

Narrative for the 2014 AIA BIM TAP: Submission Category G Outpatient Care Pavilion

Owner's Team

- Pat Newman- *Director of Construction*- (key decision maker)
- James Mladucky- *Director, Facility and Construction* (decision maker, value judge)
- Ken Kaiser – *Manager, Facility Renovations* (FM integration director)
- Shrimant Jaruhar – *Project Manager (BIM) Facility Planning and Construction* (FM Implementation specialist for campus)

Design Team

- Randy Guillot – *Lead Designer* (BIM integration with Design)
- Michael Yoshimura – *Project Manager* (Value provider leading all things BIM for design)
- James Skalla – *Project Architect* (led team with coordination of models coordination)
- Rand Ekman & Marya Graff – *LEED consultant* (BIM LEED point champion)
- Sarah Plum – *Architect BIM Manager* (Supervised set up of all model insertions and led design model execution)
- Silviu Petrea- *Architect BIM Manager* (Supervised modeling for Mechanical, Electrical, plumbing and fire protection design models and coordination)

Construction Team

- James Harding – *Executive in charge* (Value judge for technology and championed procurement implementation and use of technology)
- Eric Engstrom – *Senior Project Manager* (managed structural model contracts; execution)
- Arelias Matias – *Project Manager* (managed MEP trade coordination and execution)
- Andy Gush- *Project Manager* (managed Enclosure coordination and execution)
- Curtis Brown- *Senior Structural Superintendent* (struct and ERS model review, field Supt)
- Bill Boscelli- *Senior MEP Superintendent* (Field model sequencing and execution)
- John Jurewicz – *Senior BIM Integration Manager* (Technology setup, implementation, BEP)
- Christian Torres – *Senior BIM Model Coordinator* (GAP model support, tech go to, ID tagging)
- Kevin Bredeson- *Director of Virtual Construction* (Tenant Model support and Lead)
- Paul Berko- *VDC support for tenant build out* (GAP and conversion support)

Work-flows and Data exchanges

To realize the ambitious goals outlined in the initial execution plan, Building Information modeling was deployed for the coordination of contract documents a year before the project contracts for the new building were even awarded. In the interview process, construction simulations of the site logistics were undertaken even before they were allowed to interact with the design team. The simulations were refined as the actual schedule evolved and the design was developed; exploring options and verifying the clearances needed between structure and the temporary works, such as bracing and crane placements. Site orientation, energy modeling, and concept massing were all achieved in a smart design modeling process that involved a fluid process of working with models designers and consultants. The design ideas were totally conceived in a modeling environment. In the beginning stages of the design process, no designer wants to have limitations. Of course, with the restrictions of project costs, site limitations, energy consumption and our client's desired design esthetics; Architects are restricted before the design process begins. BIM enables us to take all the restrictions within the design of a building and measure them in a very calculated and time efficient

way. Multiple design options were undertaken early in the project in order to do quick take-offs to determine which design option meets the required fenestration ratio for energy loss. This allows us to pick the most efficient design option and maintains that Revit schedule as a live working document in our project; we can always back check our findings in case there is a design change. We input the filtering once and that filter is maintained & live throughout the project's history. In our project we had about six different glazing types, with Revit we were able to color code, schedule and identify those glazing types quickly, which is essential in a one million square foot building.

Project Scope:

- 990,000 SF Mixed use Medical office space, examination rooms and suites, 21 ambulatory surgery rooms and advanced Diagnostics and Treatment. With a 575 car parking garage that connected to the a neighboring parking garage on the South via pedestrian bridge with a second bridge and tunnel connecting to the existing Feinberg Hospital Facility.
- 25 story structure that was increased a floor to 26 stories to increase neighborhood parking, note this change was issued late in the construction document phase utilizing BIM
- \$334 Million Construction Budget, 30 Month Schedule
- Registered for LEED-certified (pending)

BIM was used as a new method of designing and visualizing the work. Design problems such as the rearranging of mechanical components and structure, were changed early on with the team during review and this just wouldn't have been possible with conventional two dimensional AutoCAD. Solving issues between the design architect and the project architects were more easily achieved in reviewing them in BIM with no explanations needed; these issues are put into plan, section and elevation with 3 clicks of the mouse. This client has taken full advantage of the BIM process, embracing it and requiring the colocation of the design team and the construction team in a single office and customized a technology room on the eighth floor of a neighboring building overlooking the site. Building Users & Facility Managers, regularly reviewed the models in this virtual lab. Our client built a BIM room on their campus which overlooks the building site. Within this BIM room we have collaborated with doctors, nurses, facilities, consultants, architects, contractors and project managers; we communicate on 2 large smart boards viewing the Revit models and Navisworks. We have used the Revit model's medical equipment families that have embedded smart links to the internet showing the medical equipment images and specifications, which allows for quicker User sign-off of specifications and locations. We used Revit and Navisworks to do fly-throughs of clinic spaces; as a tool for nurses to determine their work flows in their new spaces. We utilized the smart boards in the clients Tech room to diagram multiple work flows and patient flows; these processes can become increasingly complicated as clinic spaces can have multiple functions including: X-ray, blood draw, procedure, changing rooms, check-in/out, waiting/sub-waiting and exam rooms. This process became crucial not only for design, but for the hospital Doctors to determine best practices. We didn't just make engineering and architecture more integrated; it actually improved the building's end users' productivity through simulation of real-life work flows before it's even built.

The Benefits achieved

Developing Processes that re used the data with the following benefits:

- As built measurements pushed back into the model – For caisson centers, Bracing locations, whalers, catch basin locations and column centerline verifications. This helped the detailing efforts with a more true indication of what was happening in the field.
- Owner Benefits – Early review of design with the department heads and facilities and early tagging listing of all major serviceable equipment helped to lead the process of refining data.
- Life Cycle Improvement – Constant studies were made during the equipment selection, for access for servicing, life cycle studies compared to service life costs, through interaction of the Mechanical engineers and the contractors making equipment purchases.
- Business Factors – Although we do have stats, like the fact that 15,575 conflicts were resolved with the design even before the design models began the detailing process, through a cloud based portal solutionⁱ, the real story was catching things so early we didn't even bother to price then the original way. Like re orientating the steel trusses on the 10th floor that transferred column loads, to make it easier to set and access the primary air handling systems.
- Stretching the building – An entire floor was added the Construction Document model evolution, as an outcome of a neighborhood review meeting that sought more parking.
- Collaboration Requirement – Tablet technology was deployed to verify and study installation sequencing. Senior Supt. Bill Boscelli saw this as a cultural change for our industry. "After I took my first tablet in the field and could see what was happening before it happened, it really struck me how powerful all this (technology) really is."
- Bridge and Tunnel sequence installations After studying the assemblies, numerous changes were made to anticipate the emergency exiting needs of the neighboring buildings as well as proper fit up and erection of the structure and enclosure systems. Saving time and costs documented on average of 5% for each trade but more value was gained earlier with crane placement and Earth retention system site logistics.

The non-tech stuff

This was a new way of working for many of the team members. It required an open way of thinking; A blurring of roles, being flexible toward change. It involved the field supervisors working directly with the design team to suggest and work out issues, utilizing visualizations to pre plan, but at the same time, owner representatives were challenged to verify if the program was correct. An example of this was the situation with the engine generators. When reviewing the design model, the owner expressed concerns with the location of the engine generator radiation exhaust the heat was a problem for the people working in this area.

Technology & Innovation Implementations

- ___ Scenario-based Project Planning
- ___ Automated Design through model generations
- ___ Integrated, Consultant models copying elements
- ___ Intelligent schedules and ID tagging
- ___ Intelligent trenching of underground work (scans and hydro excavation as model underlays)
- ___ Facility Mgmt., Coordination review
- ___ Virtual OR mockup; review by users

___ Technology room overlooked job

ⁱ Original BETA test of Horizontal Glue before the Autodesk acquisition.



AIA TAP AWARDS
OUTPATIENT CARE PAVILION

2014
CHICAGO, IL



Building Information modeling for the Outpatient Care Pavilion is a tool for many: the owner, the architect, the engineer and the contractor. To tell a singular story would not satisfy the complexity of BIM's many roles & devices in the success and challenges of the project. Our goals are guided by an owner-driven BIM strategy & an integrated project process. The design team's efforts are supported by the Owners determination that both the use of BIM technologies and the process changes that accompany the use of BIM tools are vital to the future of the hospital.

The most meaningful stories that are threaded in all of the team members are our ability to collaborate, communicate and attempt new endeavors together. The Outpatient Care Pavilion uses BIM fearlessly, every team member stepped outside their comfort-zone to test the waters & discover new BIM territories.

THE OUTPATIENT CARE PAVILION (OCP) BECAME THE FIRST CONTRACTUALLY MANDATED BIM PROJECT FOR THE OWNER:

- 26 Story, 1 Million Square foot Mixed-use Medical Office Building, 575 car parking garage, Below 2 pedestrian bridges, 1 tunnel connecting to the existing hospital
- Separate contracts w/ Arch. and CM-at-Risk
- ConsensusDOCS 301 BIM Addendum amended to contracts
- BIM - FM proof-of-concepts already on-line
- Project is a laboratory for optimizing BIM processes on all future projects

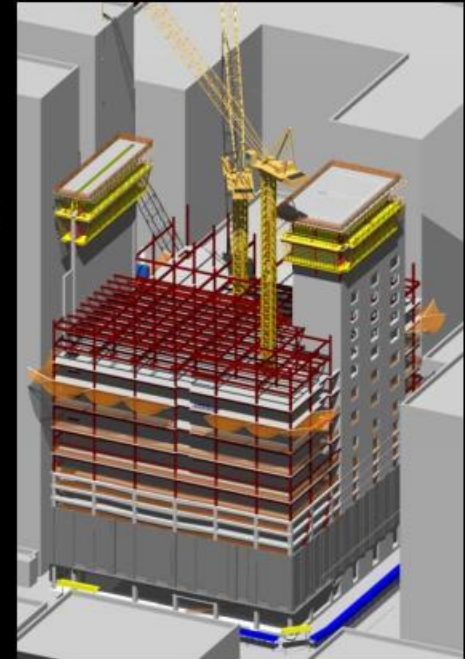
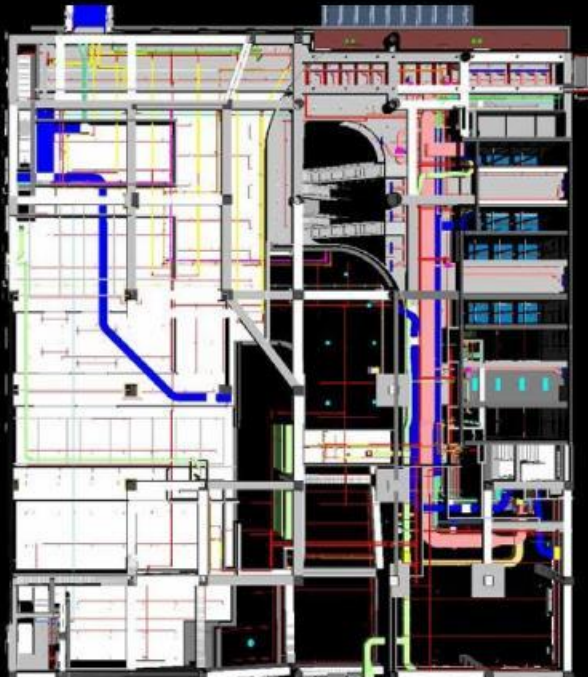
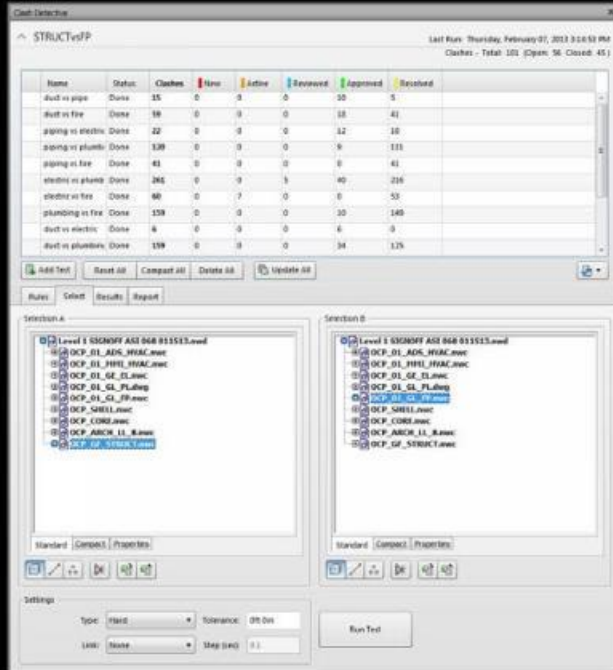
AN OWNER-DRIVEN BIM STRATEGY

DELIVERY PROCESS & TECHNOLOGY INNOVATION
AN ENTERPRISE STRATEGY



Outpatient Care Pavilion BIM Project Delivery Goals

- Better Coordinated Design
- Improve Communication
- Reduced errors
- Reduced issues during Construction assemblies
- Constructability Review during Design Development to improve decision making
- Improve the sequence of installations through 4D Visualizations to reduce risk
- More accurate Quantity Takeoff to support Estimating and design comparisons



Picture 2 - Slab on Grade

BIM GUIDELINES – VISION STATEMENT

The Owner has determined that both the use of Building Information Modeling (“BIM”) technologies *and* the process changes that accompany the use of BIM tools are of vital strategic importance to the architecture-engineering-construction-facilities management lifecycle at the hospital. Accordingly:

The Owner is fully committed to incorporating BIM tools as integral, fundamental components of the Hospital’s Project Management Methodology.

The Owner is fully committed to incorporating BIM process requirements and integrated project delivery methodologies [Integrated Project Delivery (“IPD”), Design-Build (“DB”), etc.] into the hospital’s contract acquisition and delivery requirements.

