

# W211: BIM and Integrated Project Delivery: A Roadmap for Adoption and Implementation for the Federal Marketplace

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Presented by:

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# Kristine K. Fallon, FAIA

- ▶ Managed information technology in major AE firms
  - SOM (Associate)
  - A. Epstein (VP/CIO)
- ▶ Founded KFA in 1993
- ▶ AIA Technology in Architectural Practice Advisor
- ▶ buildingSMART Board of Direction
- ▶ Author of books and many articles
- ▶ Developed computer curriculum for architectural and construction management programs

# Kristine Fallon Associates (KFA)

- ▶ KFA provides information technology consulting to the design and construction industry
- ▶ Clients include:
  - Public agencies
  - Corporate facility groups
  - Builders
  - Designers
  - Manufacturers
  - Technology providers

# KFA BIM Involvement

- ▶ Walsh Construction
  - Building systems coordination
  - Model management
- ▶ GSA 3D-4D-BIM Pilot Program
  - 2D to 3D conversion
  - Spatial program validation modeling
  - Energy modeling and analysis
  - 4D for tenant phasing and construction sequencing
  - MEP system attributes to FM
- ▶ National Institute of Standards & Technology
  - Research on BIM data interchange
  - Publications:
    - ▶ Capital Facilities Information Handover Guide (NISTIR 7259)
    - ▶ General Buildings Information Handover Guide (NISTIR 7417)
- ▶ BIM Consulting & Training

What is the market  
driver?

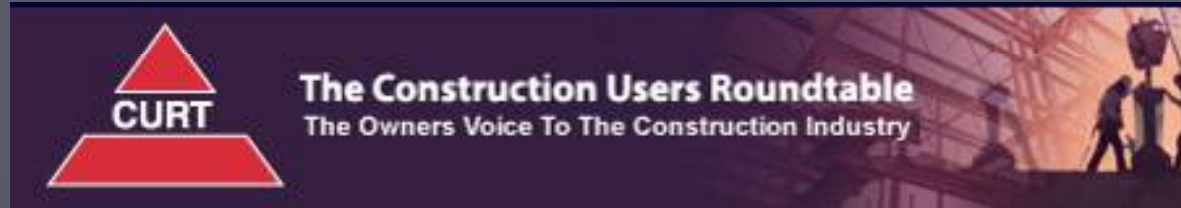
# Today



Image source: Jim Bedrick, Webcor Builders

- ▶ 45 Subcontracts
- ▶ 35 supervisory people for GC alone
- ▶ Upwards of 600 people on the site

# Owners Are Demanding Change

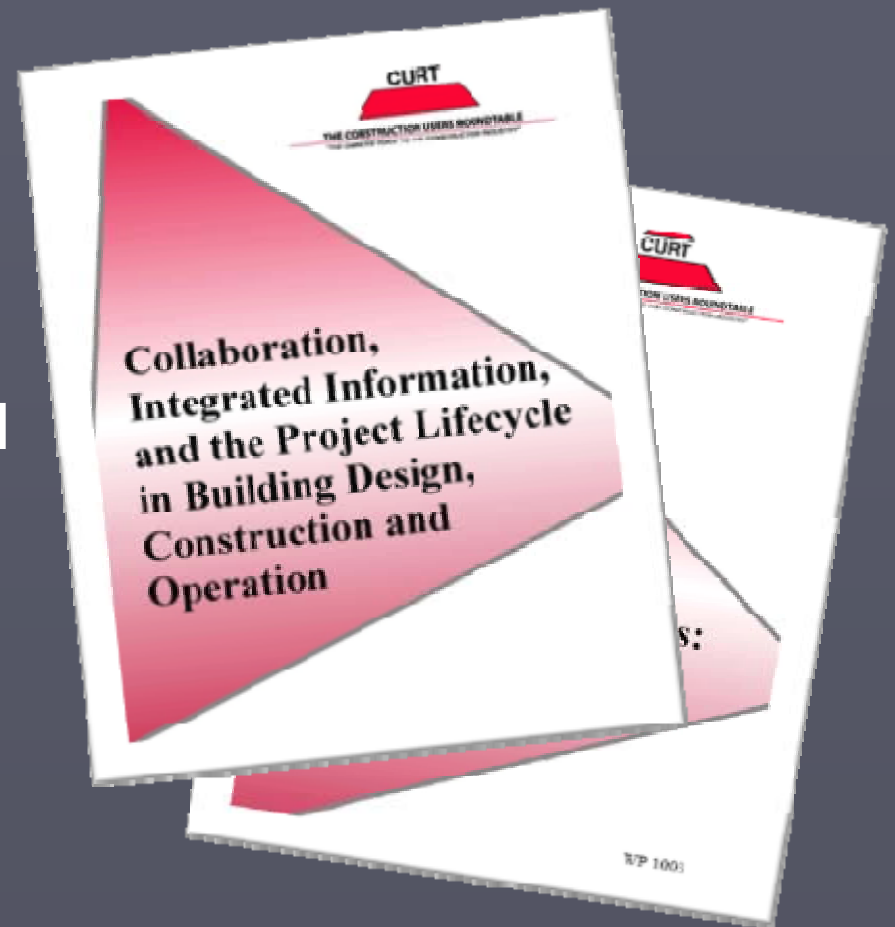


Boeing  
Caterpillar  
Cisco  
Citigroup  
DaimlerChrysler  
Dow Chemical  
Eastman Kodak  
Ernst & Young  
Exxon Mobil

General Motors  
General Services Administration  
IBM  
Intel  
Shell  
Toyota  
US Army Corps of Engineers  
Walt Disney Imagineering  
Weyerhaeuser

# CURT White Papers

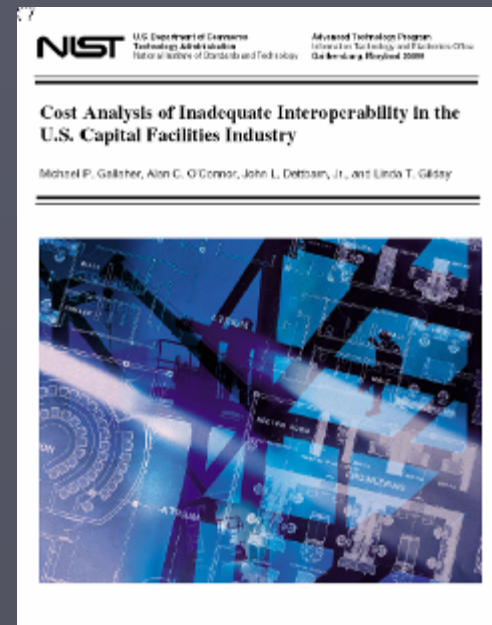
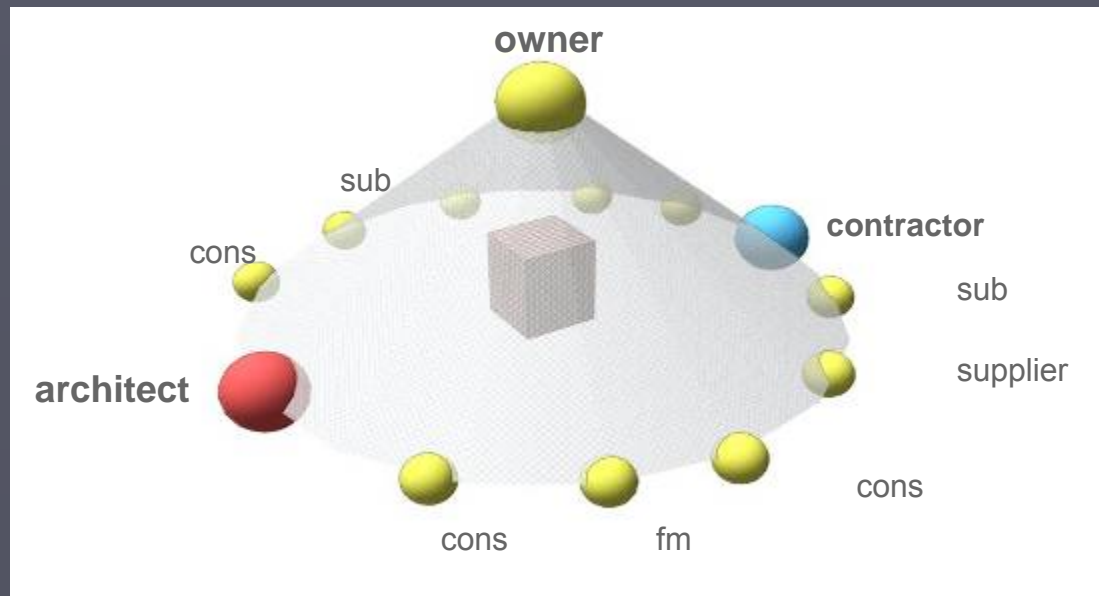
**Building owners, particularly those represented by CURT, regularly experience project schedule and cost overruns. As a result, CURT has directed this task force to evaluate how alternative processes – namely, use of information technology combined with changes in project structure and delivery processes – might address these issues.**





