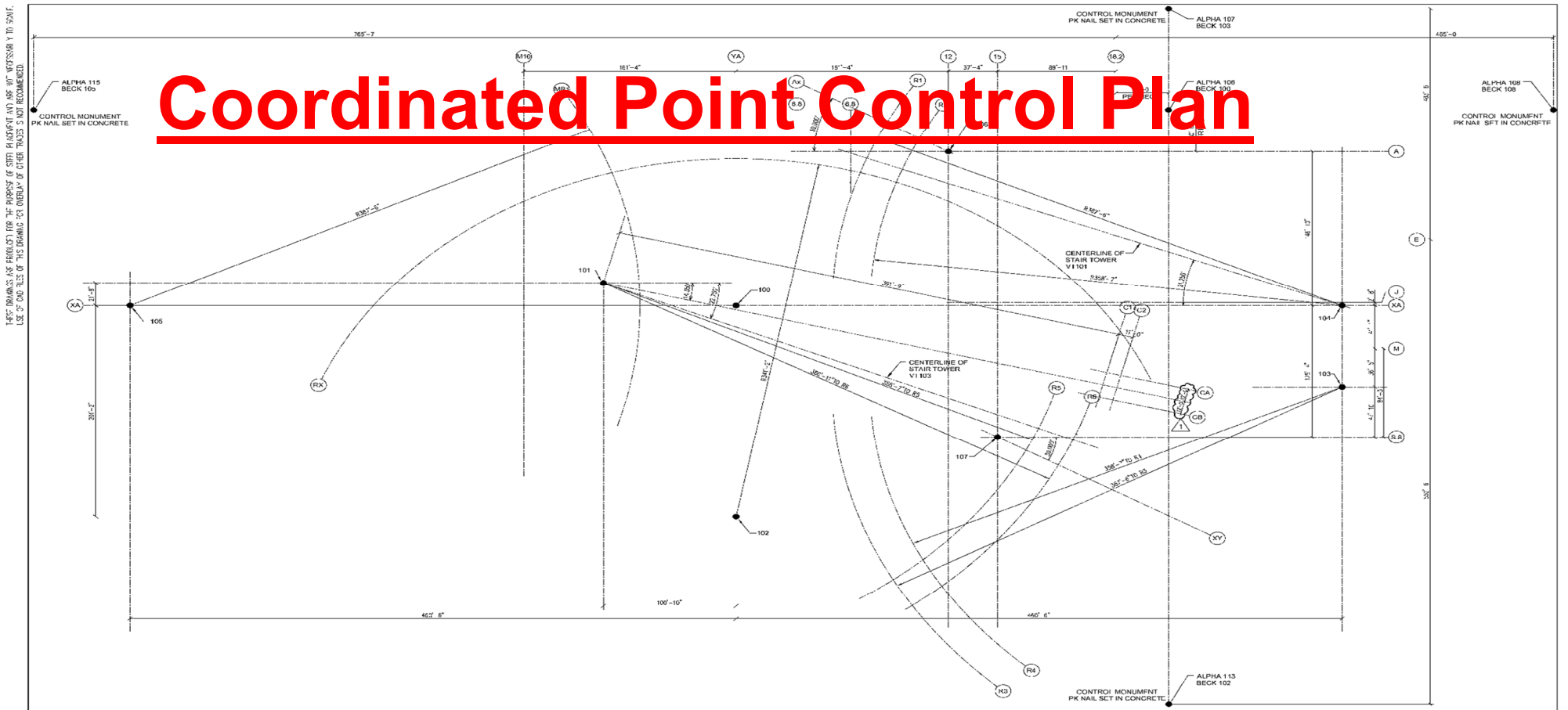
ADVANCE BILL OF MATERIAL

- The reason Fabricators hit the ground running after being notified of successful bid.
- Material is approximately 60% of fabrication cost.
- Some members have long lead times or a rolling was missed.
- Key to fabrication planning and routing.

Fabrication and Erection Sequences-Why not the complete building?