Implementation

Ownership of All Project Models after Deliverables

Expected Workflow

BIM EXECUTION PLAN



Table of Contents	
1	Northwestern Memorial Hospital: BIM Lifecycle Vision Statement 5
2	Definitions 5
3	Implementation 6
3.1	BIM Execution Plan 6
3.2	NMHC Ownership of All Project Models after Deliverables 7
3.3	Expected Workflow 8
4	Design Team Guidelines 8
4.1	Design Team BIM Software and Processes 8
4.2	Coordination with Owner’s Consultants 10
4.3	Minimum Design Model Elements 10
4.3.1	Architecture BIM Elements 10
4.3.2	Structure BIM Elements 11
4.3.3	Mechanical, Electrical, and Plumbing BIM Elements 11
4.3.4	Life Safety and Fire Protection BIM Elements 12
4.3.5	Telecommunications BIM Elements 12
4.3.6	Civil Engineering BIM Elements 12
4.4	NMHC Unique ID 13
4.5	Systems and Quantity Cost Estimating 13
4.6	Geo-Referenced BIM 13
4.7	Design Team BIM Collaboration Software & Clash/Collision Meetings 14
4.8	NMHC Existing Building/Space/Area BIM Files 15
4.9	Energy Modeling 15
4.10	Program and Space Validation 16
5	Construction Team Guidelines 17
5.1	Construction Team BIM Software and Process 17
5.2	Coordination with Owner’s Consultants 18
5.3	Construction Team BIM Collaboration Software 18
5.4	NMHC Unique ID 19
5.5	Systems and Quantity Cost Estimating 20
5.6	Fabrication Models as As-Built Drawings 20
5.7	Link to Operations and Maintenance Documentation 21
5.8	Minimum MEPFP Subcontractor Model Elements 21
6	Project Closeout Deliverables Matrix 27
7	Attachments 28

ACHIEVING MEASURABLE RESULTS

Governing Contract A/E:

Governing Contract CM:

301 BIM
Addendum

1

301 BIM
Addendum

BIM Execution Plan
("BEP")

2.5

Owner BIM
Guidelines &
Standards

2

Set: Steering & Control
Mechanisms

In Tandem w/

Model Responsibilities

Update Schedules

Energy Models, etc.

Weekly Design Clash Mtngs.

CM Milestone Reviews

4

Achieve: Cost
& Schedule
Savings

3

Monitor: Compliance

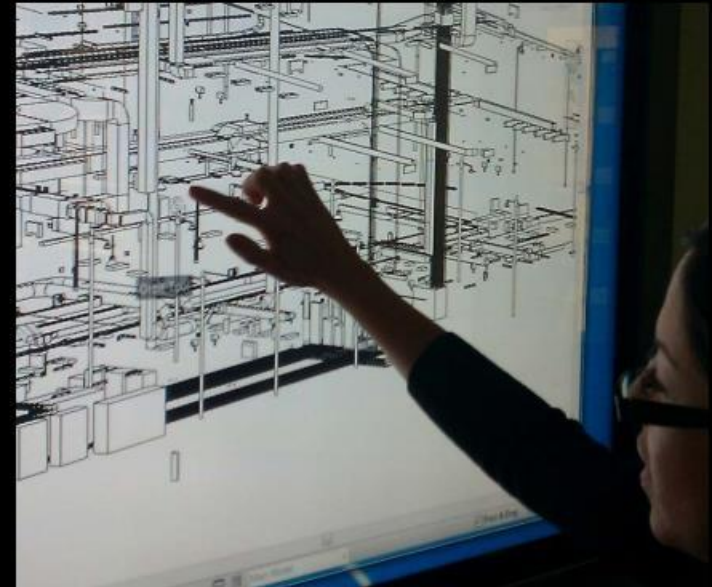
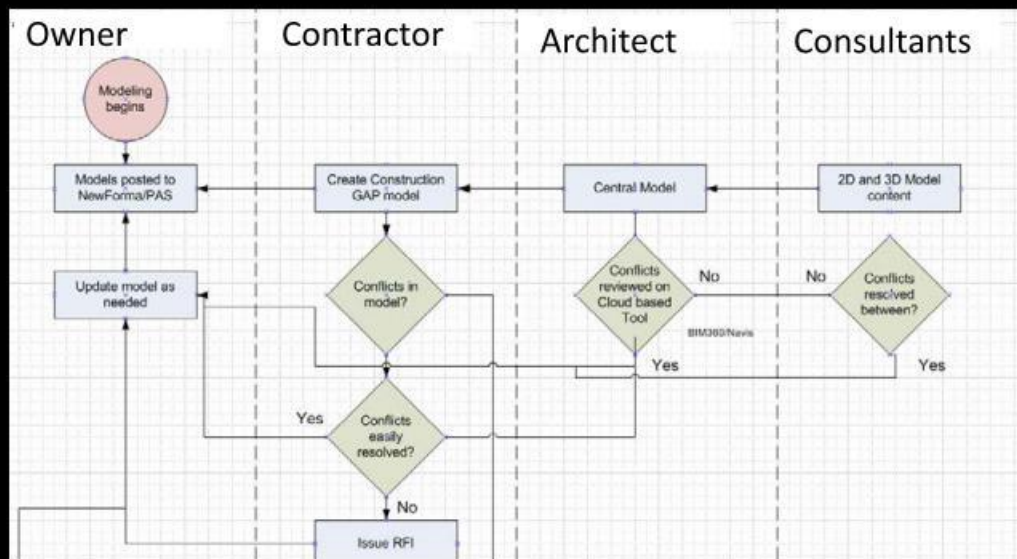
BIM: A NEW WORK FLOW

More coordination, earlier in the process

- File share site NewForma and Plans&Specs
- Processed a gig of data every 2 weeks during coordination

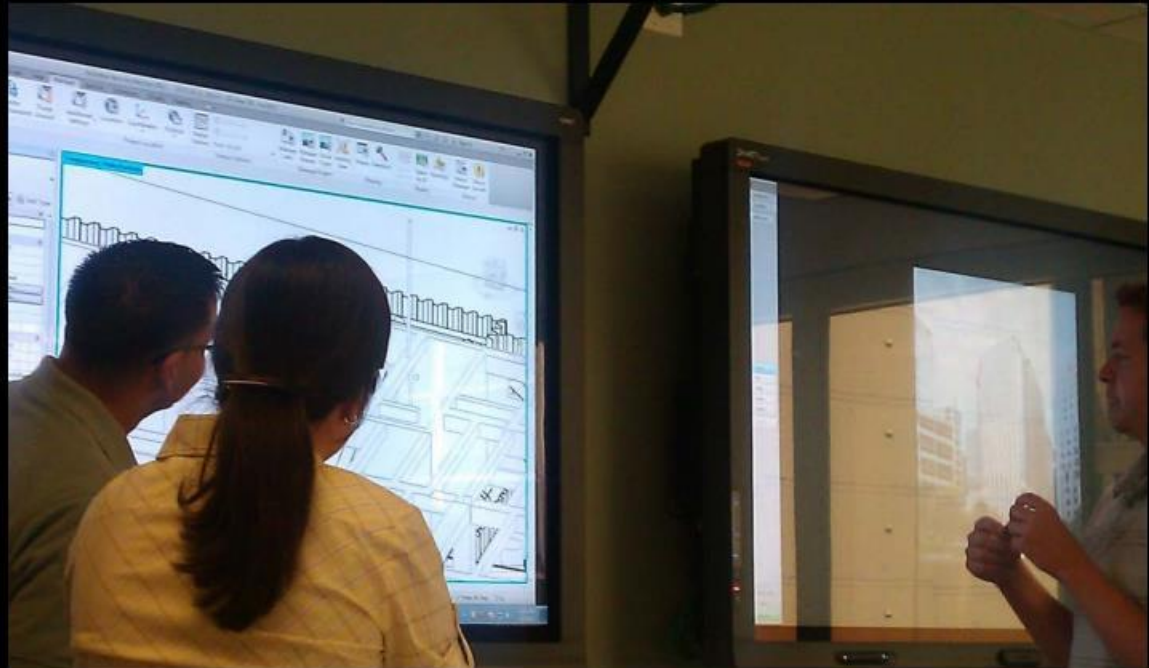
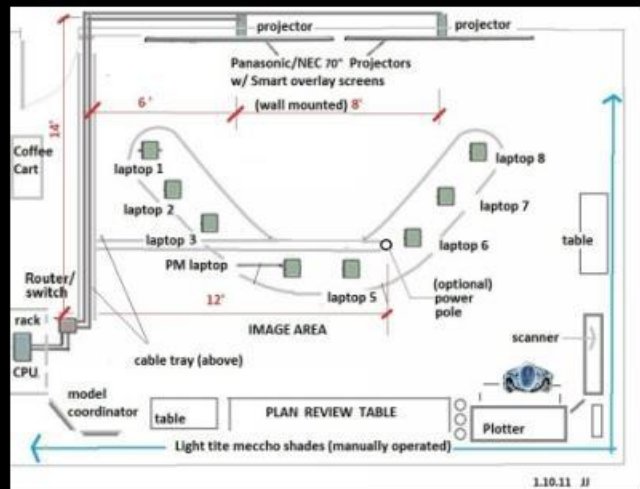
Why this project is unique:

- Design started a year early with full coordination models among consulting disciplines
- Cloud based tools tested in a co-located office with the design team and Construction Manager
- ConsensusDOCS 301 BIM Addendum Amended to Contracts
- Project is the Prototype for all projects to follow



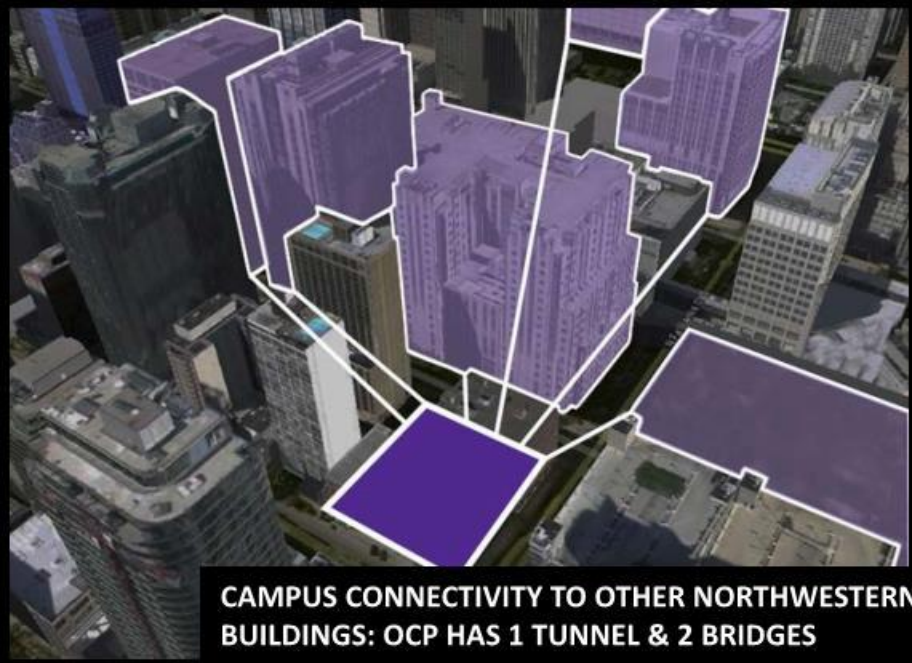
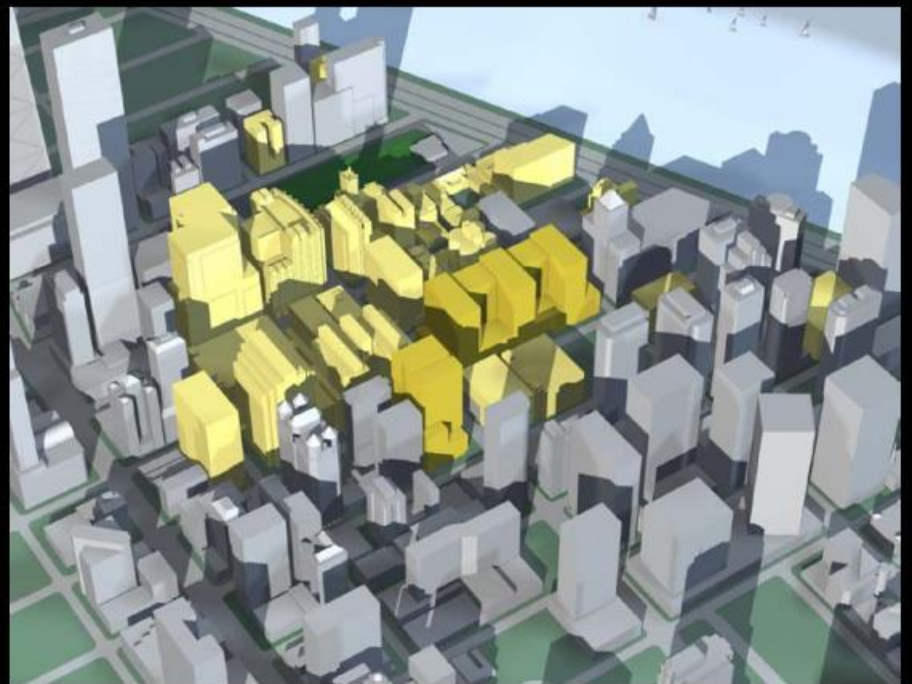
BIM: THE TECHNOLOGY ROOM

- Overlooks job site
- Interactive HD displays
- Markup tools built-in
- Open Layout
- U Shape fosters collaboration
- Computing Power
- Dedicated Bandwidth
- Equipment is upgradeable
- Widely used by entire team
- Custom built for the project