# AIA TAP: Inevitable Technologies

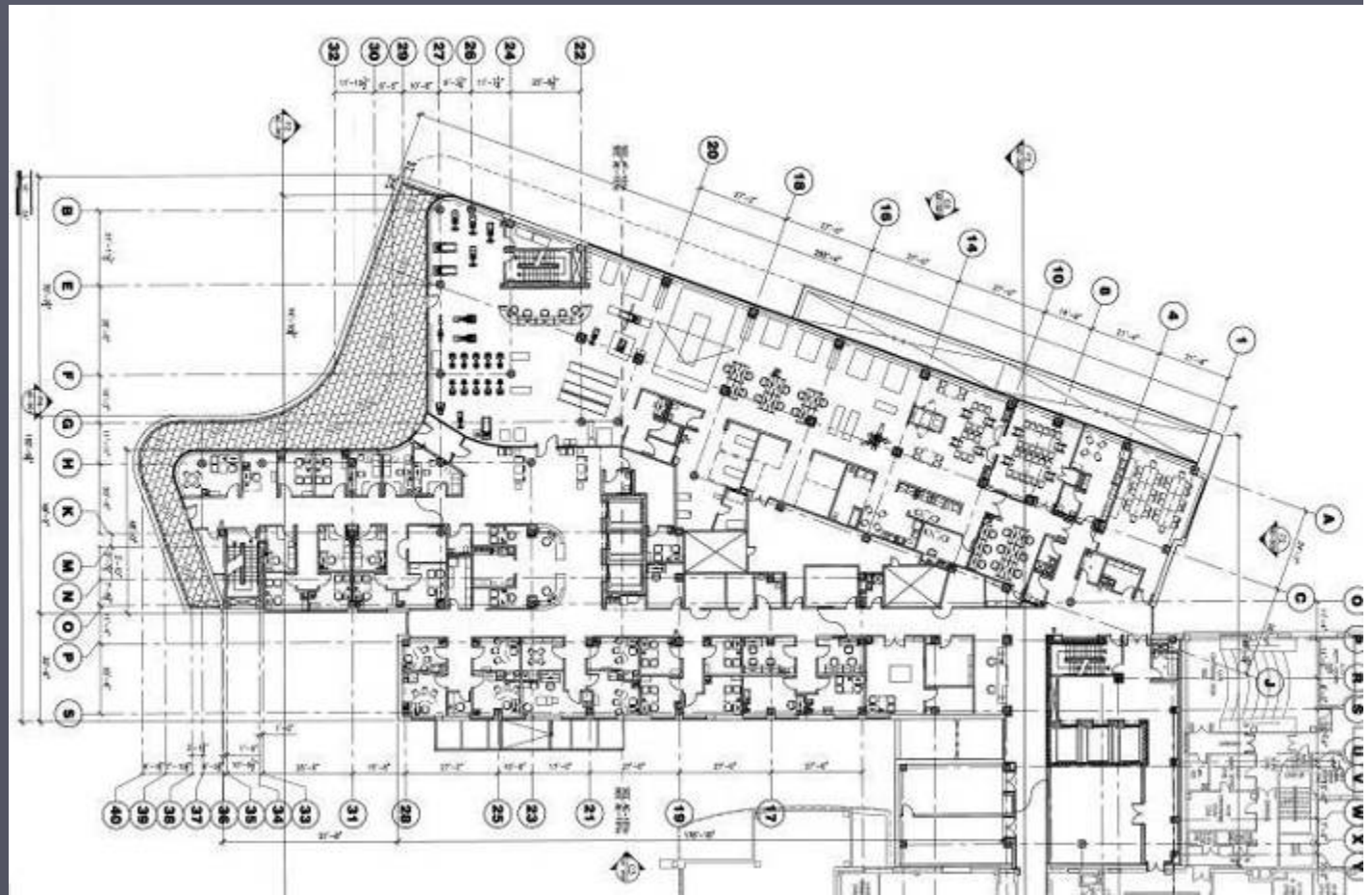
- ▶ BIM
- ▶ Collaboration
- ▶ Interoperability



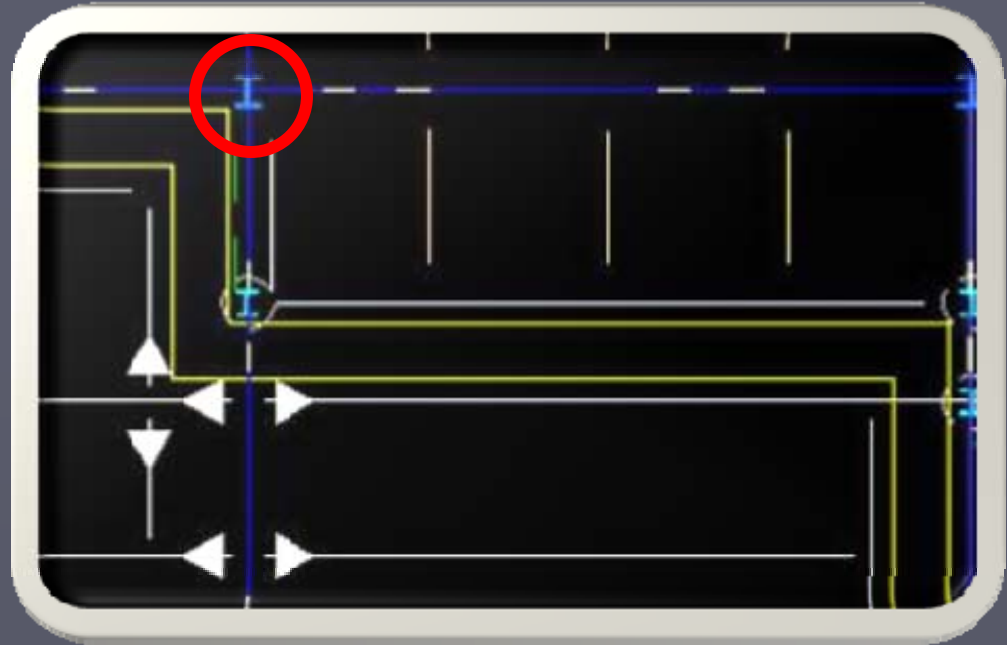
# Building Information Modeling (BIM)

# Paradigm Shift

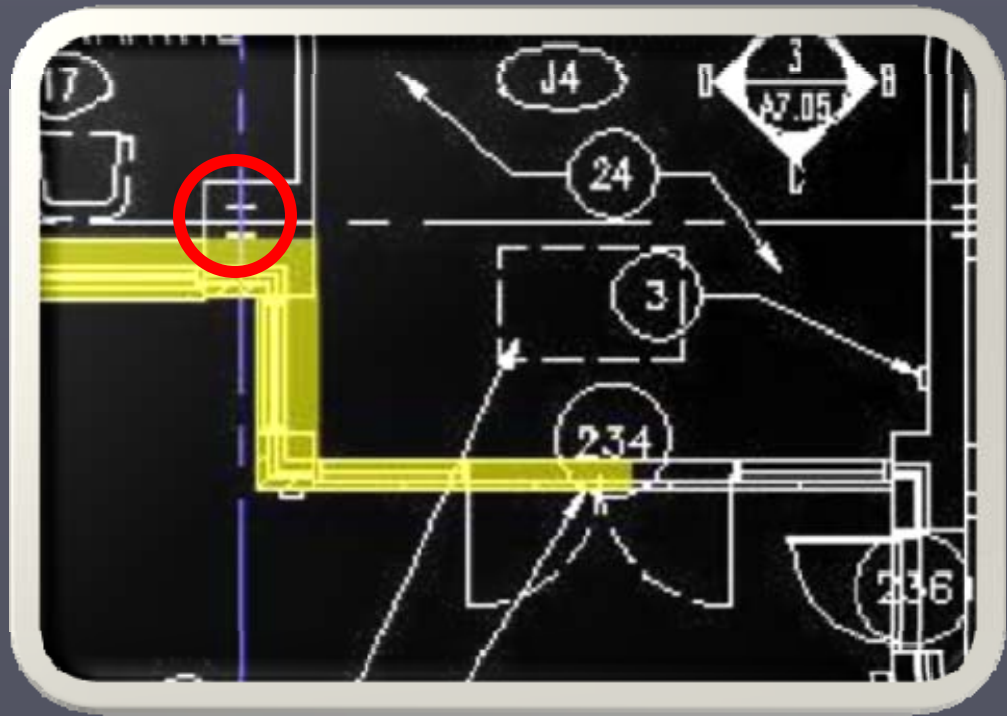
- Old: Drawings
  - 2D
  - Symbolic representations