Coordinated Point Control Plan



THESE DRAWINGS ARE PRODUCED FOR THE PURPOSE OF SITE PLACEMENT AND ARE NOT NECESSARILY TO SCALE.
USE OF CAD FILES OF THIS DRAWING FOR OVERLAY OF OTHER PLANS IS NOT RECOMMENDED

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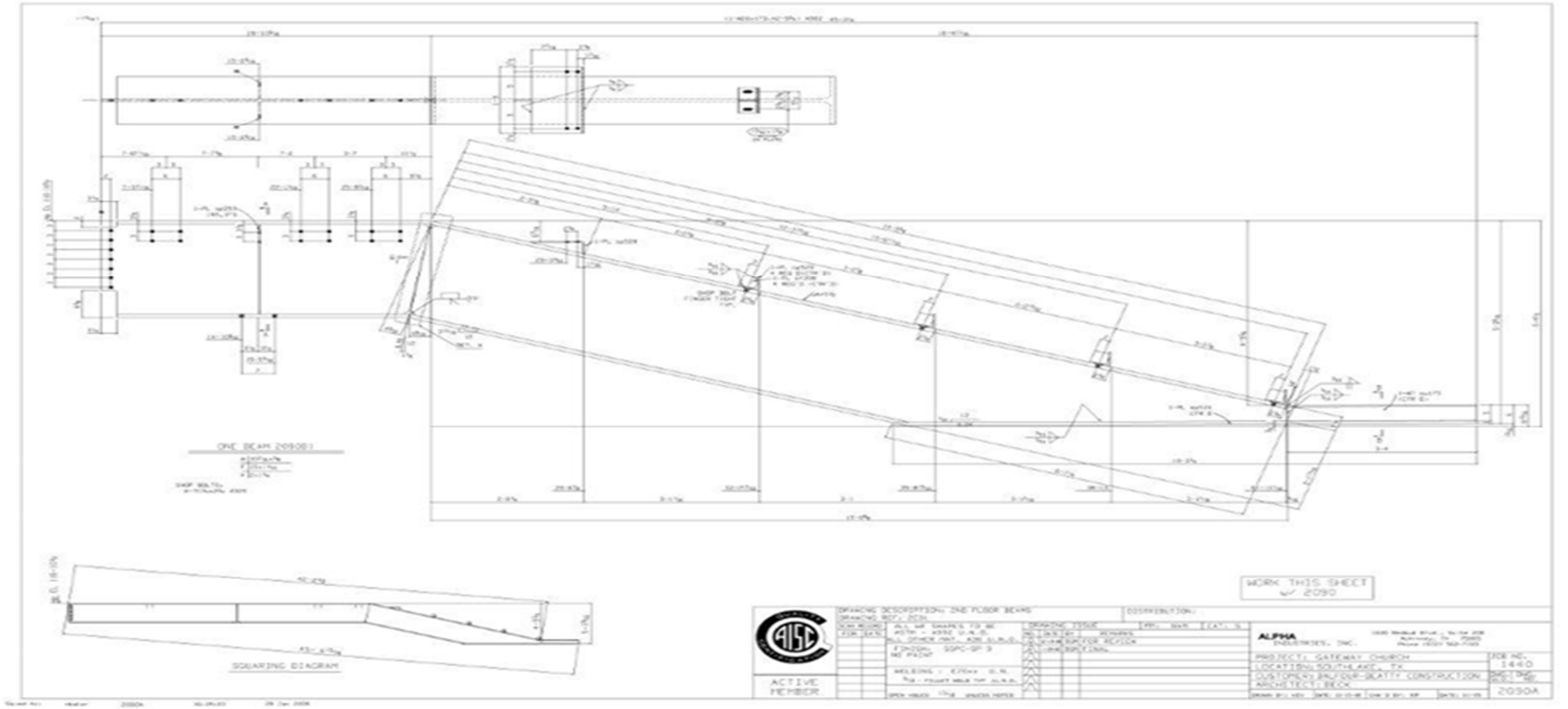
SHOP DRAWING QUALITY



How is quality defined?

Quote from ANSI/AISC 360-10. Chapter "N" "Quality Control and Quality Assurance"

N.5.1 "For QC inspection, the applicable construction documents are the shop drawings and the erection drawings and the applicable referenced specifications, codes and standards."

5 Points Within the Detailing operations

Quality in production

Both the model and the "paper" reflect job and fabricator requirements

Quality in check

Both the model and the "paper" conform to design and fabrication standards

Quality Control

Are procedures in place to ensure the outcome are predicable

Quality Management

Do the system and procedures of the organization reflect management's commitment to maintain and improve quality

Quality Assurance

Do your clients have confidence that your quality meets their quality goals

Who is responsible for the quality of the shop and erection drawings?

Ultimately the responsibility for quality falls to whoever holds the “contract”. The fabricator is generally that responsible party. The selection of a detailer by a fabricator should be based on “his” quality control manual.