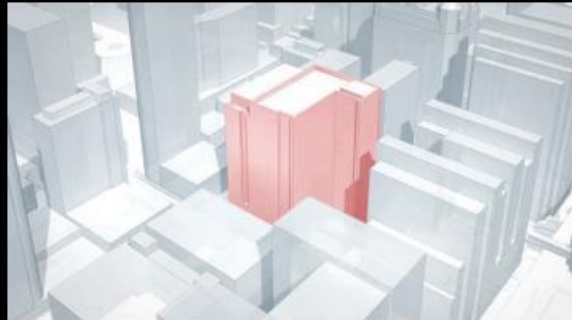




OWNER, ARCHITECT, CONTRACTOR
JOINT VENTURE OFFICE ACROSS FROM THE SITE



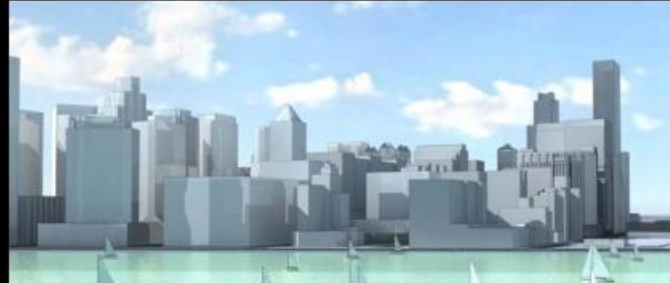
CAMPUS CONNECTIVITY TO OTHER NORTHWESTERN
BUILDINGS: OCP HAS 1 TUNNEL & 2 BRIDGES



DESIGN PROCESS & TECHNOLOGY INNOVATION

A STORY OF AN URBAN M.O.B

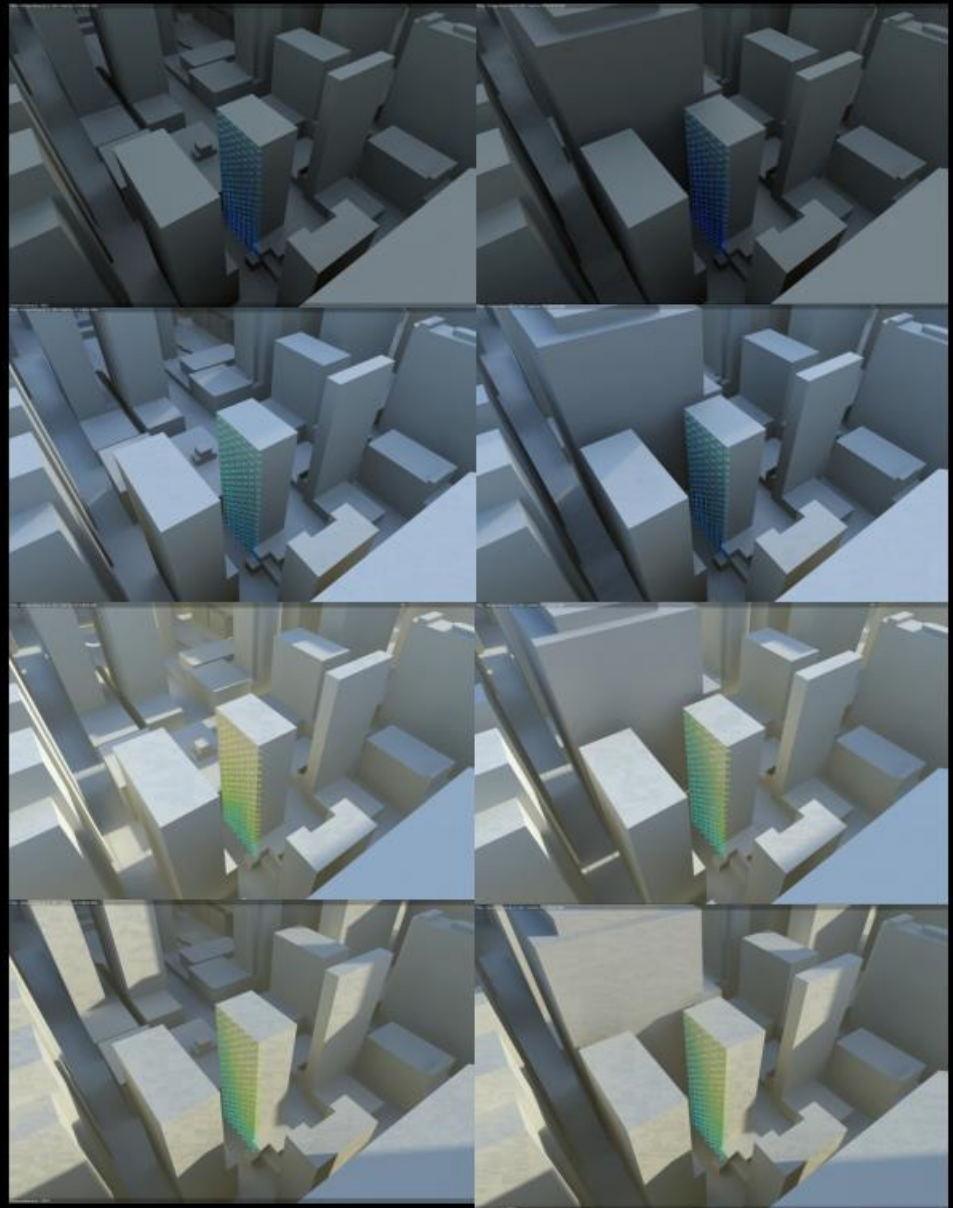
CHICAGO, IL



DESIGN PROCESS

in a Urban Setting

Revit Massing, 3D CAD and 3DsMAX Design Lighting Analysis Tool were used to determine the sun & shading levels of the adjacent residential building on the site.



WITHOUT THE OCP

WITH THE OCP

STACKING DIAGRAM

MECHANICAL

LOW INTENSITY D&T

HIGH INTENSITY D&T

MECHANICAL

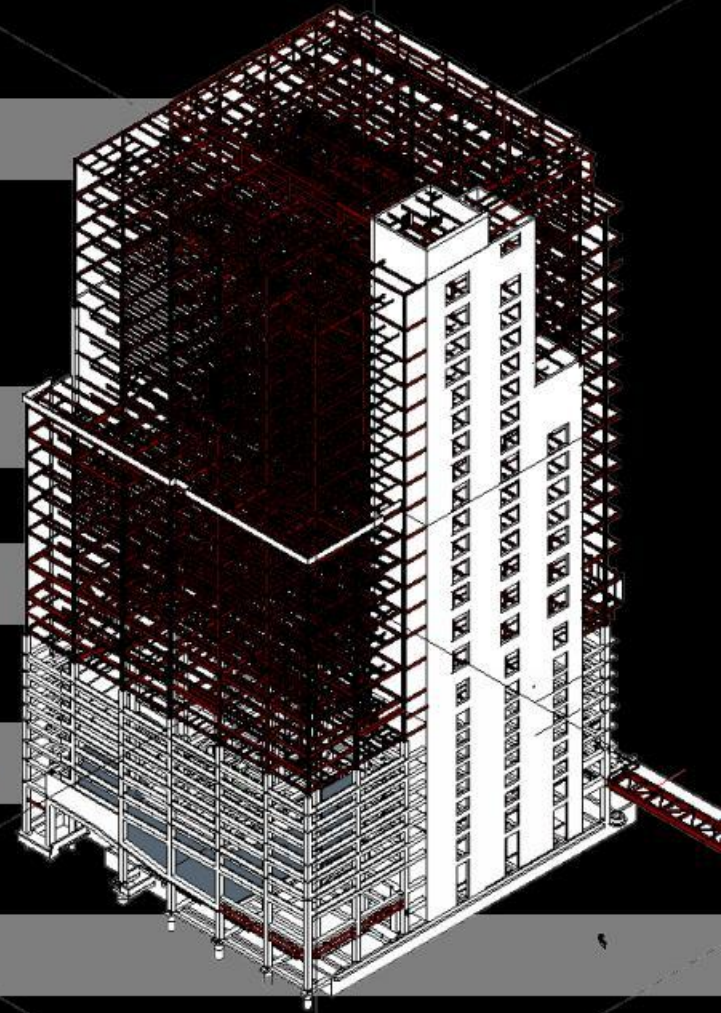
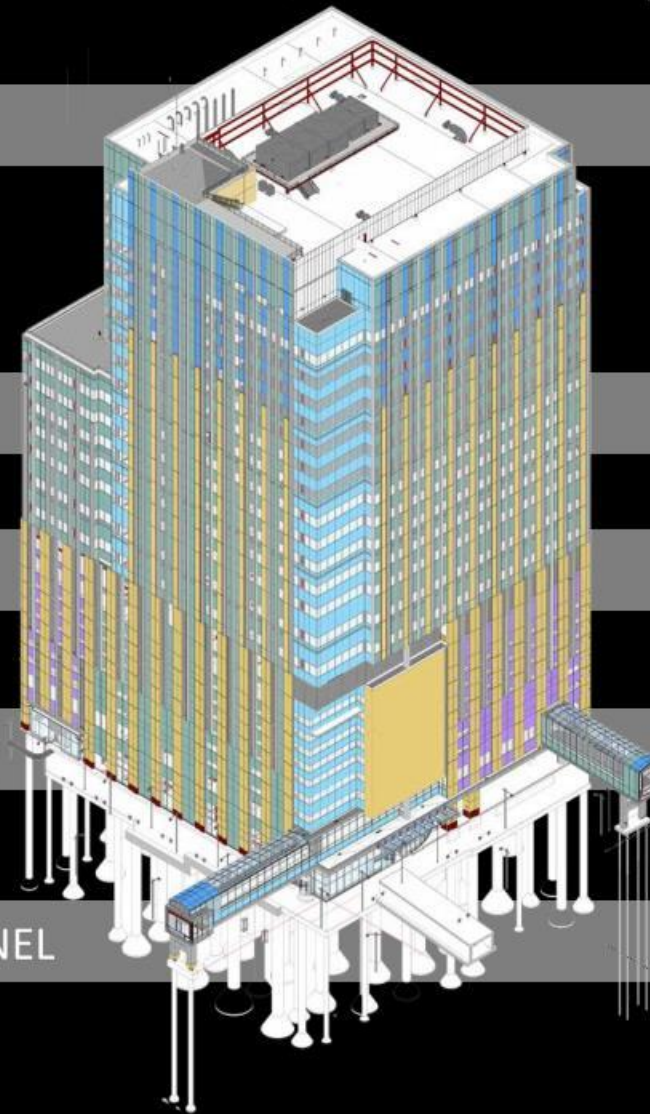
PARKING

