Autodesk® InfraWorks™ 2014: Realizing the Potential of a Fully Integrated BIM Process

How many Autodesk products does it take to change a light bulb?

Mark I Hughes AIA, LEED AP
BIM Program Manager – Denver International Airport - AECOM

HINT:

- We are specifying the light
- We are analyzing/optimizing the light performance
- We are locating the light
- We are purchasing, scheduling and installing the light
- We are tracking performance and life cycle of the light
- We are changing the light bulb (with LED fixtures, because the contractor VE'd these out this first go round)

Panel Presenters

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Class summary

- We will explore the process of integrated planning, design, construction, commissioning, and as-built delivery for Large Programs

Key learning objectives

- Describe a comprehensive BIM process - Will
- Plan deliverables that translate into model content - Mark
- Assess the potential of a planning with BIM process - Chris
- Evaluate the value of accurate as-built documents - Dennis

Denver International Airport: By the Numbers

Denver International Airport: *by the numbers…*

- 53 million in passenger traffic in 2012
- 5th Busiest airport in the US
- 24 hour/365 day operation
- 53 square miles
- 19.2 million square feet of facilities
- 30,000 (approx.) people employed
- Economic Impact to Colorado: $26.3 Billion dollars annually

Why BIM at DIA?

You Know WHY!

- ✓ Poor or no As-builts – Poor visibility of assets and systems across entire campus
- ✓ 9 Million CAD Files to date
- ✓ Dysfunctional maintenance program due to lack of information
- ✓ Cross department silos and redundancies
- ✓ Subjective budget justification battles
- ✓ Incomplete physical/financial picture
- ✓ No vertical to horizontal integration
- ✓ Inconsistent naming – way finding, security, asset location issues
- ✓ Etc….

Current Projects Listing

	2011	2012	2013	2014	2015	2016	Total (2011-2016)
Airfield*	$27,658	$9,599	$9,488	$15,016	$15,995	$8,660	**$86,416**
Roads	9,103	4,510	3,325	1,125	1,125	1,125	**$20,313**
Environmental/ Utilities	18,113	95	-	-	-	-	**$18,208**
Technologies	14,464	4,085	1,690	990	3,550	3,850	**$28,629**
Terminal Complex	24,100	23,449	20,420	27,618	16,128	19,833	**$131,548**
Baggage/AGTS	1,600	12,700	19,700	13,000	16,500	16,500	**$80,000**
Cargo/Support	4,977	700	5,106	-	-	-	**$10,783**
South Terminal Redevelopment	117,051	111,803	206,640	32,004	-	-	**$467,498**
Miscellaneous/Art	6,031	6,098	5,203	4,561	3,866	3,795	**$29,554**
TOTAL	**$223,097**	**$173,039**	**$271,572**	**$94,314**	**$57,164**	**$53,763**	**$872,949**

Note: Dollars in thousands; Beyond 2016, an annual allowance of $139M was used for analysis; $80M in projects will also be carried over from previous year's plans
*Airfield costs are mostly eligible for FAA grants but reflect full cost here

Chris' Awesome project planning description

- Field Capture
  - Geological Reports
  - Survey / Utility
- Planning interpretation
  - Platt documents
  - GIS Data
  - Zoning descriptions
- Existing Document
  - Plans
  - Program information

Comprehensive BIM Process

Will Lineberry - HNTB

Program Overview

—519-room Westin hotel and conference center 433,000 sf
—Public Transit Center / RTD Commuter Rail Station 212,000 sf
—Open air plaza 82,000sf
—Improvements to existing baggage and train systems
—New Restaurants