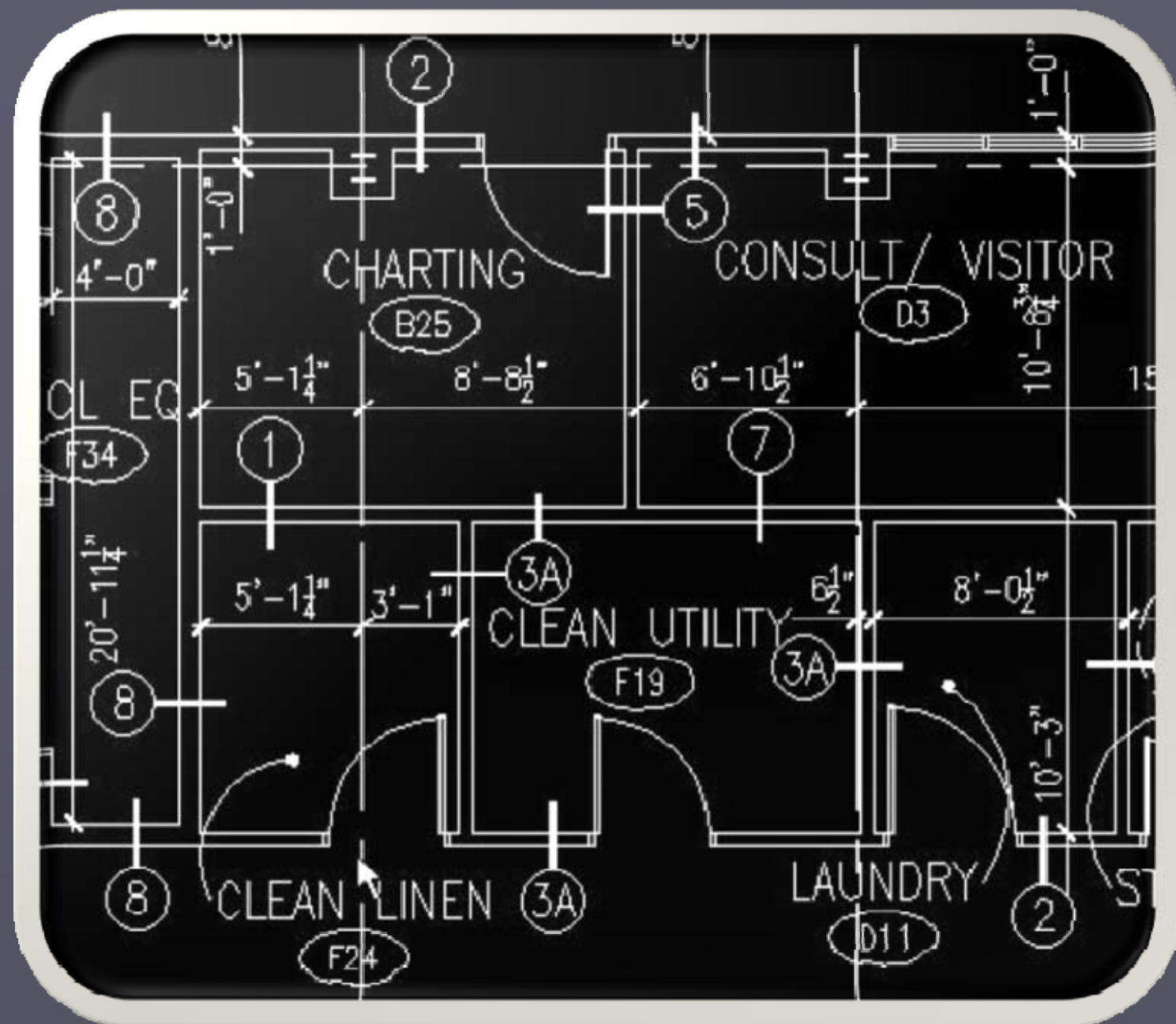


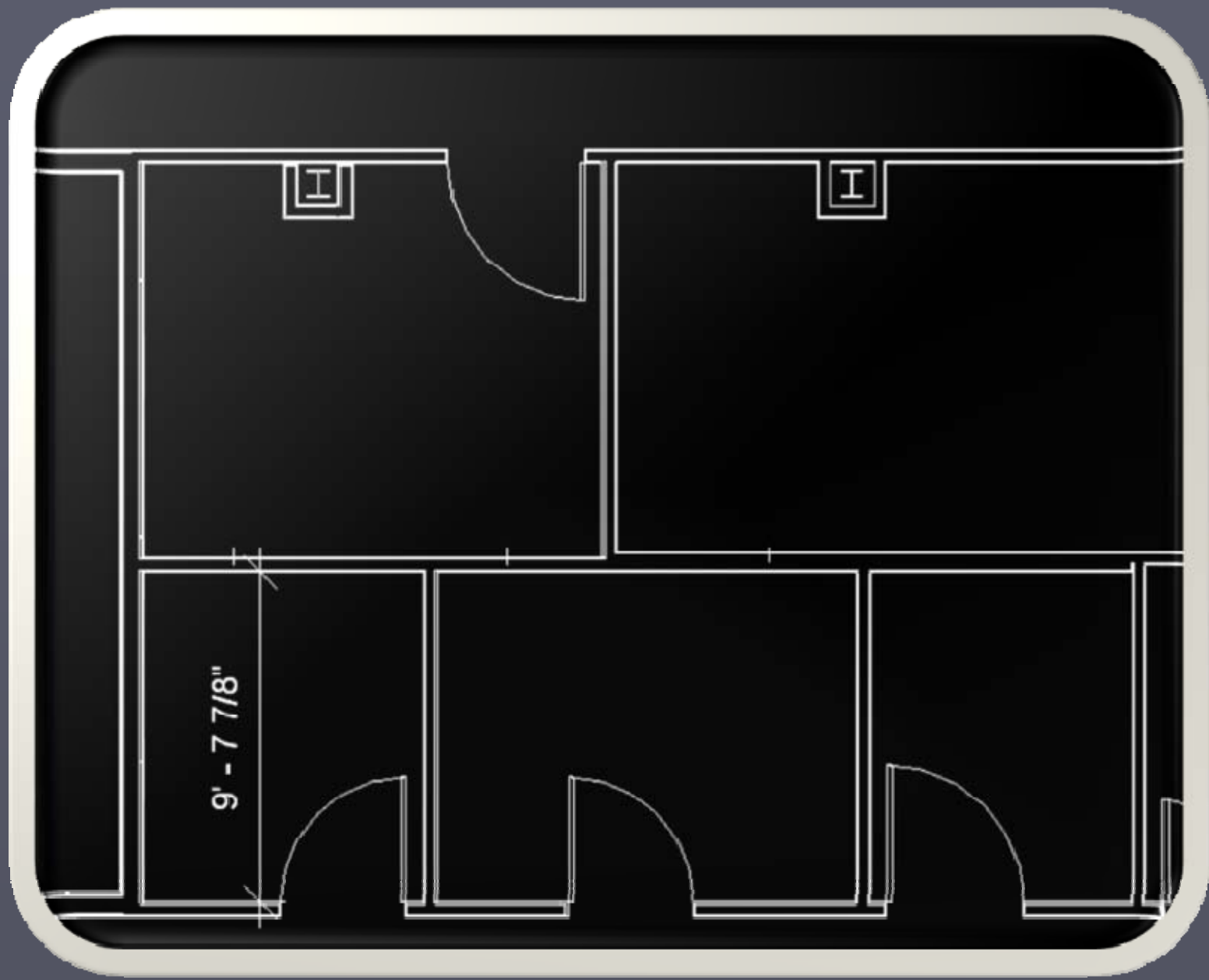
**Structural:**



**Architectural:**







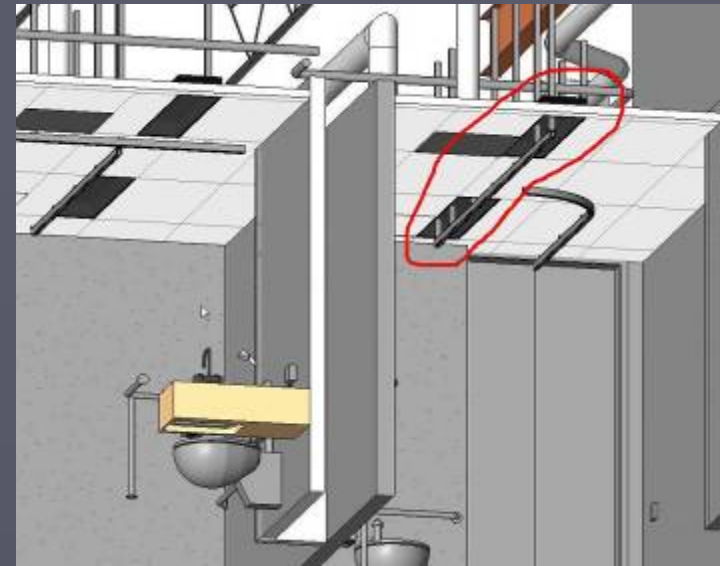




# Paradigm Shift

## ► New:

- 3D
- Model is assembled from “virtual” building elements:
  - Walls, slabs, beams, columns, ducts, pipes, etc.
- Complete (to some level of detail)
- Unambiguous (non-symbolic)
- Machine-interpretable