BRIDGES & LOBBY

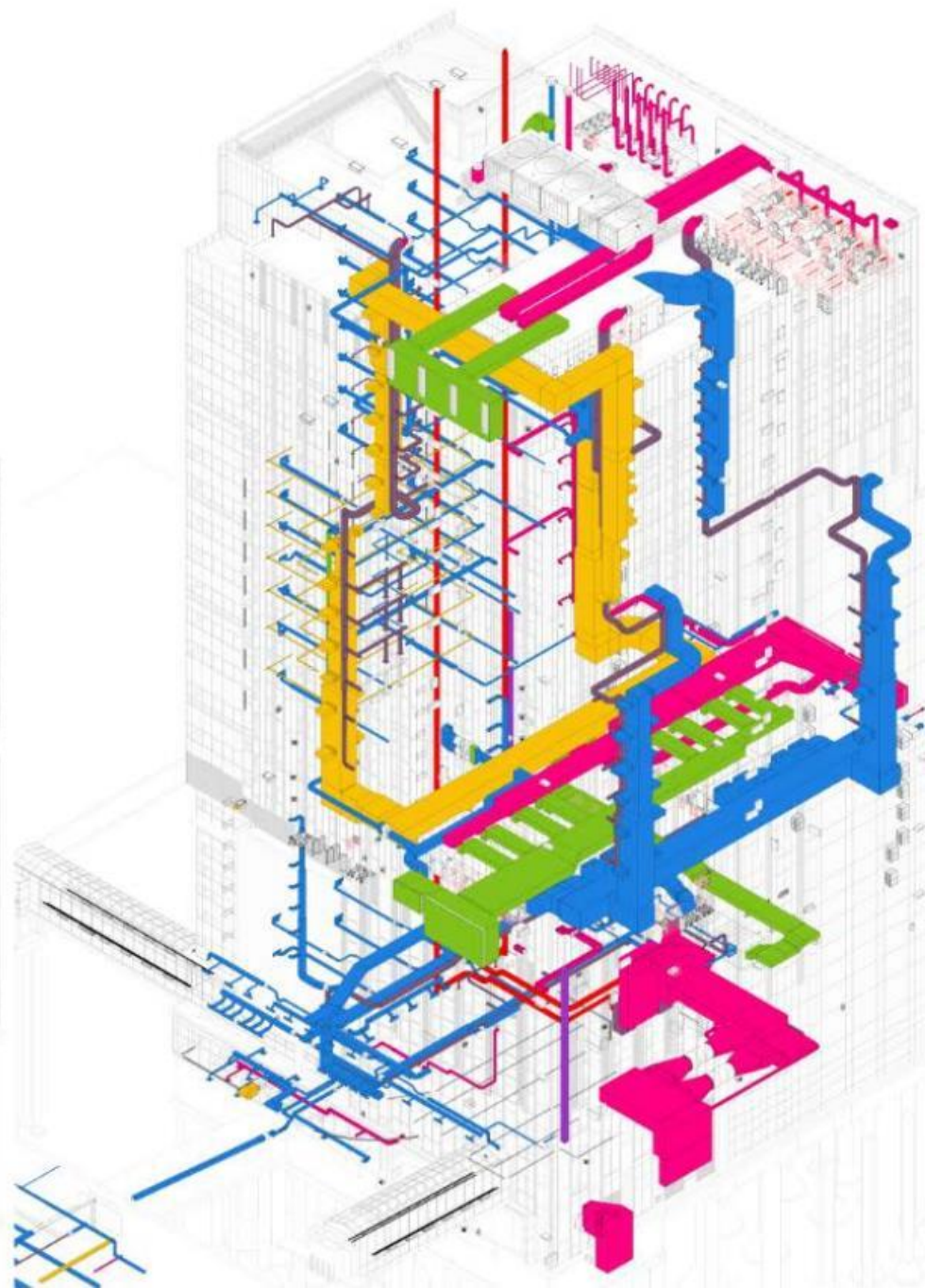
PUBLIC & RETAIL

DRIVE DROP OFF

LOADING DOCK & TUNNEL

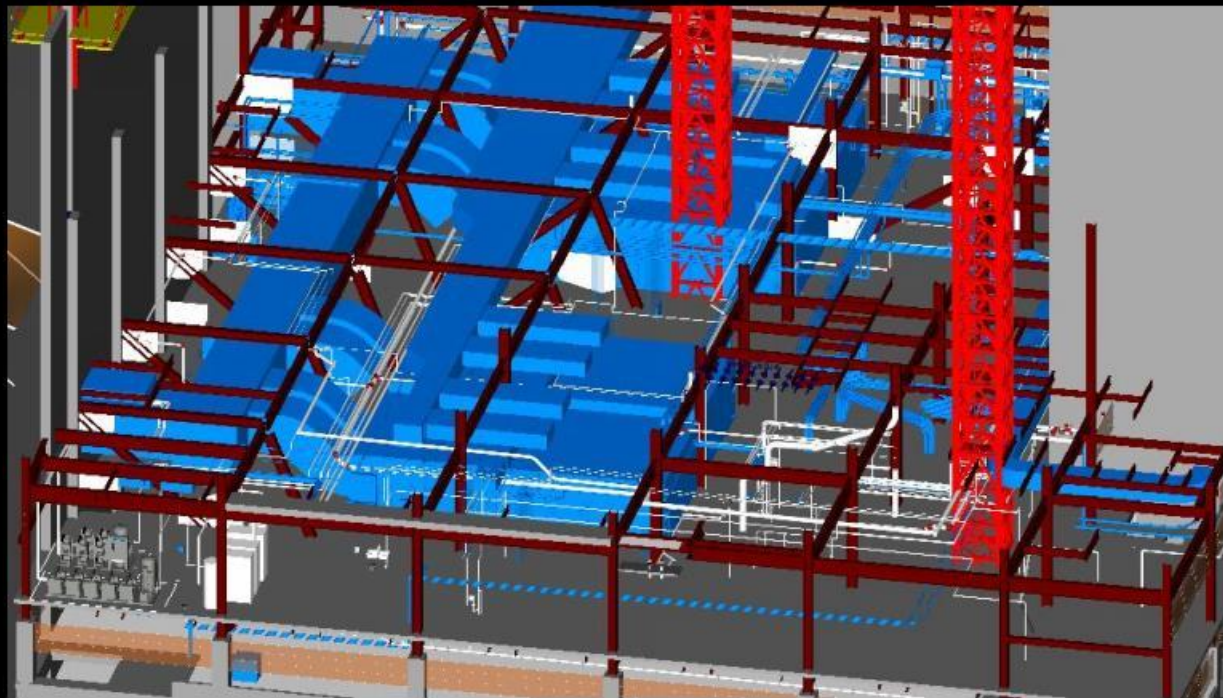
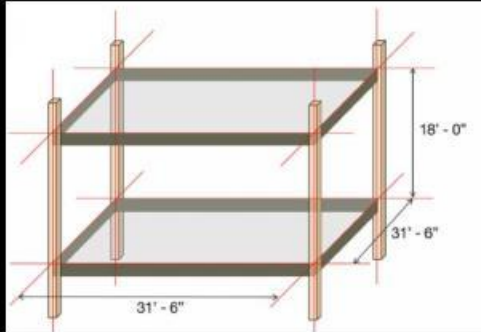


3D IMAGES IN REVIT ARCHITECTURE & REVIT STRUCTURE



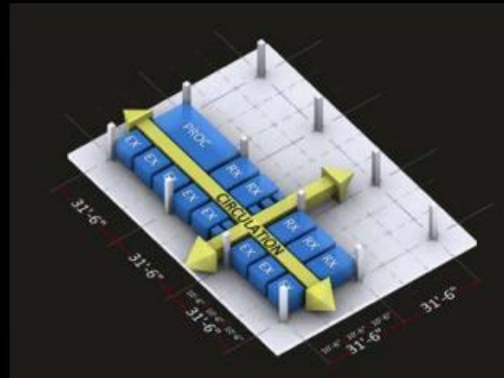
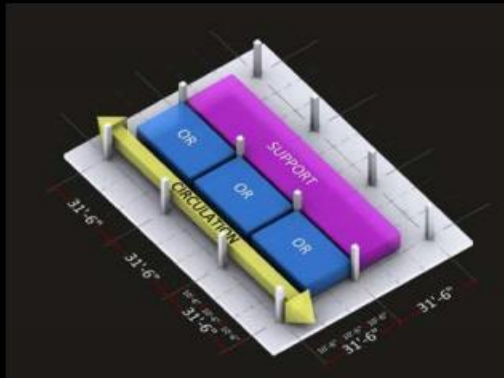
Revit & Navisworks

enabled the design team to transfer a concrete parking garage & loading dock to a steel universal grid within the complicated infrastructure of the 10th floor mechanical space through the means of large structural transfer trusses.



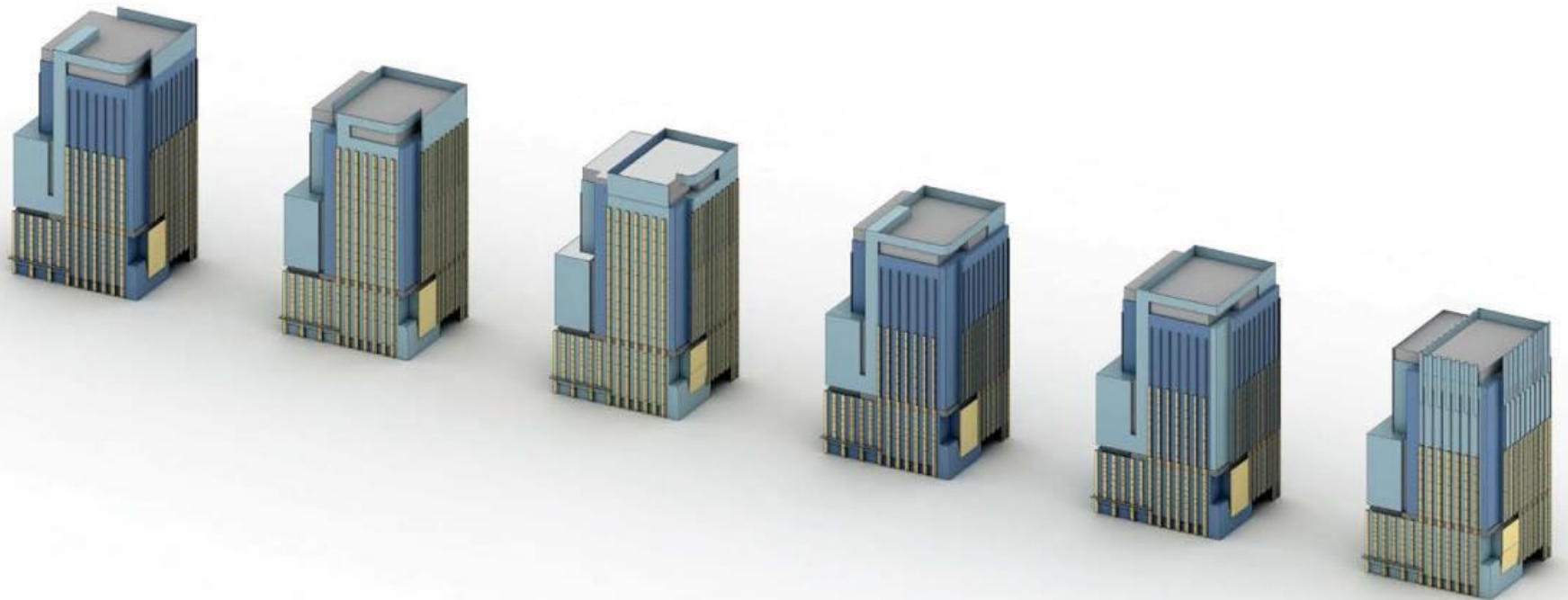
FUTURE-PROOFING

EARLY CLASH DETECTION IN NAVISWORKS



Universal Grid Theory

We have hypothesized, designed and built healthcare and science facilities utilizing a universal grid planning module. The premise focuses on the transformability, flexibility, and adaptability of our buildings to unknown future conditions. The use of the universal grid planning module shows positive results in both the speed to design and the efficiency to deliver higher performance buildings at equal or lesser cost and to invest in "future-proofing."



VIRTUAL MOCKUPS

MASSING STUDIES IN RHINOCEROS 3D

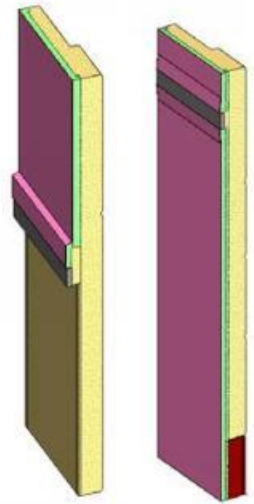
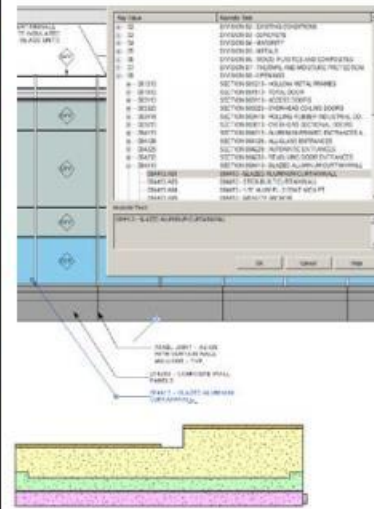


RENDERINGS IN 3D STUDIO VIZ UTILIZING THE REVIT MODEL & DESIGN OPTIONS



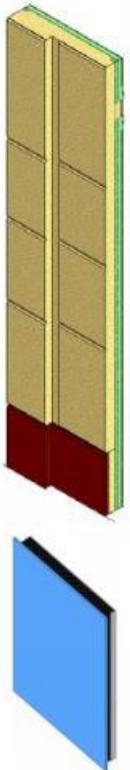
Custom Revit Generic Models of insulated, fire protected precast modules & glazing spandrel panels, as well as the use of **e-SPECS for Revit**, allowed for the following:

- Modular design
- Ease of fabrication
- Quick design changes
- Ease of scheduling
- Smart keynoting



VIRTUAL MOCKUPS

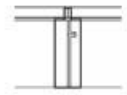
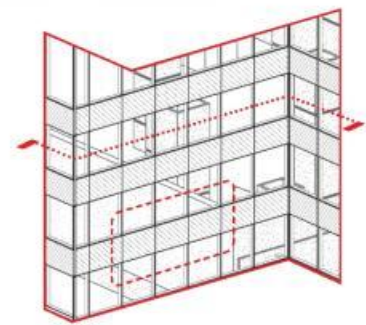
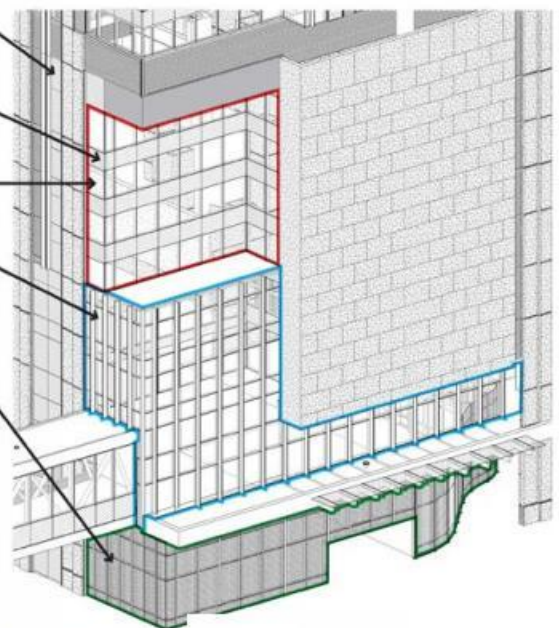
Using Revit Design Options & Generic Models allowed flexible modeling & satisfied the client's design requests in a timely manner.



VISION GLASS + SPANDREL:
VRE1-59 W/DOTS + SPANDREL
COATING

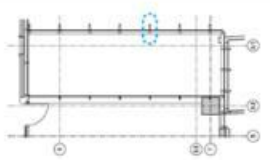
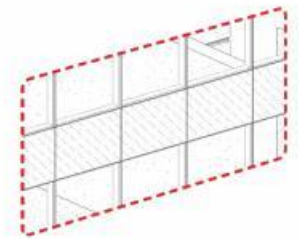
SPANDREL:
VE1-2M W/SOLID LIGHT GRAY
FRIT ON #4

VISION GLASS:
VE1-2M

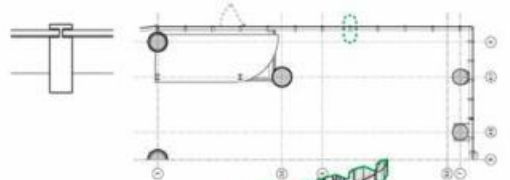


VISION GLASS:
VE1-2M

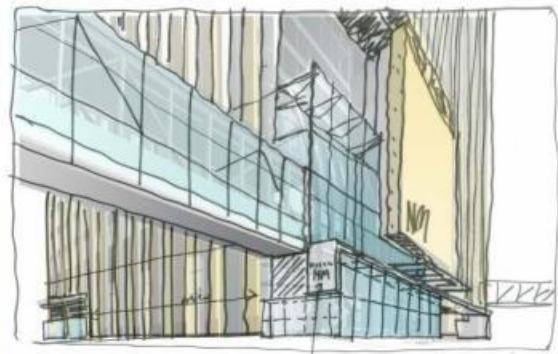
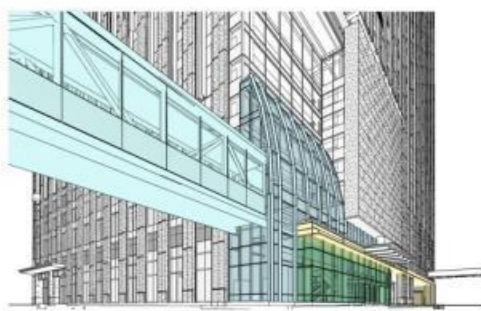
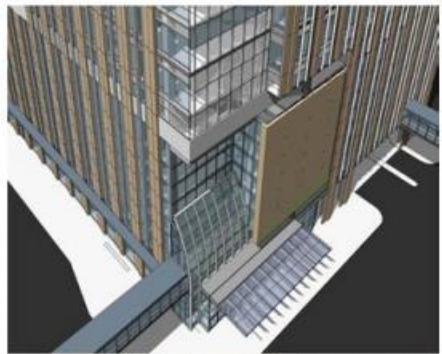
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FRIT ON #4