Why Fabricators need a standard presentation

Communication from the model to other programs Within the organization require a standard language to communicate. Fabricators define piece marking system based on how purchasing/ production control and the shop floor have defined elements . (Bar versus Flats or Plate)

The same organization on drawings prevents errors on the shop floor. (members marks or weld symbols always in the same relative position)

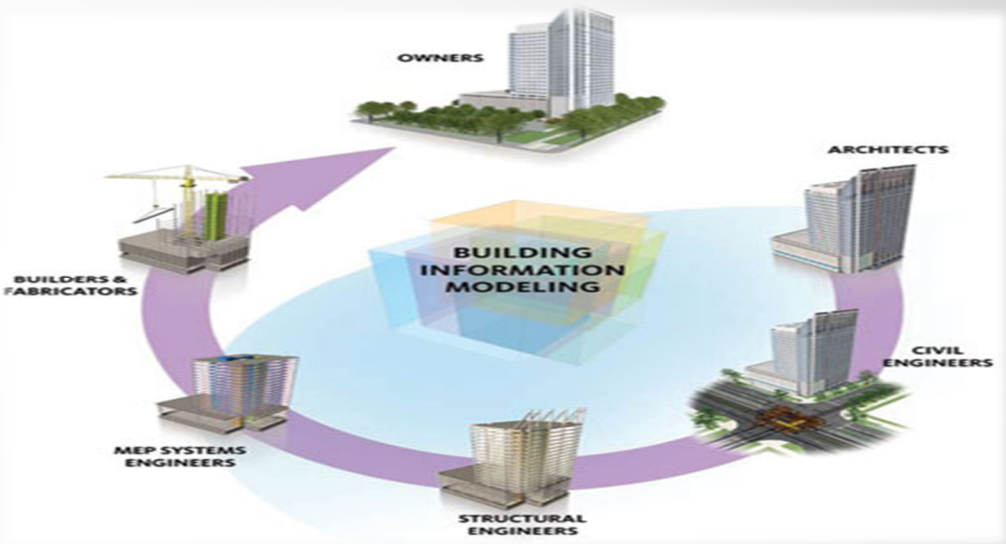
The role of Detailers/Modelers in todays work flow

- Shop Drawings are the Contractors Achilles heel.
- Detailer/modelers are the translators of design ideas into fabrication elements (thoughts into reality)
- Most Fabricators sub-contract the Modeling/shop drawings process.
- Most sub-contract firms are not local to the project.

HOW DO YOU DEFINE DETAILERS/MODELERS

- Design
- Fabricate
- Build
- Operate

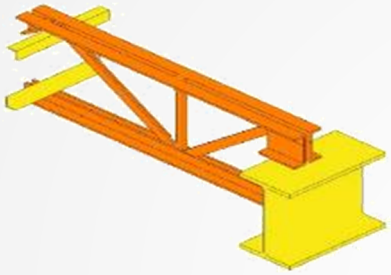
- **Modelers/Detailers are at all stages of projects.**



Trade Detailers/Modelers

STEEL STRUCTURE

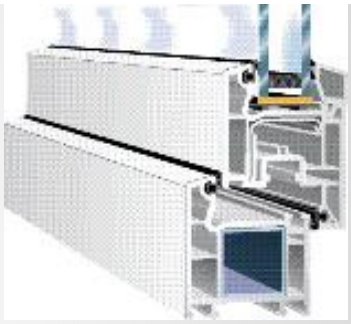
STEEL JOIST



BUILDING PC

MASONRY

CURTAIN WALL



REBAR

ELECTRICAL

MECHANICAL

HVAC

PLUMBING

BIM for the Modeler Masses

The whole team needs to know modelers/detailer have training with:

1) BIM Fundamentals
2) Understand BIMXP Requirements
3) File Sharing Concepts
4) Time sensitive submittals

Solution: CD-BIM

Certificate of Detailing in BIM

1)Free Training Content

2)Basics of BIM for Modelers

3)Simple Online 1 hr Exam
for a nominal fee

CD-BIM FAQs

CD-BIM National Institute of Steel Detailing

Certificate of Detailing
in Building Information Modeling
CD-BIM Part 2 : Structural Steel

John Doe Detailer

Has met the requirements of the CD-BIM program for part 2 Discipline Specific Structural Steel.

Helen Walker Sherd — Dec. 1, 2015 | #xxxxxxx

- Introduced at the Fall BIMForum in October. Developed with BIMFORUM, AUTODESK and NISD.
- Free Online Training Content
- Assessment to validate training
- Targeted at beginning and experienced BIM team members
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