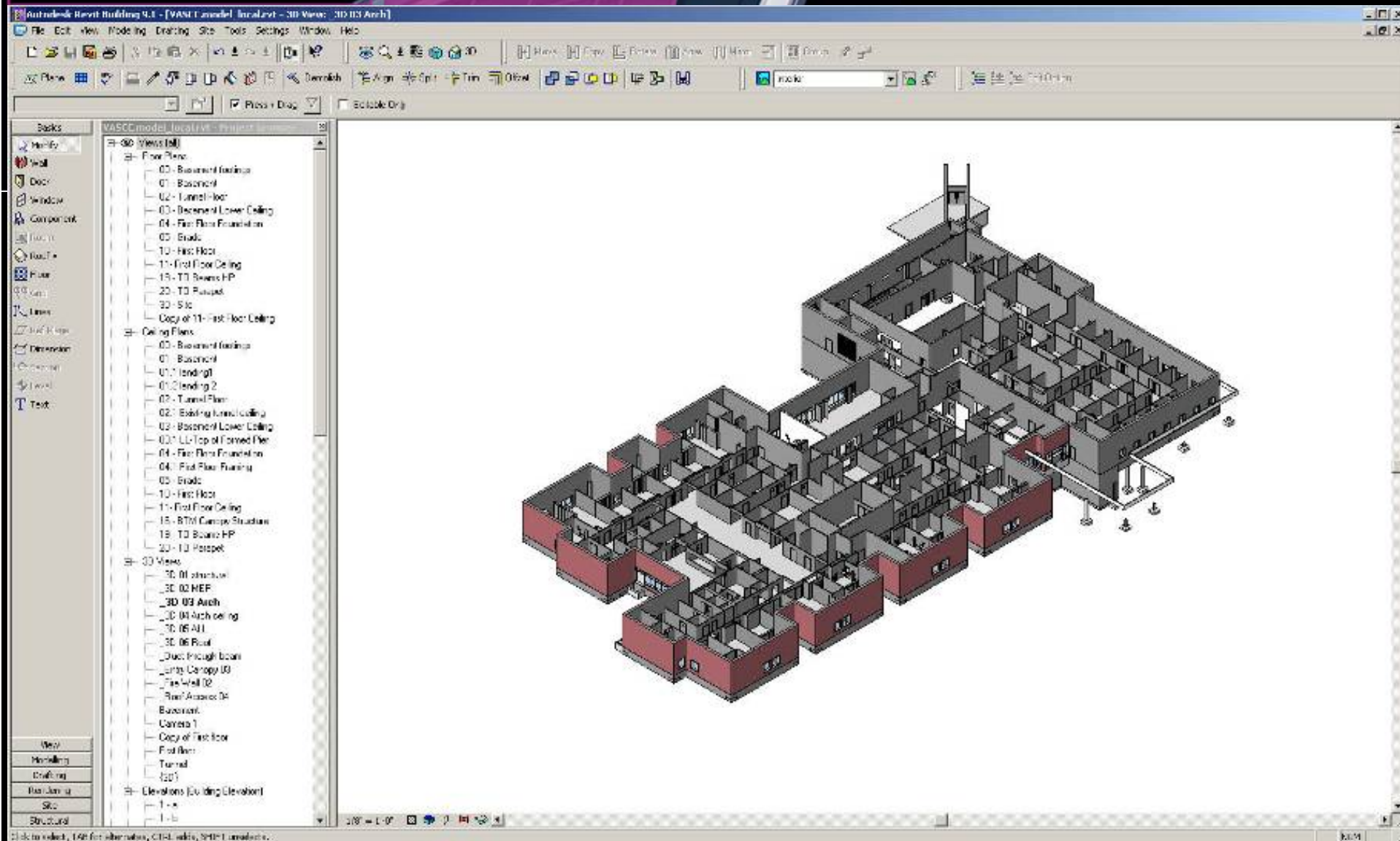
# BIM Authoring Software

- ▶ Creates a single, graphical and informational building database
- ▶ Provides tools for:
  - Selecting/ creating/ editing construction products and assemblies
  - Managing the relationships among building components
  - Maintaining associated data
  - Generating multiple views of the model
    - ▶ 3D views
    - ▶ 2D drawings
      - Plans
      - Sections
      - Elevations
    - ▶ Reports of associated data
    - ▶ Bills of materials
  - Identifying interference conditions
  - Driving fabrication

# Revit

## Architecture

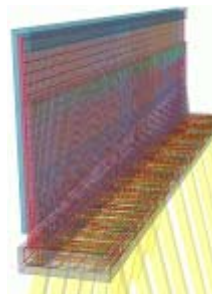
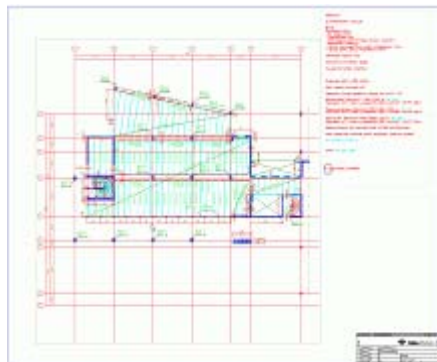
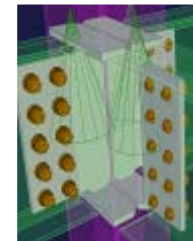
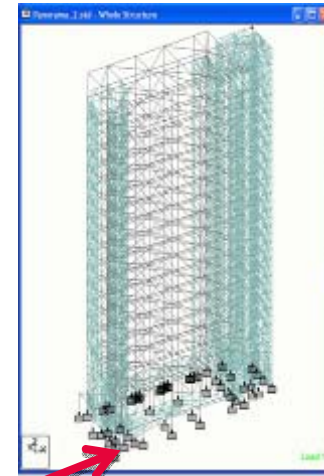
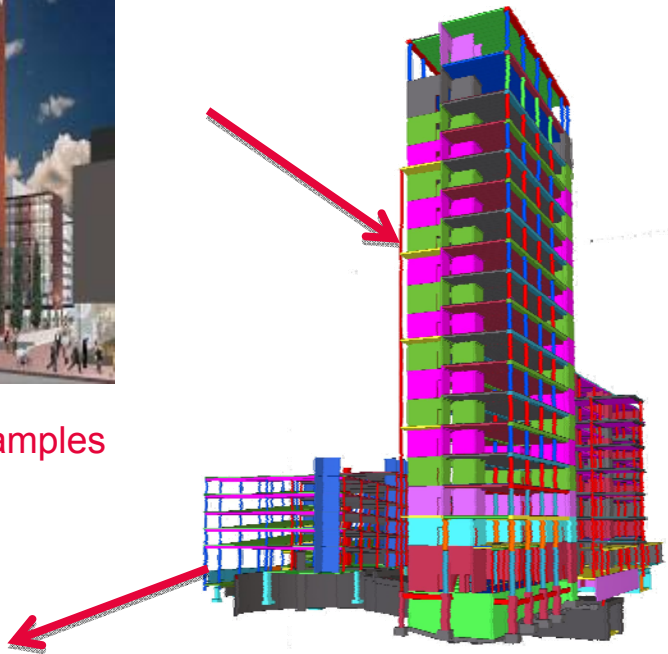
Purpose-built building information modeling software that works the way you think, so you create naturally, design freely, and deliver efficiently.





Panorama Tower, Finland

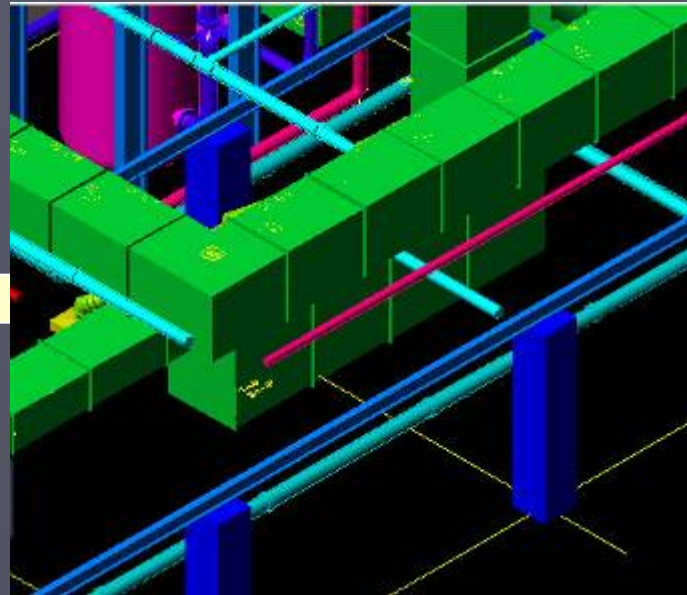
Import/Export Samples



# Ductwork, Plumbing

- ▶ CADPIPE
- ▶ QuickPen

Estimating



Fabrication





## HOME

WELCOME

NEWS

TO M.E.P.CAD

## FEATURES

INTELLIGENT ELEMENTS

QUICK DESIGN WIZARDS

ADVANCED HYDRAULICS

REUSABLE COMPONENTS

DWG / DXF COMPATIBLE

STOCK LISTING

## SALES

NEW FEATURES

TESTIMONIALS

SYSTEM REQUIREMENTS

PURCHASE AUTOSPRINK

## SUPPORT

ONLINE MANUAL

TRAINING

MESSAGE FORUMS

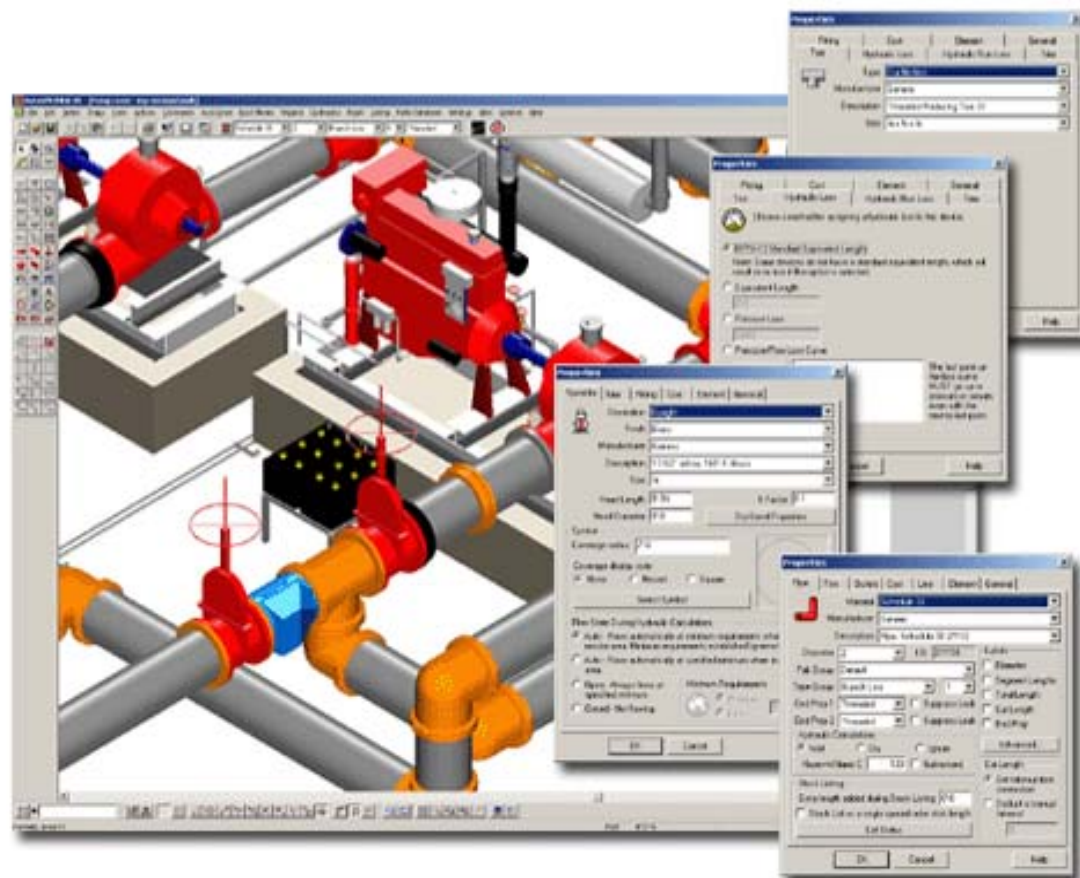
AUTOSPRINK Q&A

DOWNLOADS & UPDATES

TECHNICAL SUPPORT

# AutoSPRINK® VR

## Intelligent Elements



"Internally intelligent" elements emulate real world construction components in both appearance and performance taking on the exact characteristics of their real life counterparts. An AutoSPRINK VR pipe for example "knows" among other things, its size, pipe type and material, internal diameter, and Hazen/Williams C-factor; it also knows it has two pipe end-preps and must connect to another pipe, fitting or device