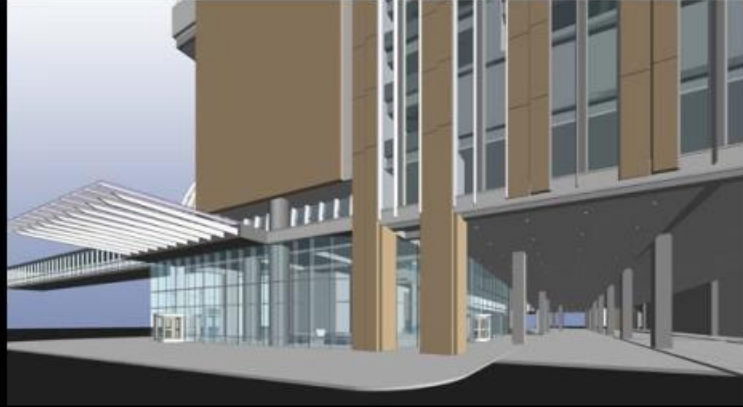
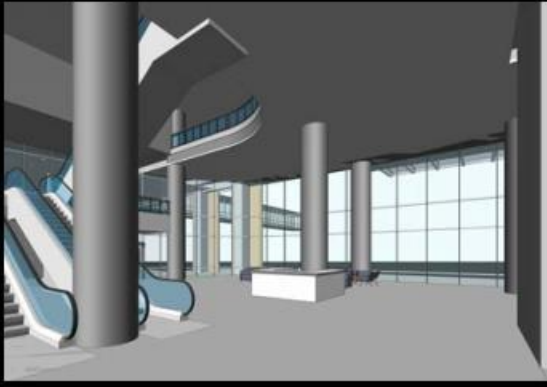
VISION GLASS:
VE1-2M



VISION GLASS:
VE1-2M



A NEW METHOD OF VISUALIZING



ARCHITECTURE SUBMODELS

SHELL.rvt LL-09.rvt 10-26.rvt CAD CIVIL.rvt FITOUT.rvt

- exterior skin
-bridges
-canopies & vestibules
-roof plans
- floor slabs
-column enclosures
-base building interior walls & doors
-garage ramps & loading docks
-tunnels & elevators
-core toilet rms, telecom/data/elec/jc rooms
- floor slabs
-base building interior walls & doors
-stairs & elevators
-core toilet rms, telecom/data/elec/jc rooms
- CAD files from CIVIL, LANDSCAPE, SURVEYOR
-Any CAD files of existing buildings or areas on site
-Any existing demolition
- all interior build out
-each floor-or- each rental space should be broken out into a separate model

ARCHITECTURE SHEET MODEL

MASTER.rvt

- ALL ARCH SHEETS with no linked views:
 - cover sheet
 - drawing index
 - general notes
 - mounting height
 - partition types
 - code matrix
 - code compliance plans
 - door/window schedules
 - finish schedules
 - room schedules
- ALL ARCH SHEETS with linked views:
 - floor plans
 - exterior elevations
 - building sections
 - exterior details
 - interior details/elevations
 - rcps
 - finish plans
 - furniture plans

BIM TEAM'S COORDINATES

SHARED COORDS.rvt

- Import Survey plan with project coordinates & base point, create a common object for linking & exporting

EXTENDED BIM
Communication is key.
BIM MODEL MATRIX & RESPONSIBILITIES

ARCHITECTURE SUBMODELS

SHELL.rvt

LL-09.rvt

10-26.rvt

CAD CIVIL.rvt

FITOUT.rvt

ALL SHEETS WITHIN FITOUT MODEL.S. NO LINKED VIEWS TO MASTER.rvt

LINKED VIEWS TO MASTER.rvt

exterior elevations
exterior details
roof plans
**Copy/monitor grids from SHELL

floor plans
site plans
enlarged plans
interior elevations & details
reflected ceiling plan

floor plans
enlarged plans
interior elevations & details
reflected ceiling plan

site/landscape plan
existing condition interfaces

ARCHITECTURE SHEET MODEL

MASTER.rvt

NON-LINKED VIEWS

- ALL ARCH SHEETS:
 - cover sheet
 - drawing index
 - general notes
 - mounting height
 - partition types
 - code matrix
 - code compliance plans
 - door schedules
 - finish schedules
 - room schedules

SHARED COORDS.rvt

- survey plan with project coordinates & base point, create a common object.

LINKED VIEWS TO MASTER.rvt

all floor plans
**Copy/monitor grids from structural

roof plan & mechanical equipment rooms per floor plan

plumbing fixtures per floor

parking strips & equipment per floor plan

CONSULTANT MODELS

STRUCT.rvt

MEP.rvt

PFP.rvt

PARKING.rvt

TELECOM.rvt

GRAV CHUTE.rvt

PTUBE.rvt

SECURITY.rvt

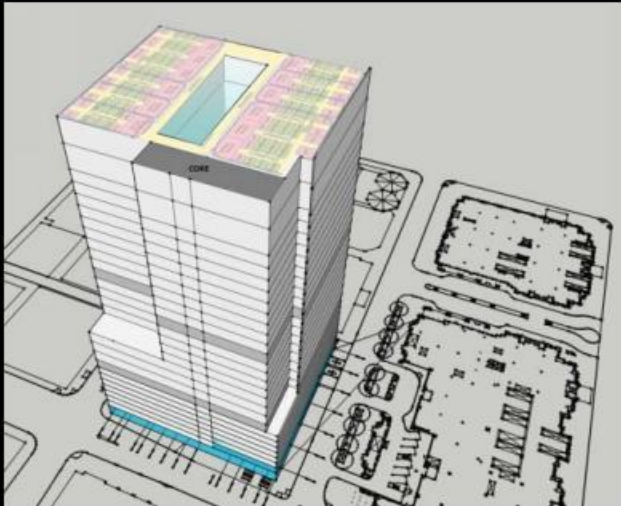
MED EQ.rvt

medical equipment layouts per floor for FITOUT.rvt

SHARED COORDINATES

Is a vital contributor to the success of the project & future projects on the Northwestern Campus. Working within the confines of a tight property line we were able to utilize shared coordinates when the North side of the building grew in the design process, allowing us to shift the building in shared coordinates to the South to stay within the property line, this process took less than a day.

16 REVIT MODELS were used on the OCP Shell & Core, all using shared coordinates and copy/monitoring grids & levels from the structural Revit model. All consultants were required to use Revit on the project & Civil 3D for the Civil Engineers. The CM created a Revit logistics site model in the Design Documents phase. The Fit-out team benefited from the shared coordinates as well, even the medical equipment consultant had a Revit model.




- NMH-OCP_SITE.rvt
- NMH-OCP_PFP_[Central].rvt
- NMH-OCP_10528-00_MEP_[Central].rvt
- NMH-OCP-GRAV-CHUTE.rvt
- NMH_OCP_TELECOMMUNICATIONS_CENTRAL.rvt
- NMH_OCP_SHELL_AR.rvt
- NMH_OCP_PARKING.rvt
- NMH_OCP_MASTER_AR.rvt
- NMH_OCP_LL_08.rvt
- NMH_OCP_CORE_AR.rvt
- NMH_OCP_CAD_CIVIL.rvt
- NMH_OCP_9_25_AR.rvt
- NMH Security.rvt
- LL FND Logistics.rvt
- B-EQ-NWH-2011.rvt
- NMH_OCP_9_25_FO_AR.rvt

Over 400 BIM Equipment Unique IDs were used for HVAC Ventilation Model tags for Air Handling Units, Air Terminal Units, Exhaust fans, Supply fans, Infrared heaters, Air curtains, Fire dampers and Fire smoke dampers. These are used for the hospital's Facility maintenance systems.

Scope of Work: HVAC Ventilation			Last Revision: 10/16/2013		
BIM As-Built Model Tag			Temporary tag on equipment during construction	Permanent tag on Equipment	
No.	Unique ID - (Asset Number)	Level	TAG per Design Drawings	Equipment Tag on As-Built Drawings	Equipment Tag - Field
Air Handling Units					
1	CHI-OCP-AHU-01-10	Level 10	AHU-1	AHU-01-10	AHU-01-10
2	CHI-OCP-AHU-02-10	Level 10	AHU-2	AHU-02-10	AHU-02-10
3	CHI-OCP-AHU-03-10	Level 10	AHU-3	AHU-03-10	AHU-03-10
4	CHI-OCP-AHU-04-10	Level 10	AHU-4	AHU-04-10	AHU-04-10
5	CHI-OCP-AHU-05-25	Level 25	AHU-5	AHU-05-25	AHU-05-25
6	CHI-OCP-AHU-06-02	Level 02	AHU-6	AHU-06-02	AHU-06-02
Air Terminal Units					
	CHI-OCP-AT-01-00	Level 00	AT-0001	AT-01-00	AT-01-00
	CHI-OCP-AT-02-00	Level 00	AT-0002	AT-02-00	AT-02-00
	CHI-OCP-AT-03-00	Level 00	AT-0003	AT-03-00	AT-03-00

Example of the Owner's BIM Unique ID Identified Equipment to be tagged.

CHI-OCP-AHU-02-10
[Hide Expanded View](#)



TITLE	VALUE	Document Attachments
TechnicalID	CHI-OCP-AHU-02-10	Cut Sheet - AHU (001)
AssetBarcodeID	AHU-02-10	Op Manual - AHU (006)
Floor	10	Warranty - AHU (009)
System	HVAC	
Manufacturer	STULZ	
Warranty Start Date	8/24/2013	
Serviceable Components	YES	
PM Part No.	234PAS	

Document Meta Data			
1	Asset Profile ID	6123568	6 Serial# E13C00644422001001
2	Building	OCP-MOB	7 Warranty End 8/23/2015
3	Room	10U-E	8 Special Instructions NO
4	Part Of	N/A	9 PM Schedule QUARTERLY
5	Model	FSS-210A	

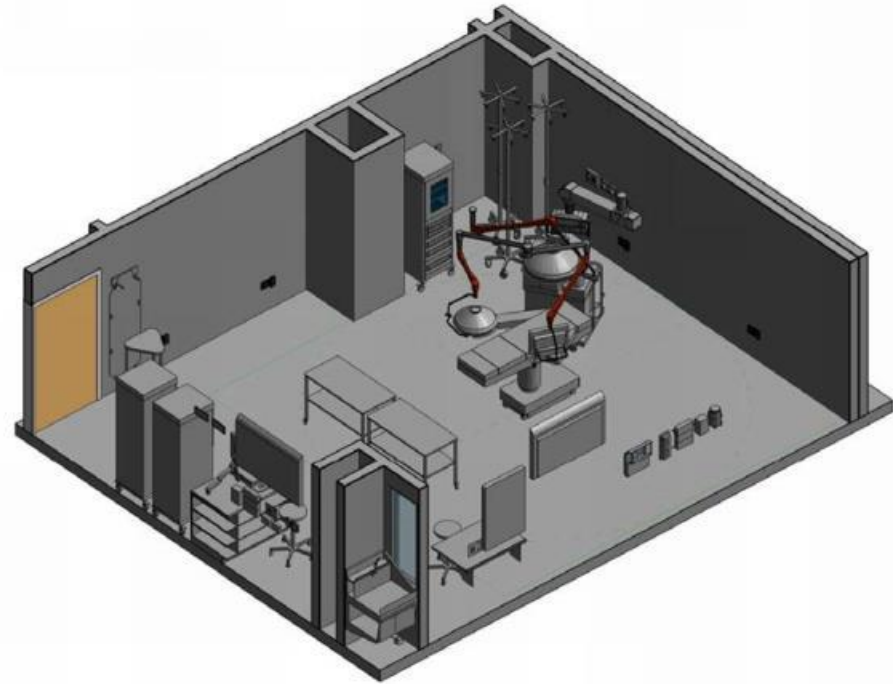
Example of a fan coil unit used on the Owner's system BIMfx