Program Challenges

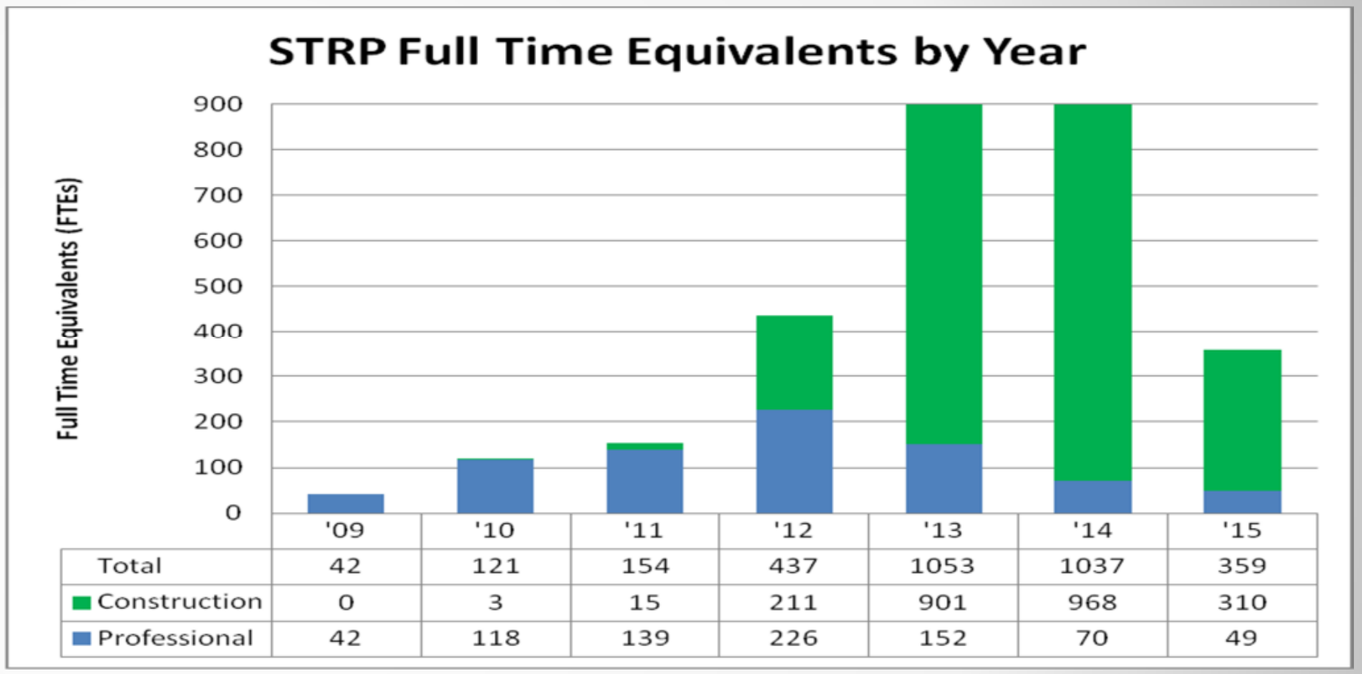
Large and diverse team

Firm facts:

- **260** firms are working on the Program
- **227** firms are local
- **107** are minority/women-owned businesses
- **28%** of budget is MWBE

BIM content:

- **25** firms creating BIM content for Design efforts
- **10** firms creating BIM content for construction efforts.