# BIM Vision:



Image source: Autodesk

# Transitional Phase

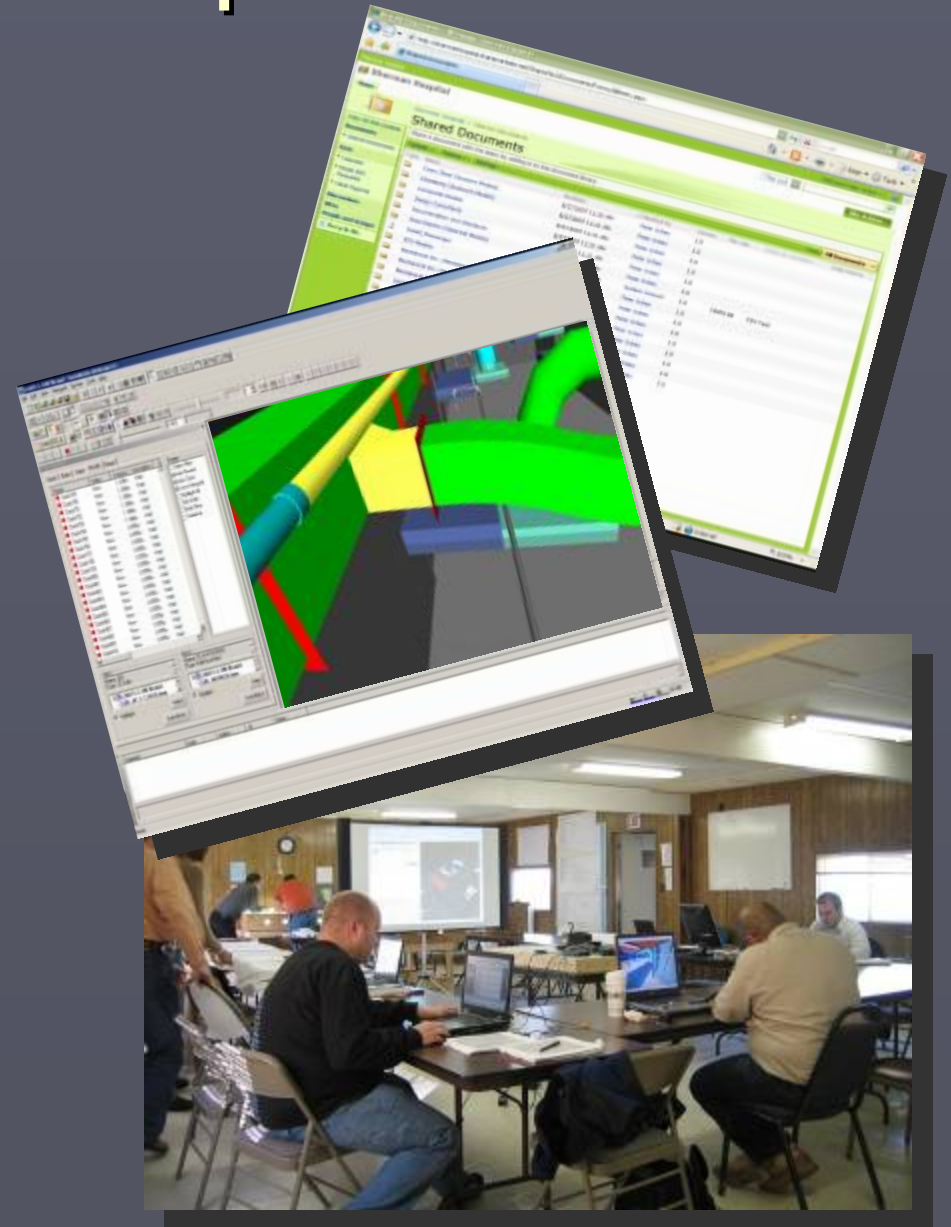
- ▶ A/E produces 2D drawings
- ▶ BIM modeler creates 3D models based on 2D CAD files
  - Architectural
  - Concrete structure
- ▶ Subcontractors/fabricators model individual systems
  - Structural steel
  - HVAC
  - Plumbing
  - Electrical
  - Fire Protection
- ▶ Model manager merges all 3D models to perform interference checks