HEALTHCARE INTERIORS & BIM



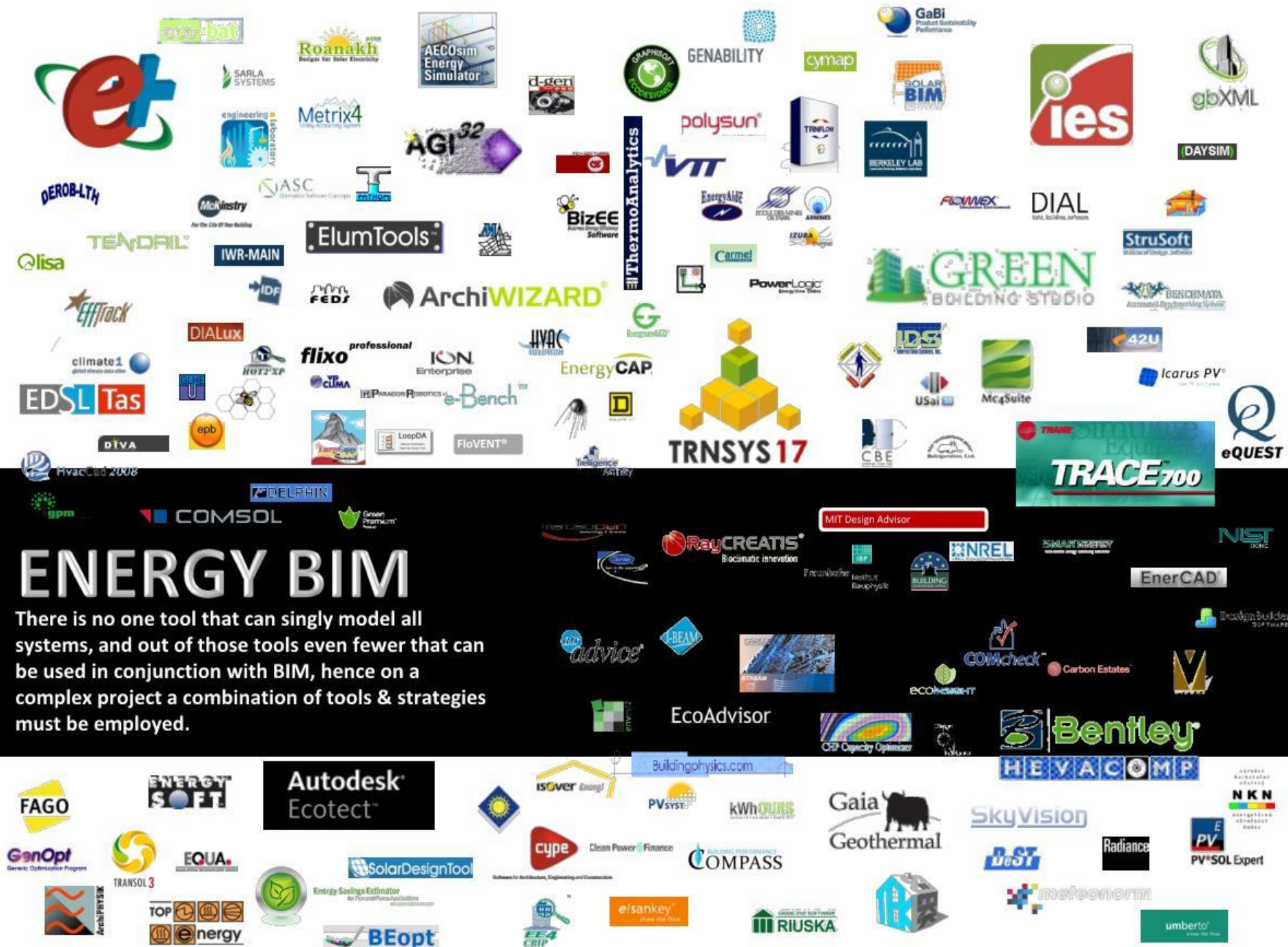
LEVEL 12 SURGERY ROOMS

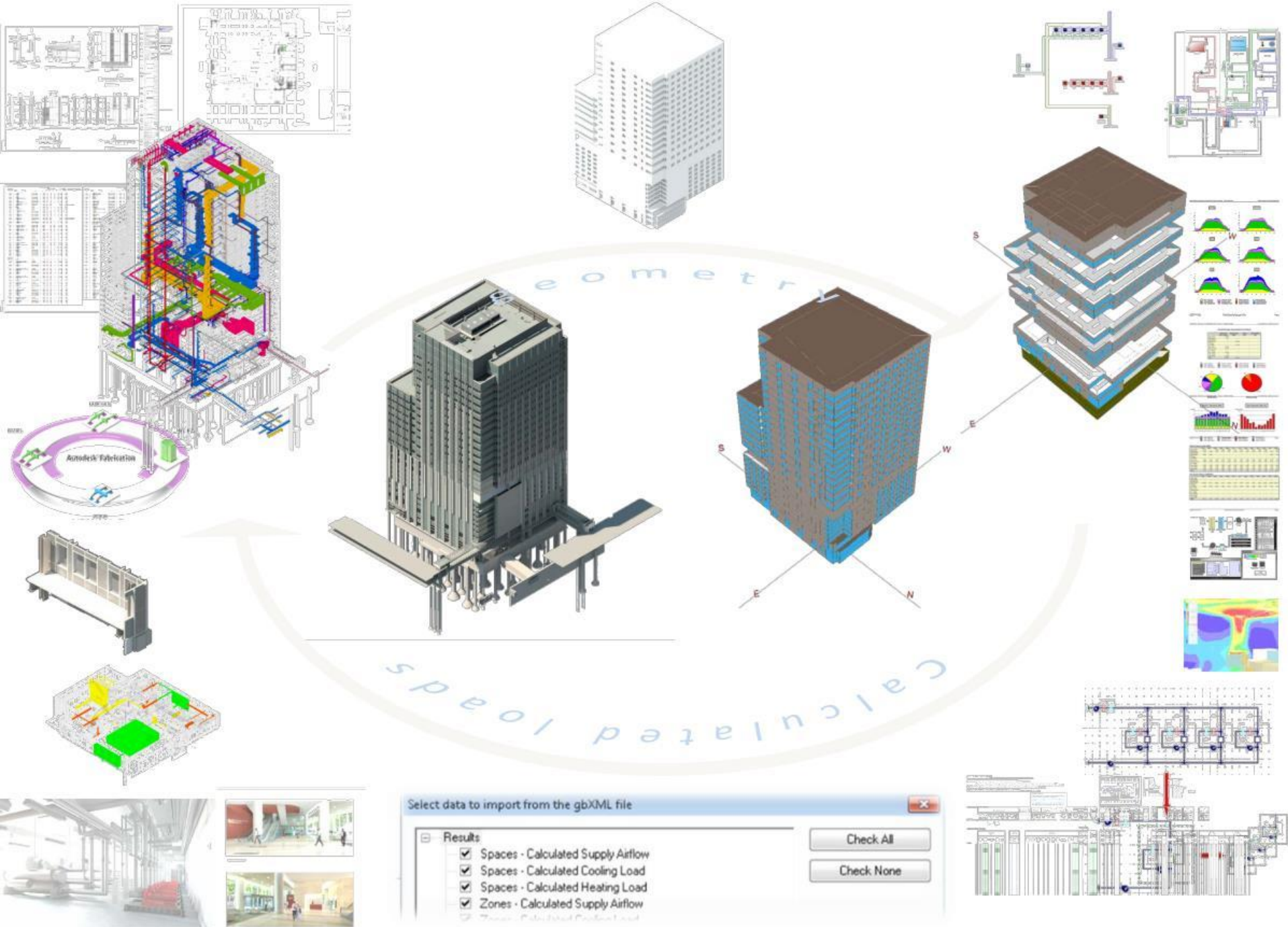


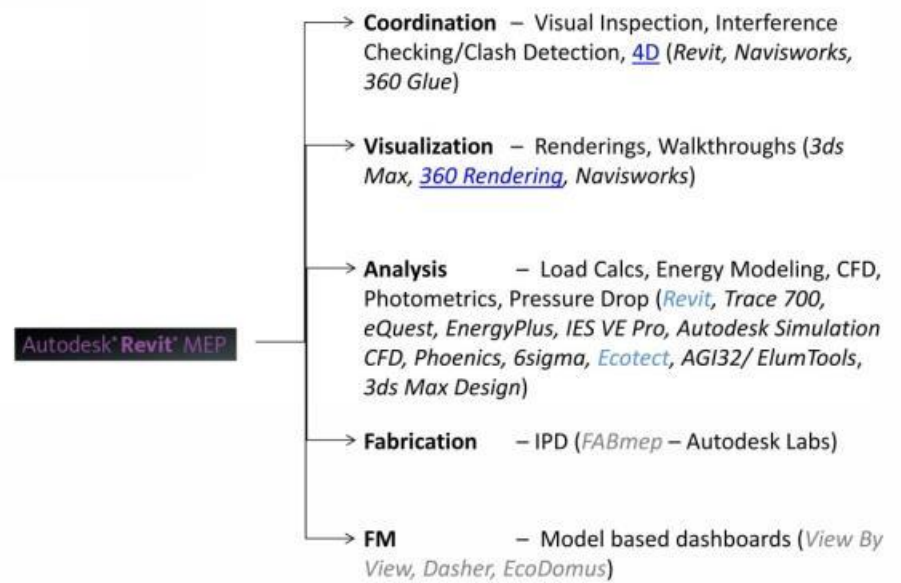
MEDICAL EQUIPMENT & BIM

ENERGY BIM

There is no one tool that can singly model all systems, and out of those tools even fewer that can be used in conjunction with BIM, hence on a complex project a combination of tools & strategies must be employed.







Autodesk's BIM-authoring platforms:

- Revit Architecture and MEP
- AutoCAD Architecture and MEP

Autodesk's building performance applications:

- Vasari
- Autodesk 360
- Green Building Studio
- Ecotect

All Autodesk's energy modeling applications are developed for conceptual, basic, early stages analysis, or are focusing on passive/architectural strategies. None of the Autodesk's building performance applications are capable of performing detailed MEP systems simulations, which leaves a considerable gap currently filled by third-party developers.

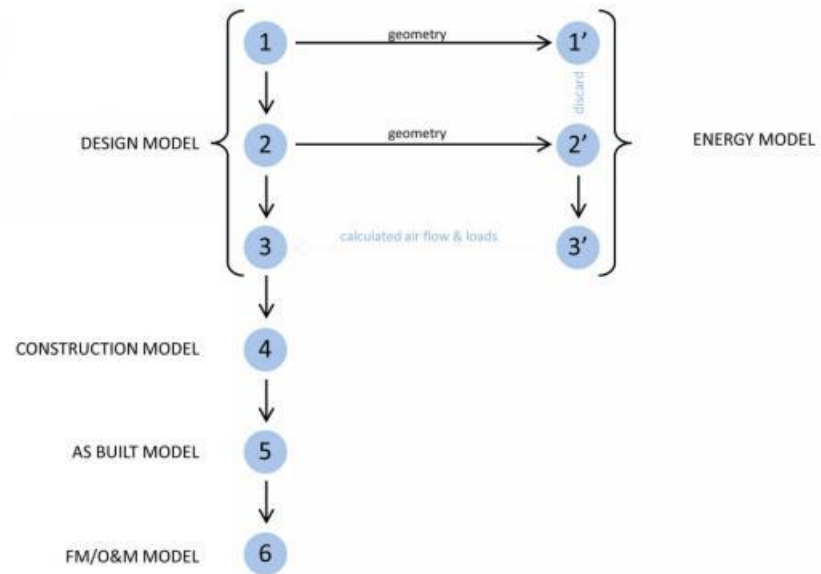
- Concept is for comparative modeling analysis rather than precision design validation
- Concept delivers quick and understandable feedback on design alternatives and sustainability strategies



	SOFTWARE					
Capabilities	eQuest	Trace-700	TRNSYS	EnergyPlus	DOE-2	BLAST
Load Calculation Heat Balance Method Conduction/Convection/Radiation	N1	Y	Y*	Y	N	Y
Simultaneous loads, system & plant solution	HVAC and plant only	Y	Y	Y	N	Y
Air and plant loop iterations Air and water loops are solved iteratively at each time step	N	N	Y	Y	N	N
Time Dependent Conduction Conduction transfer functions Finite difference model	Y N	Y N	Y Y	Y Y	Y N	Y Y
Building material moisture adsorption Combined Heat and Moisture Finite Element	N	N	N	Y	N	Y2
Component-Based HVAC configuration	N	N	Y	Y	N	N
Human Thermal Comfort Metrics	N	N	Y	Y	N	Y
Sub-hourly Time Steps	N	N	Y	Y	N	N

1 - eQuest-Weighting factors (simplified heat balance method)

2 - feature of IBLAST



	SOFTWARE			
System Description	eQuest	Trace 700	TRNSYS	EnergyPlus
DOAS	P	Y	P	Y
DOAS w/Energy Recovery	Y	Y	P	Y
DOAS w/Dual Wheel	N	Y	P	N
Radiant Heating	P	P	Y	Y
Radiant Cooling	N	N	Y	Y
Chilled Beams	N	Y	P	P
VRF/VRV	N	Y	N	Y
Geoechange	P	P1	P	Y
Condensing Boilers	Y	Y	Y	Y
Heat Pump Heat Recovery	P	Y	P	P
Natural Ventilation	P	N	P	Y
Daylighting 2	P	P	P	P
Active Shading Systems	P	N	P	Y

Y = yes

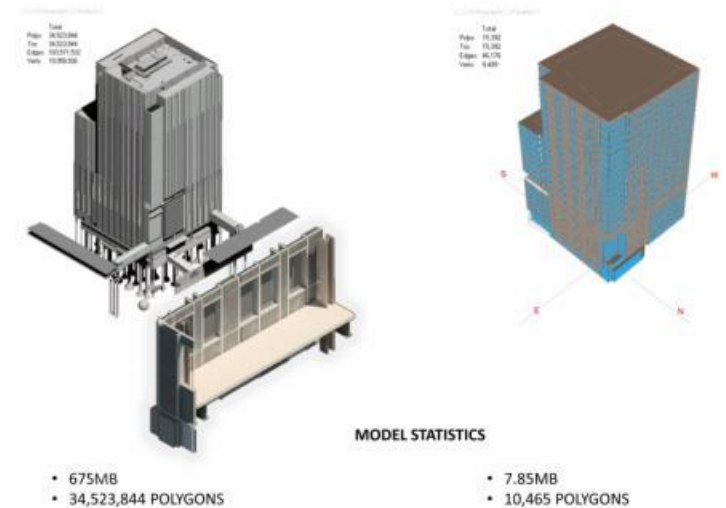
N = no

P = partial/workaround required

1 – Predefined borefield calculation from GLHE-Pro for vertical bore field temperatures

2 – Software included here generally provides quantitative energy impacts of daylighting controls with little to no qualitative analysis

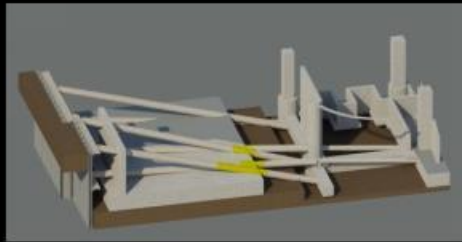
THE CHALLENGE IS REPURPOSING A DOCUMENTATION/CONSTRUCTION MODEL AS AN ANALYSIS MODEL, OFTEN TIMES RESULTING IN PARALLEL MODELS