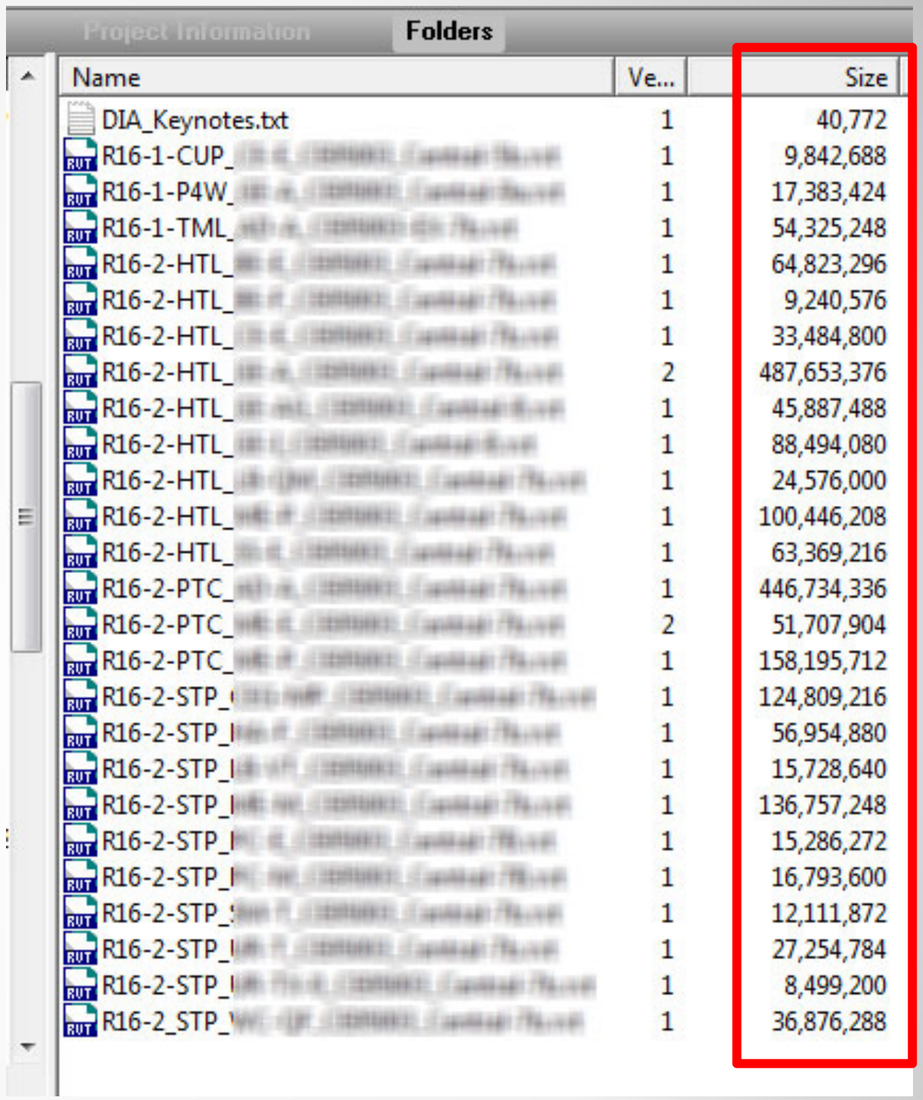
	'09	'10	'11	'12	'13	'14	'15
Total	42	121	154	437	1053	1037	359
Construction	0	3	15	211	901	968	310
Professional	42	118	139	226	152	70	49

Peak Manpower projection for 2013 is 1,053 full-time equivalents

Program Challenges

Managing large data sets

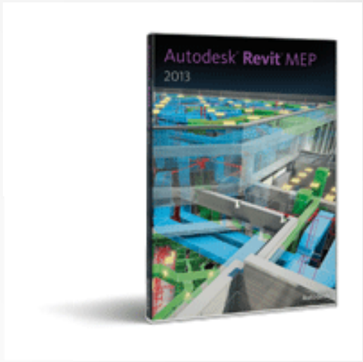
- Many LARGE Models
- Software interoperability
- Sharing data
- Design Review
- QA/QC procedures
- Document Control
- Managing deliverables

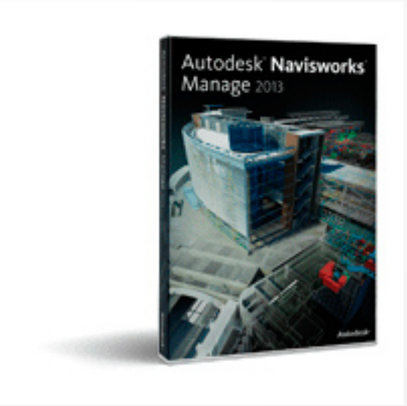


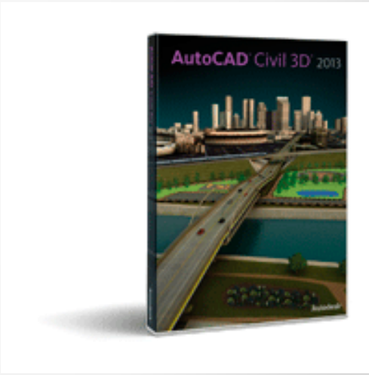
Communication and Documentation is critical