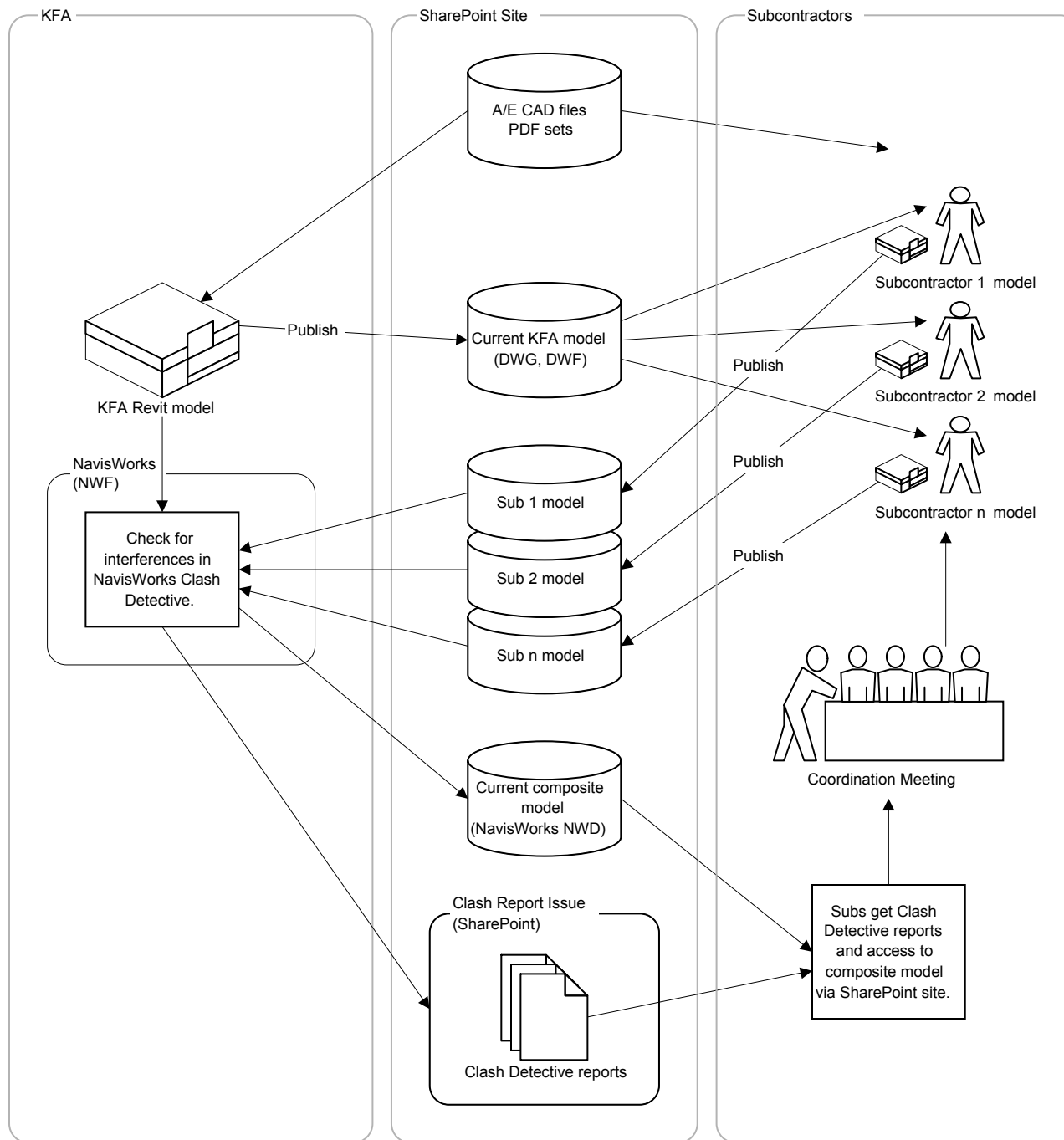
# Collaboration

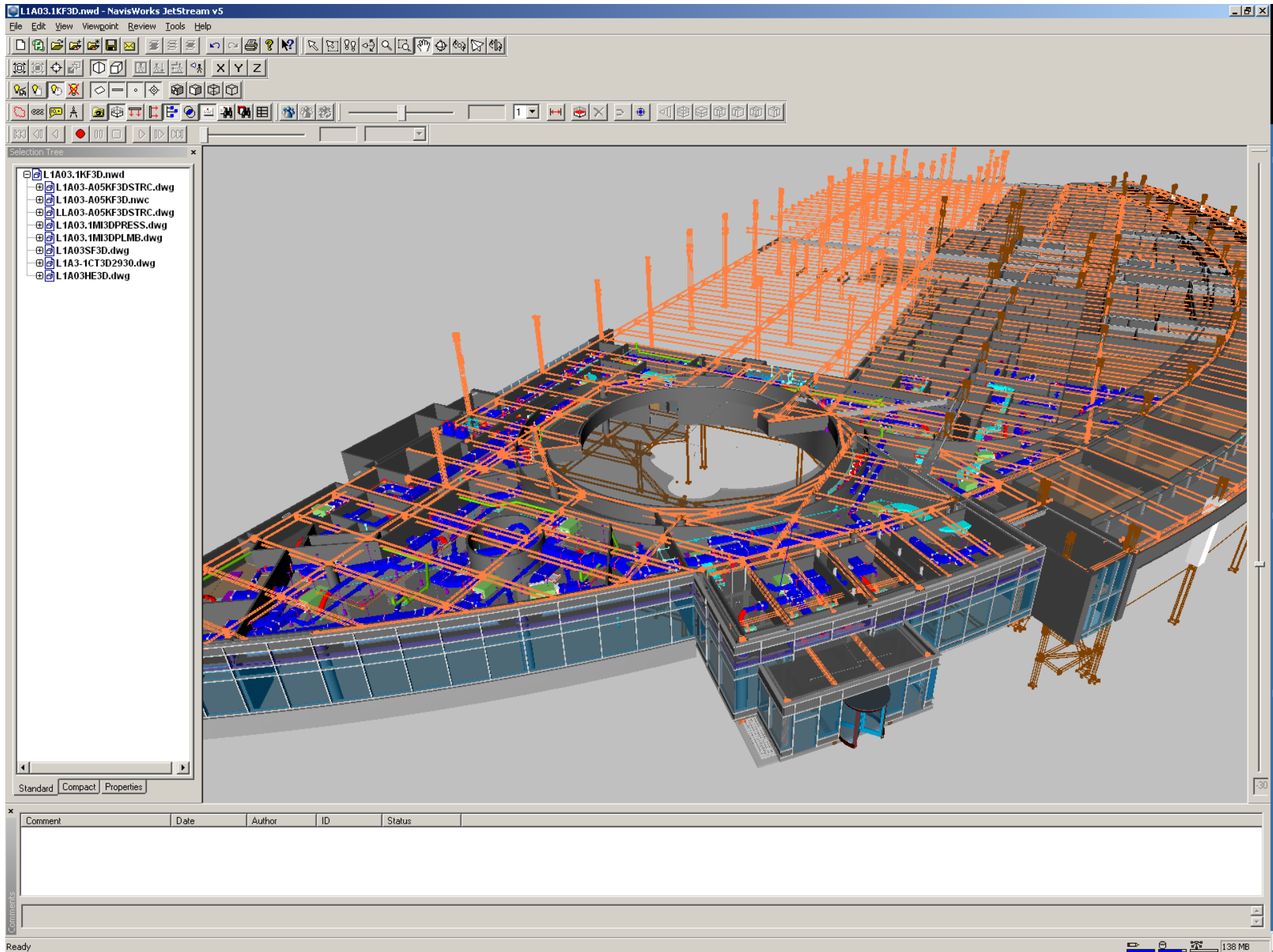


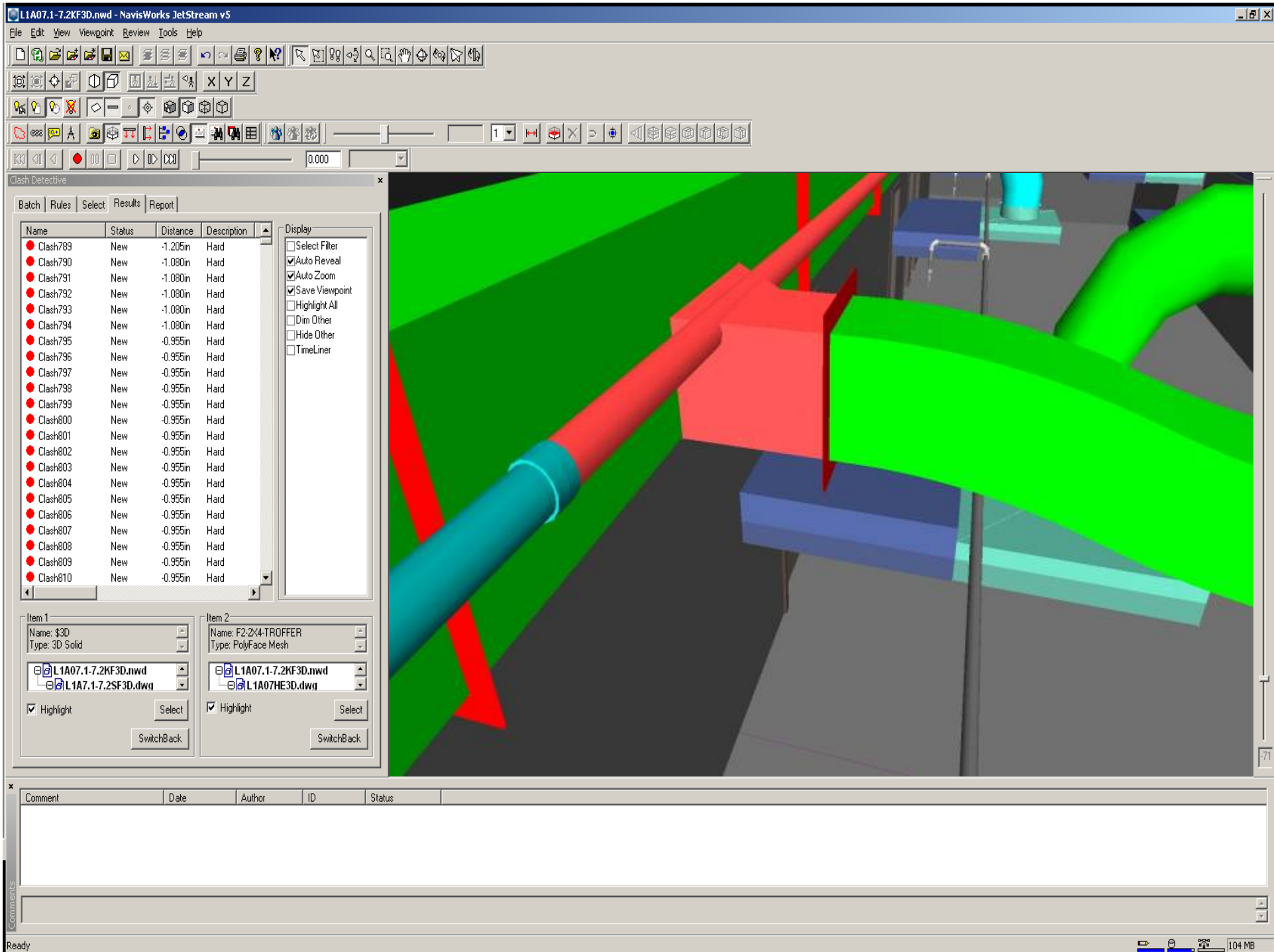
# New Tools & Techniques

- ▶ Multiple BIM products
- ▶ NavisWorks Clash Detective
- ▶ NavisWorks Freedom
- ▶ Interactive clash review sessions
- ▶ Website for sharing models, clash reports