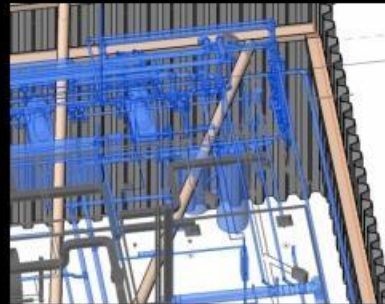
CONTRACTOR MEANS & METHODS



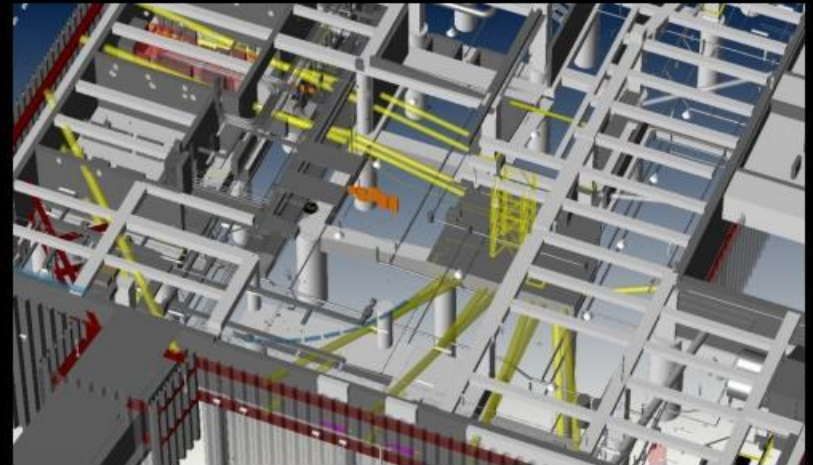
Bracing & Crane Placement & Equipment Clearances



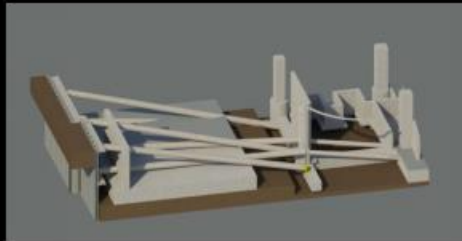
Bracing hit



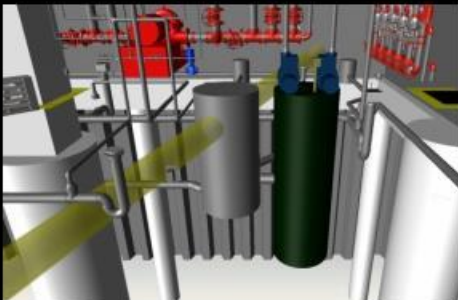
Catch basin hit with brace



North half rakers hitting pipe



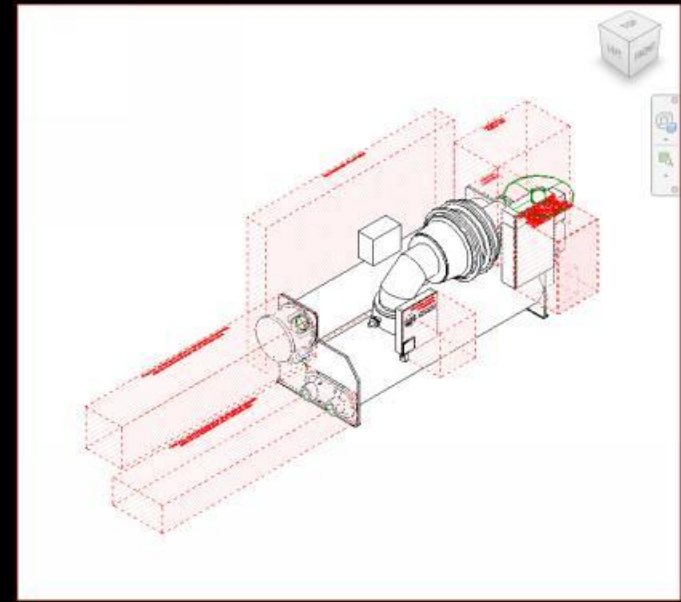
Bracing fix



Fire Pump Basin hitting brace



Caissons

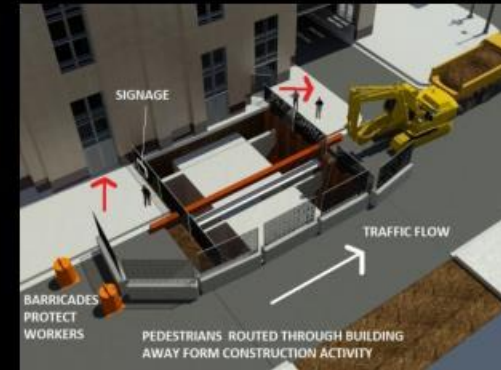


Pump Access & Clearances

BIM: LESSONS LEARNED

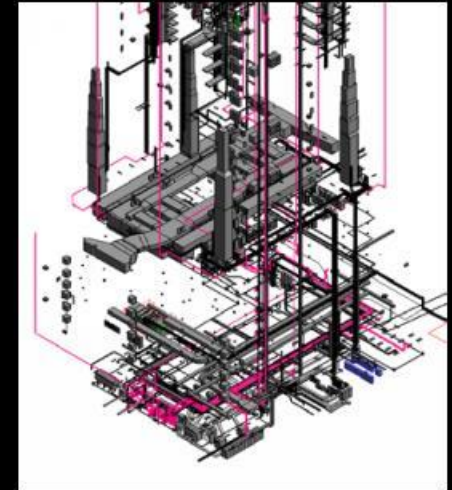
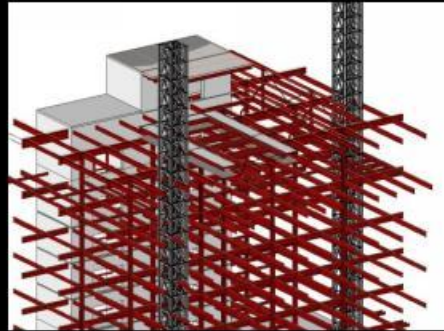
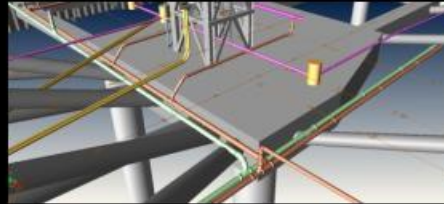
EARTH RETENTION SYSTEMS

- Often 2D traditional means was all that was available
- Contractor Took over modeling process to reduce errors
- Numerous conflicts resolved in advance
- Smoother workflow in field
- More certainty it will work



COORDINATION OF TOWER CRANES WITH STRUCTURE

- It began from the beginning
- Balancing material handling needs
- Lateral ties are problematic
- Accessing equipment
- Simulating placement

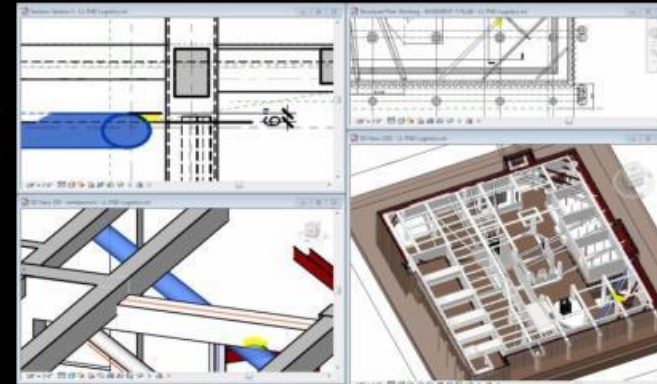
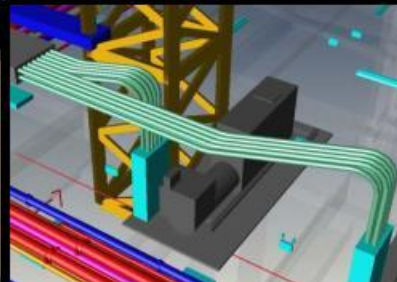


SYSTEM COORDINATION

- Pneumatic tube considerations
- Optimizing by rules
- Steel framing issues
- Equipment placement studies

4D SIMULATIONS

- Safety and routing considerations
- Virtually Building with Supt, early cause a deeper evaluation of risk
- Less problems later on



BIM: ACHIEVING MEASURABLE RESULTS

INTEGRATED PROJECT PROCESS - DESIGN TEAM EXPECTATIONS:

- Continuously maintain and update the Design Models through end of construction
- Publish the Design Model at a minimum of once (1) per month during construction
- Review the as-built models published by the Construction Team

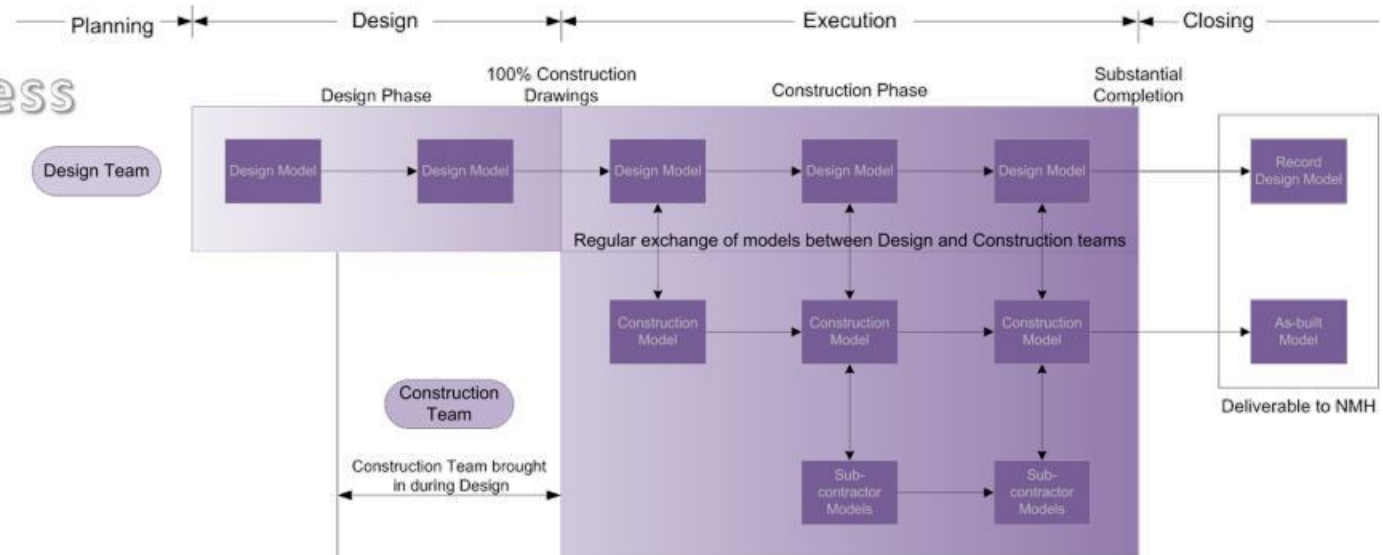
BENEFITS TO THE OWNER: AN INCREASED AWARENESS OF WHAT IS TO TRANSPIRE:

- Better Decisions through more accurate Coordination earlier in the process
- The opportunity for early, meaningful review, can payoff with a more maintainable design

KEY METRIC:

- +1,200 meaningful clashes avoided prior to Contract Documents issued
- <1% variance b/w SD and GMAX budgets
- First use of an integrated BIM Viewer (BIM 360 with Planandspecs)
- Reduced Response Time through interacting cloud technologies (breaking down the silos)
- More accurate As-Built driven earlier in the process

Integrated Project Process

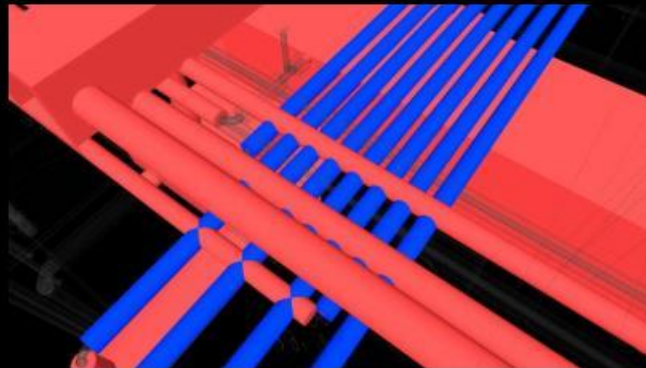


BIM: Cost Avoidance: Integrated Clash Detection

A/E Teams
modeling? Yes.



A/E Teams
clashing? YES.



CM/GC Teams
clashing? Yes.

CM/GC Teams
Modeling? YES.



DESIGN

CONSTRUCTION

OCP MOB Conflict avoidance example: 10th Floor Mech area:

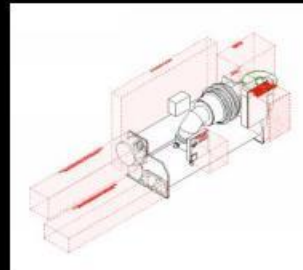
Potential for Cost Avoidance: \$565,000

Potential Value accrual to Owner: \$1,630,000 (Total Life Cycle Study)

A/E Teams 10th
produces model



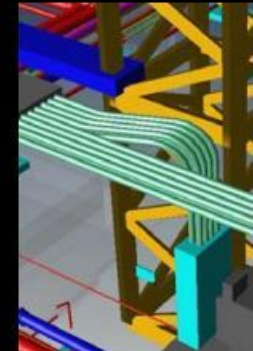
AEI performs equipment
access and selection study



CM Team adds cranes,
sequencing

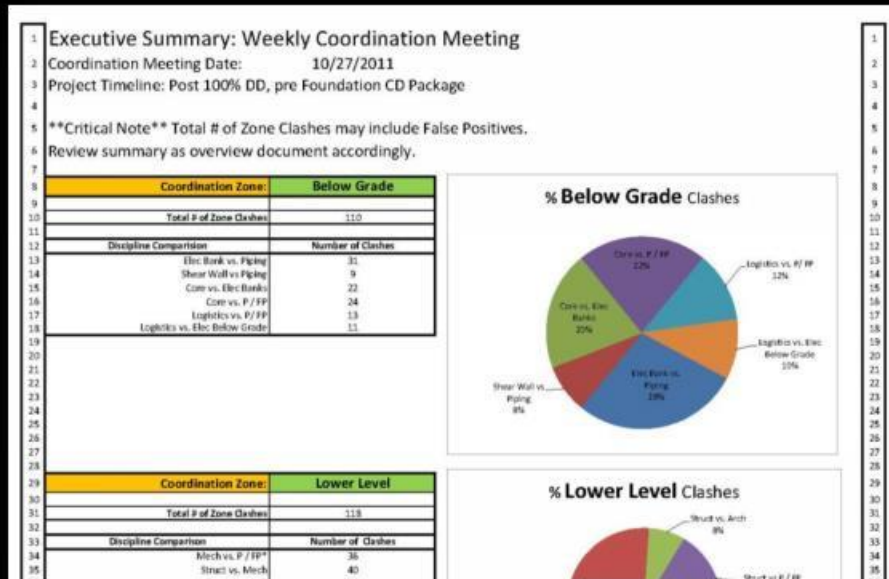


Subcontractors add
access and no fly zones.