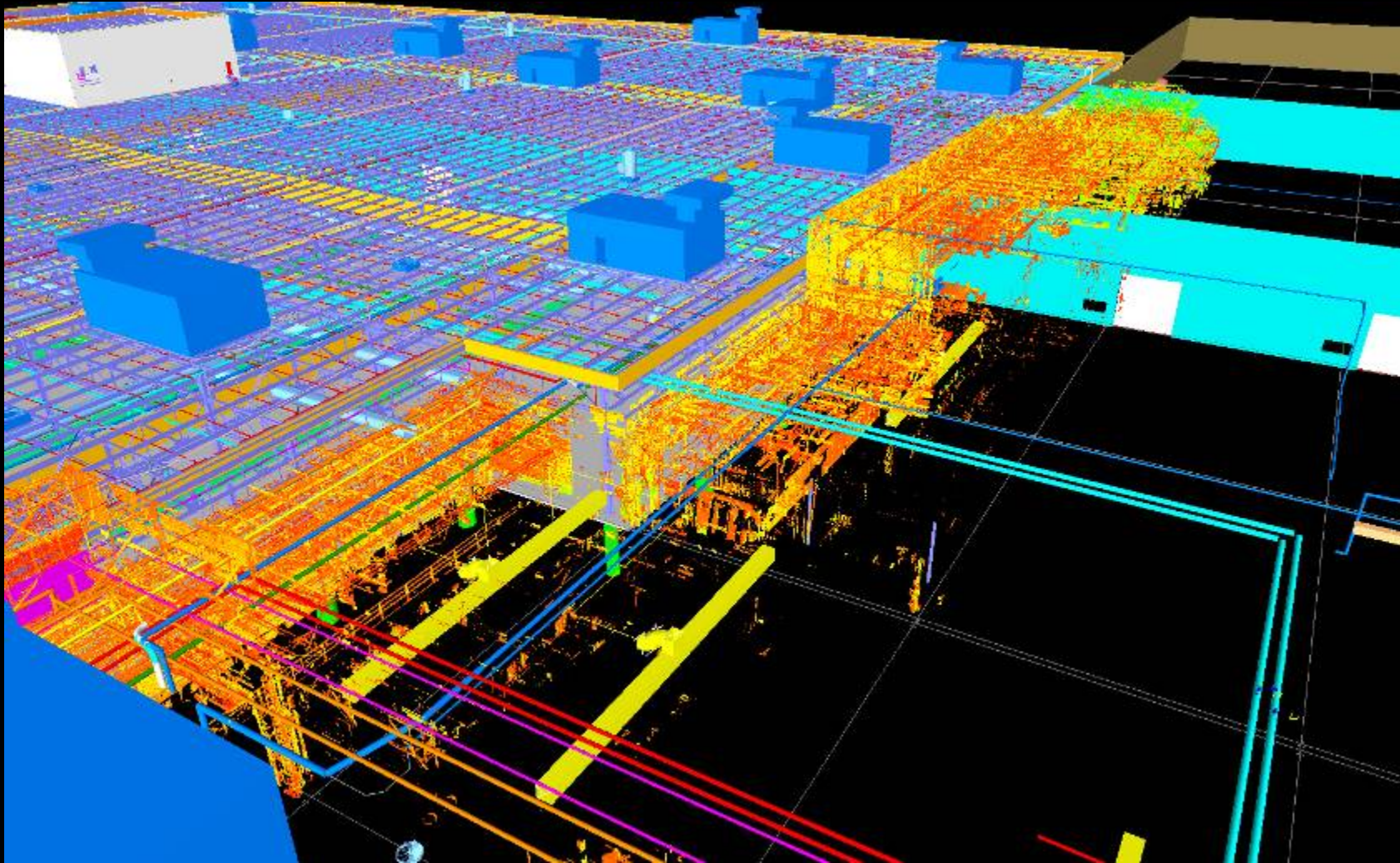


# Benefits Realized

- ▶ 1/10<sup>th</sup> of the field rework compared with other projects
- ▶ More is fabricated off site, in controlled environments, and not sitting in field
  - Better safety
  - Improved quality
- ▶ Up front time investment by 12 people in the trailer leverages the time of 150 in the field
  - Fewer work stoppages to resolve problems
  - No need to reassign people while tasks are on hold
- ▶ MEP substantial completion projected about 2 months ahead of schedule



# GM Virtual Factory Initiative



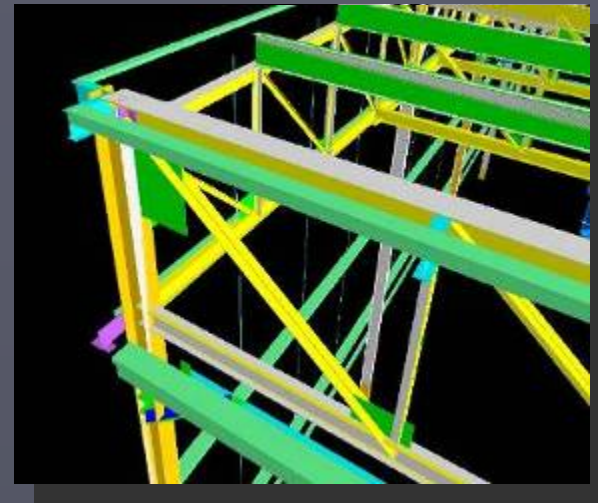
# GM Virtual Factory Initiative

- ▶ Lean construction approach
- ▶ 3D/4D technology-enabled design/build project delivery process
- ▶ Four automotive plant projects completed, 2004 -2006
- ▶ Extended the use of these technologies with each project

# Build It First Virtually

- ▶ Build 100% complete 3D model incorporating all elements:

- Architectural
- Structural
- Mechanical
- Electrical



- ▶ Include shop drawing-level details provided by the subcontractors and fabricators
- ▶ Identify and resolve all interferences before the start of construction.
- ▶ Build to the model, without deviations



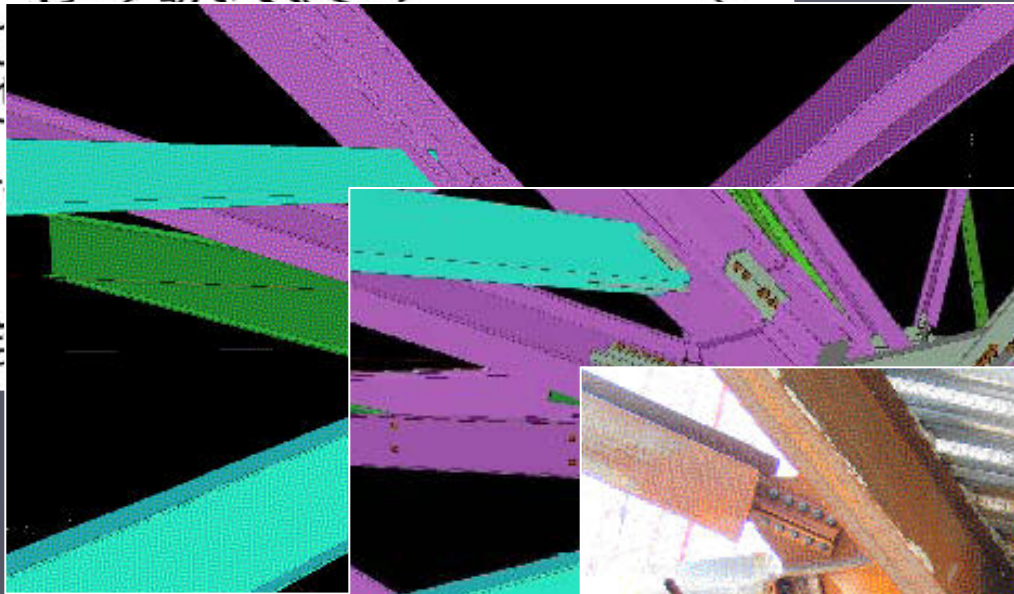
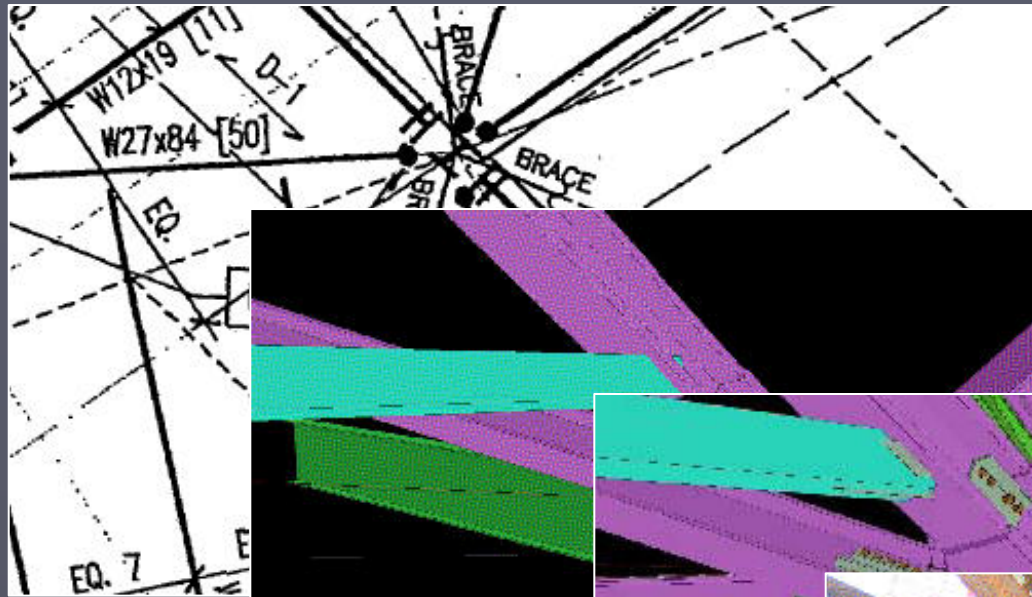
# Benefits Realized

- ▶ Improved site safety
  - More off-site fabrication
  - Fewer people on-site
  - Less material staging and debris
- ▶ Six-figure savings in trash removal
  - Green impact
- ▶ By 2<sup>nd</sup> project:
  - Design/construction time reduced 28% over design/bid/build
  - All building systems interferences resolved in model before construction began
- ▶ Change orders, historically 8-10% of project cost reduced to less than 0.5%

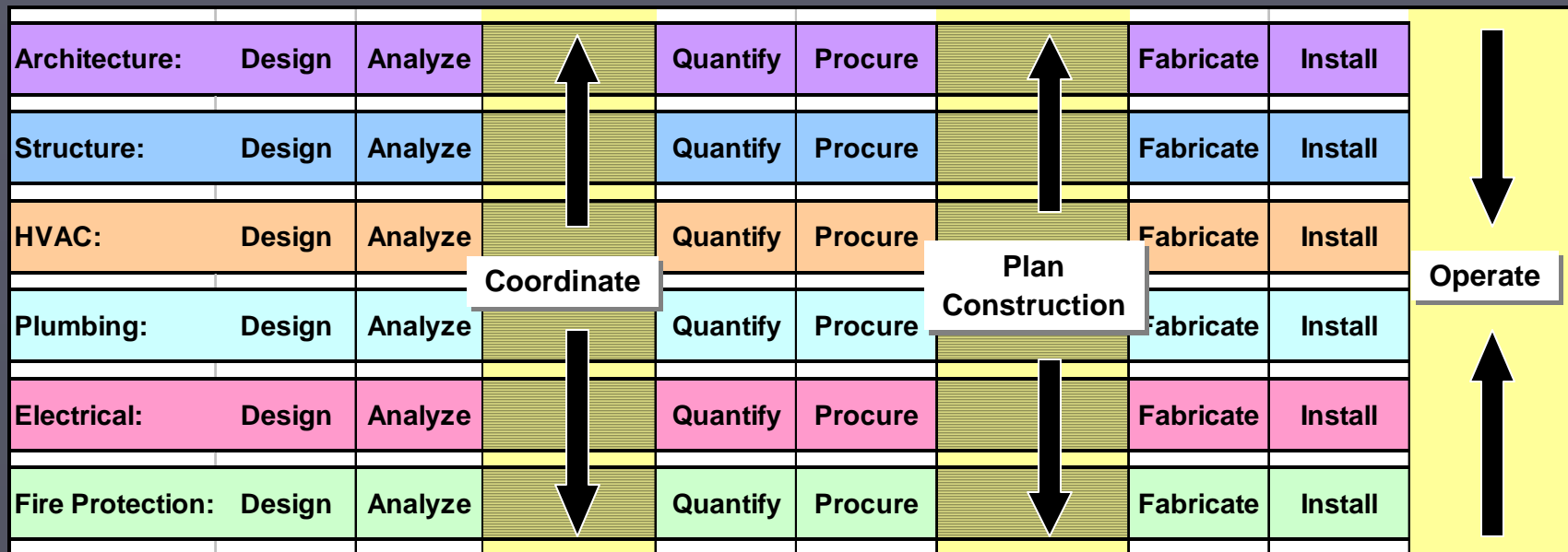
# Interoperability

# BIM Vision





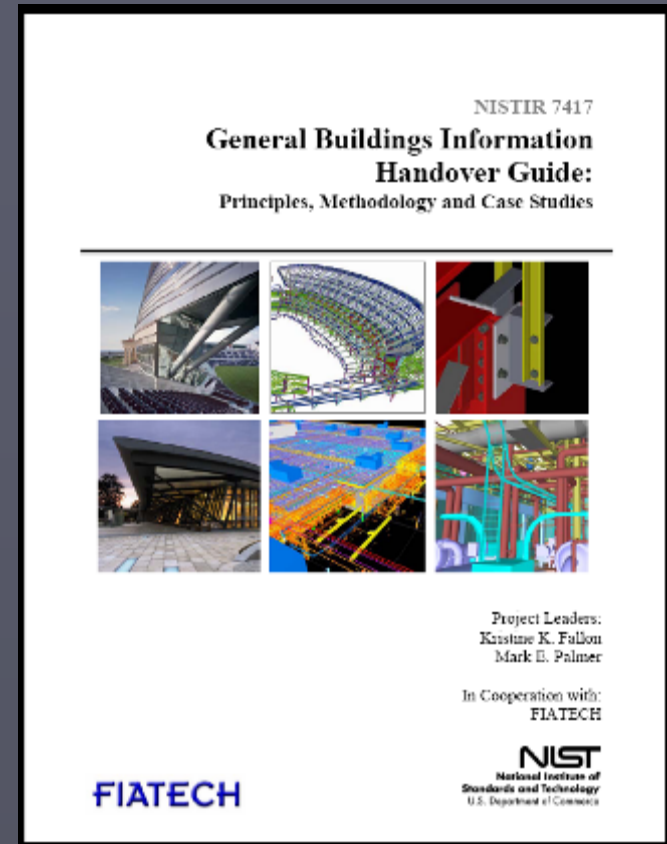
# Need for Interoperability



# BIM/ Interoperability Research

- ▶ General Buildings Information Handover Guide: Principles, Methodology, Case Studies (NISTIR 7417), 2007

[http://cic.nist.gov/staff/NISTIR\\_7417\\_GBIHG\\_2007-08.pdf](http://cic.nist.gov/staff/NISTIR_7417_GBIHG_2007-08.pdf)



“The most complete, comprehensive and useful document written to date on BIM that I have seen” - Tom Faraone, AISC

# Lessons Learned by Early Adopters

- ▶ Keys to success:
  - Human Factors
  - Quality of Collaboration

# Human Factors

- ▶ Corporate sponsorship
- ▶ Grassroots leadership
- ▶ Buy-in by the team
- ▶ Sophisticated users: skills, process flexibility and tools



# Quality of Collaboration

- ▶ Transparency & accessibility of information for more people
- ▶ Ability to use the information across the design/ construction team
- ▶ Collaboration, including the trades
- ▶ Mutual trust
- ▶ Recognition of new project roles, especially the Information Manager

# Lessons Learned by Early Adopters

## ► Barriers exist:

- Commercial
- Behavioral
- Technological

# Commercial Barriers

- ▶ Model ownership and use
  - New roles, responsibilities and risks
  - New contract language required
  - Does insurance cover?
- ▶ Conflicting business models
- ▶ Traditional process, phasing and content of deliverables
  - Entrenched expectations
  - Defining deliverables in this new environment
- ▶ Need for continuous training (time and money)

# Behavioral Barriers

- ▶ Internal staff
  - Resistance to change
  - Ability to think/problem solve in new ways
- ▶ Conservative attitude of some professions resisting new information delivery methods
- ▶ Clients expect “More for Less”
  - Why do you think/expect my model is reusable by others?
  - If it is, then why shouldn't you have to pay for the portion of their work that I completed?
- ▶ Owners must understand and lead

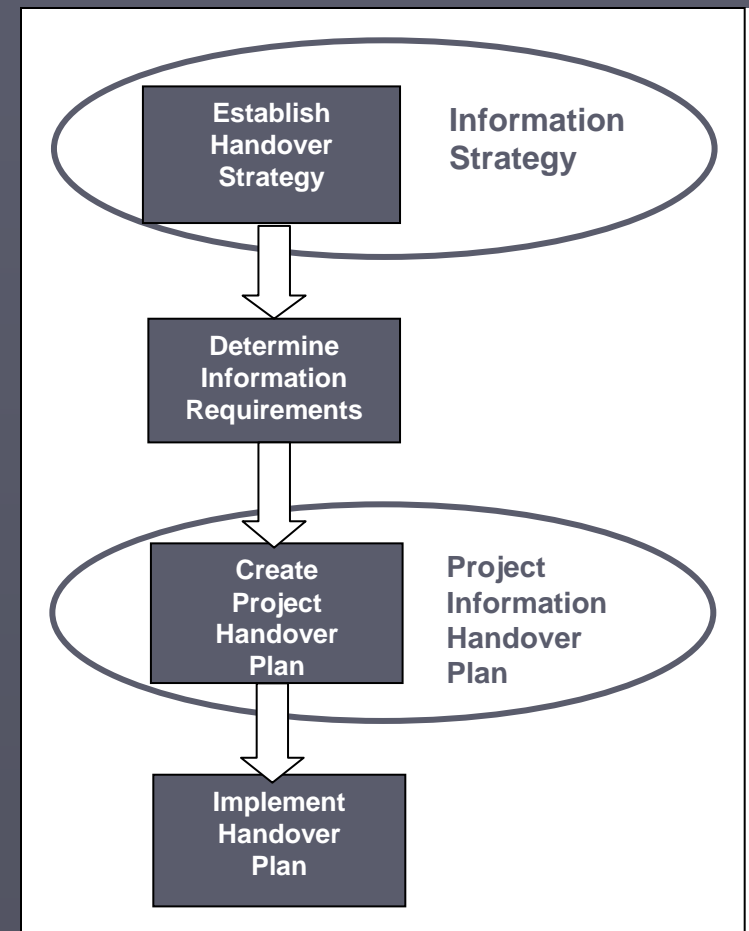
# Technological Barriers

- ▶ Software compatibility
- ▶ Data re-usability
  - Effort required to make the information usable by others
  - Worse in 2-way exchanges
- ▶ Lack of standard “views” for information
- ▶ Infrastructure
  - Wireless access, speed (processing time, bandwidth), appropriate viewing devices
  - Collaborative tools
  - Model repository: central model for all of the team: single authoritative source vs. distributed control of copies of the central model
- ▶ Persistence of 2D standards
- ▶ “Hybrid” (part electronic/ part paper) processes vitiate benefits
- ▶ Disparate levels of IT infrastructure and understanding, e.g. structural engineer vs. construction site



# Handover Guide Methodology

- ▶ Information handover strategy
  - What information packages do you need?
    - ▶ Regulatory requirements
    - ▶ Asset management
    - ▶ Operations
    - ▶ Maintenance
  - When do you need them?
  - Where do they come from?
- ▶ Information requirements
  - Detailed contents of each package
  - Data format
- ▶ Project Handover Plan
  - Combined requirements
  - Responsibilities
  - Timing of exchanges
- ▶ Project implementation
  - Contractual terms
  - Technical approach
  - Procedures
  - Training for all team members



# Remaining Challenges

- ▶ Today, we are achieving some effective information handovers
  - CIS/2 works well for steel
  - Other exchanges are worked out by project teams over a period of several weeks
- ▶ This is a huge cost to the construction industry!
  - Repeated for every project
- ▶ An owner presently cannot receive an integrated model useful for ongoing O&M activities

# Interoperability Initiatives

- ▶ Define common “information packages” that need to be exchanged
- ▶ Select a standard data format for the exchange
- ▶ Create appropriate model views
- ▶ Encourage all software vendors to support those model views

# Examples

## ▶ AISC CIS/2 initiative

- Started in 1999
- Has been effective in streamlining exchange of structural steel data:
  - ▶ Design
  - ▶ Analysis
  - ▶ Detailing
  - ▶ Fabrication
  - ▶ Erection

## ▶ buildingSMART/NBIMS initiative based on IFCs

- Extremely broad design/ construction/ operations coverage
- Needs industry groups to
  - ▶ Define needs
  - ▶ Champion development and implementation
  - ▶ Provide funding

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