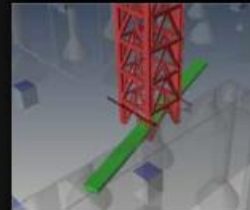


BIM: COST AVOIDANCE CLASH DETECTION

CLASH DETECTION – TRACKING METRICS



“...over 1,200 meaningful clashes prevented...” prior to 100% CD’s.



ACHIEVING MEASURABLE RESULTS: Owner Driven Benefits:

- Ensures Designer’s full participation
- More opportunity to engage Facilities & Operations
- Constant Transparency
- Change Management for Schedule and Budget
- More Frequent & Accurate Updates
- Concise & Consistent Reporting Metrics

OCP BIM – GMAX SUPPORT – TRACKING METRICS

At 100% DD, there were documented savings of roughly 200hrs in back-checking quantity counts, allowing estimators to focus on quality, and thoroughness, not counting.

E.G. OF TYP. CM QUANTITY REVIEW AT 60% CDS

- Centrifugal fan was added at level 15
- 806 heater motors (at level 10 and 25)
- 3,520 LF of pipe was added (HW/CHW)
- 4 chilled water and hot water pumps added - total to 39.
- 219 electric panels defined
- 64,086 LF of plumbing pipe in the current model
- 4,500 LF of cable tray, 6,928 LF of IDF conduit and 768 data racks
- 36,835 LF of major conduit (excluding branch wiring)

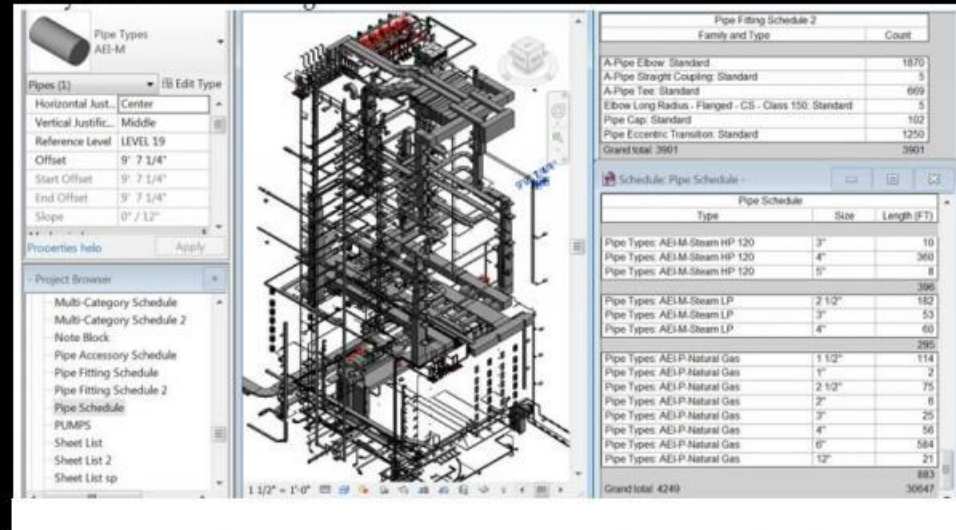
BIM: COST AVOIDANCE BIM IN SUPPORT OF GMAX

QUANTITY EXTRACTION – GMAX SUPPORT – TRACKING METRICS

Findings of BIM by the CM during DD: Improved accuracy and speed

Picture 1 - Concrete Garage Slabs

Family	Family and Type	Volume (CY)	Area (SF)	Perimeter Level	Struct Type
Floor	Floor, 10" Concrete	7.07	229	74 LF L02-T/SLAB	Yes 10" Concrete
Reinforcing Steel (1.5 LB/SF Allow)		0.17 TONS		PT Steel (0.8 LBS/SF Allow)=	0.09 TONS
Family	Family and Type	Volume (CY)	Area (SF)	Perimeter Level	Struct Type
Floor	Floor, 12" Concrete	1.77	48	28 LF T/FND BASEMENT	Yes 12" Concrete
Floor	Floor, 12" Concrete	1.77	48	28 LF T/FND BASEMENT	Yes 12" Concrete
Floor	Floor, 12" Concrete	1.77	48	28 LF T/FND BASEMENT	Yes 12" Concrete
Concrete (CY) =		5	144		
Reinforcing Steel (1.5 LB/SF Allow)		0.11 TONS		PT Steel (0.8 LBS/SF Allow)=	0.06 TONS
Family	Family and Type	Volume (CY)	Area (SF)	Perimeter Level	Struct Type
Floor	Floor, 12" Concrete	646.75	17462	587 LF L01-T/SLAB	Yes 12" Concrete
Floor	Floor, 12" Concrete	597.74	16139	867 LF L02-T/SLAB	Yes 12" Concrete
Floor	Floor, 12" Concrete	140.71	3799	293 LF L02M-T/SLAB	Yes 12" Concrete
Floor	Floor, 12" Concrete	94.84	2561	206 LF L03-T/SLAB	Yes 12" Concrete



BIM ENABLED DESIGN CHANGE COMPARISONS:

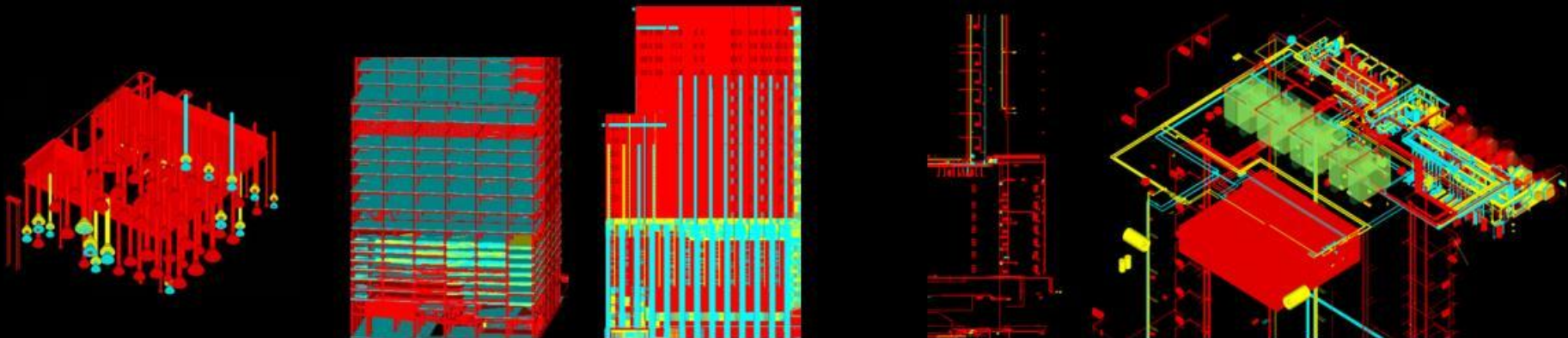
Comparing model iterations real time with budget review

- What is **Blue** is new, **Yellow** is old, **red** is unchanged

Structure

Enclosure

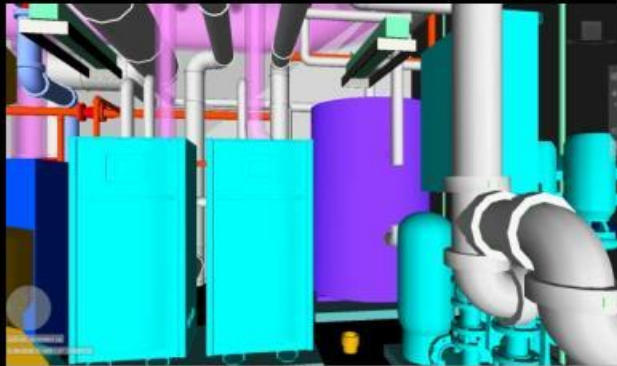
Piping systems



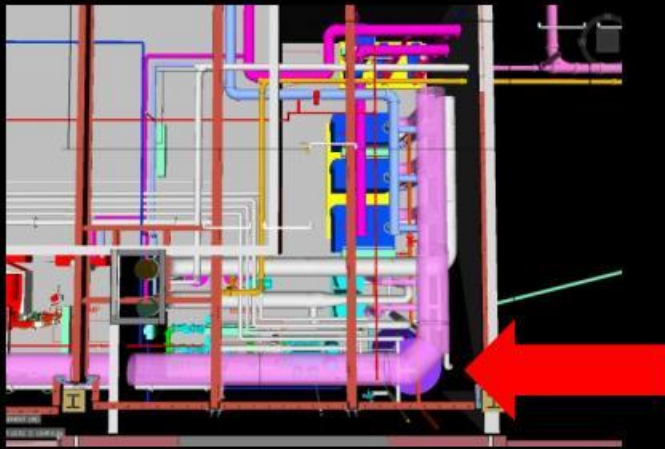
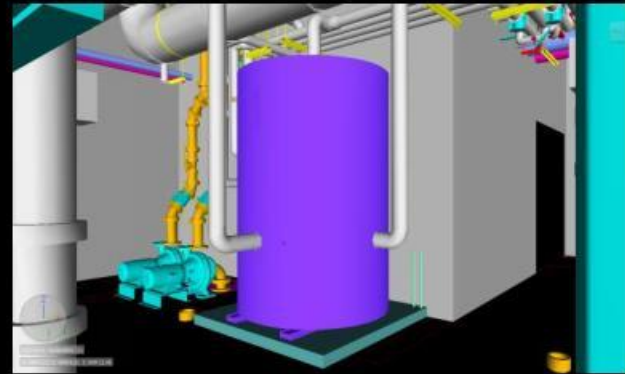
BIM: ACCESSIBILITY REVIEW

BOILER RELOCATION – CONSTRUCTION TEAM GUIDELINES

Before – No access



After – Access for maintenance

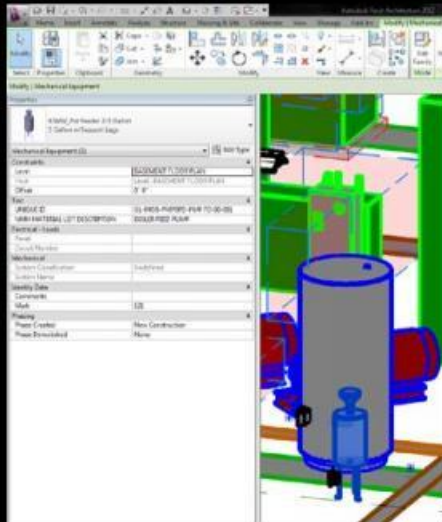


BIM-ENABLED FACILITY MANAGEMENT

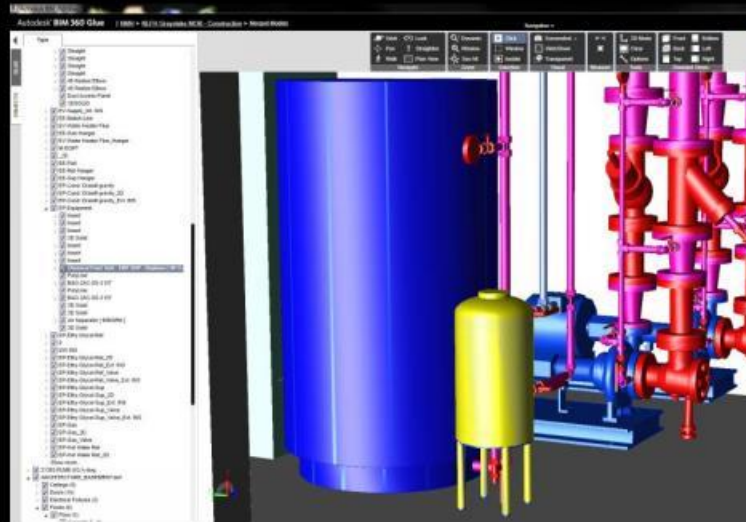
SOURCE OF TRUTH- CONSTRUCTION TEAM GUIDELINES:

- Integration of Multiple Datasets & Systems
- Contractually Required Model Content and System Information that Co-exist Among Multiple Databases

Autodesk® Revit



Autodesk® BIM 360 Glue



Plans and Specs

	Data Field	Field Type
1	Name	Alphanumeric
2	Barcode #	Alphanumeric
3	NMH Asset ProfileID	Number
4	Building	Alphanumeric
5	Floor	Alphanumeric
6	Room	Alphanumeric
7	Department ID	Alphanumeric
8	System	Alphanumeric
9	Part Of	Alphanumeric
10	Manufacturer	Text
11	Model	Alphanumeric
12	Serial #	Alphanumeric
13	Warranty Start Date	Date
14	Warranty End Date	Date
15	Special Instructions	Yes/No
16	Serviceable Components	Yes/No

BIM INITIATIVES WE ACHIEVED

MEASURED RESULTS:

- Standardization of design spaces
- Early-design energy modeling
- Design review
- Design-side clash detection
- Cost Estimation
- Construction clash detection
- 4D-Linked to construction schedule
- Capturing facility information
 - BIM Model
 - Spreadsheets
 - Photo-documentation
- SiteFM, ATG, Plans&Specs Integration
- RFI and Change order Integration

FOR FURTHER DEVELOPMENT:

- Virtual Reality Design Reviews / User Training / Wayfinding
- End-of-design Energy Modeling

ENTERPRISE WIDE SUCCESS: SETTING THE STAGE - NEXT STEPS:

- Ensuring building data is accurate, organized, and accessible through lifecycle
- Energy Modeling and Forecasting for purchasing
- Enhanced Design Reviews & User Group input
- Standardization / Modules for Safer Environments
- Property & Real Estate Management as the Owner transitions to multi-campus
- BIM now = Business Information Management



MULTIPLE APPLICATIONS INTER-OPERATING