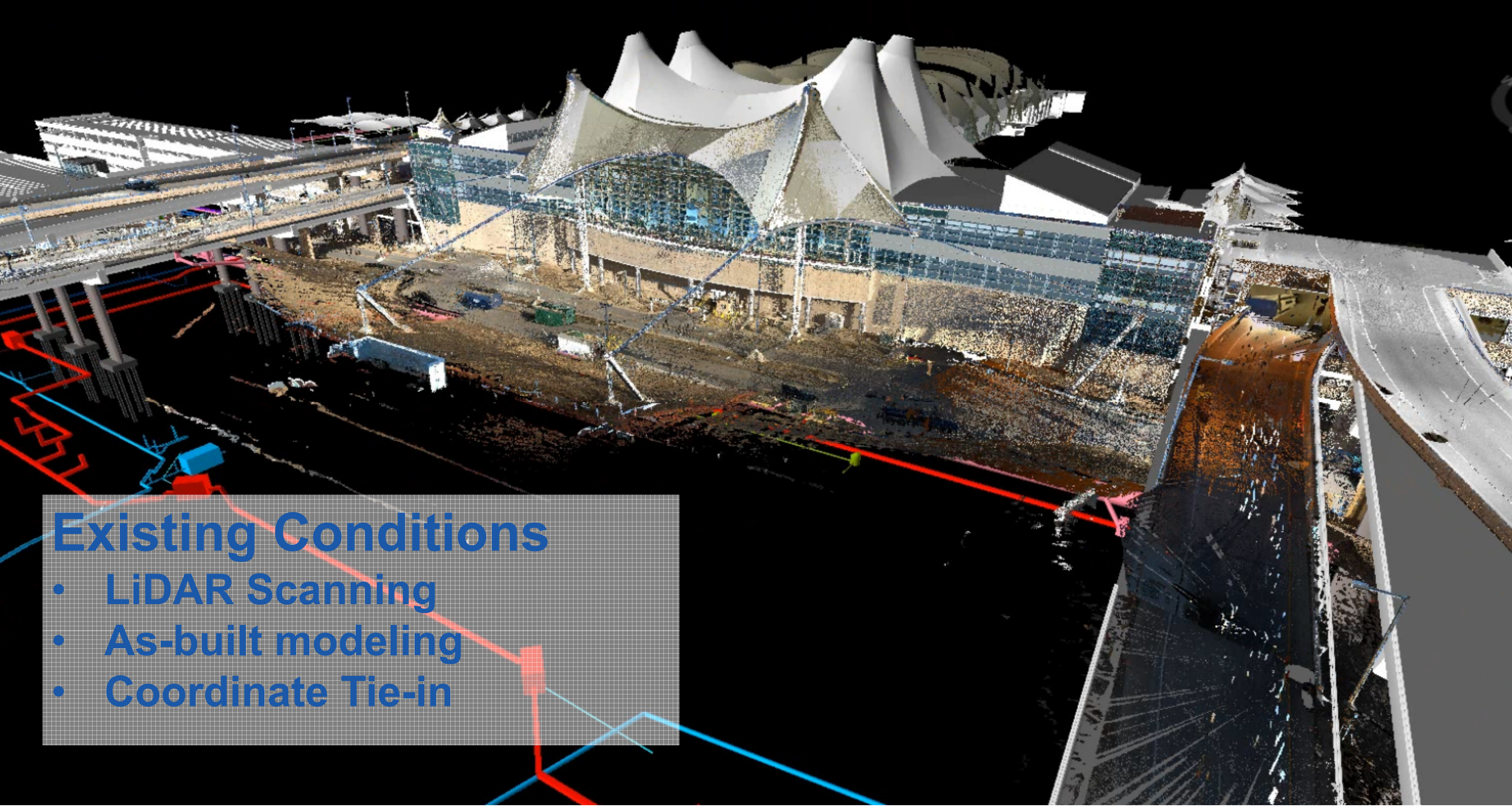
Specified Software

- **Authoring (Design):**
  - Autodesk Revit Architecture
  - Autodesk Revit Structure
  - Autodesk Revit MEP
  - Autodesk Civil 3D
- **Collaboration:**
  - Autodesk Navisworks
  - Autodesk Buzzsaw
  - Autodesk Design Review







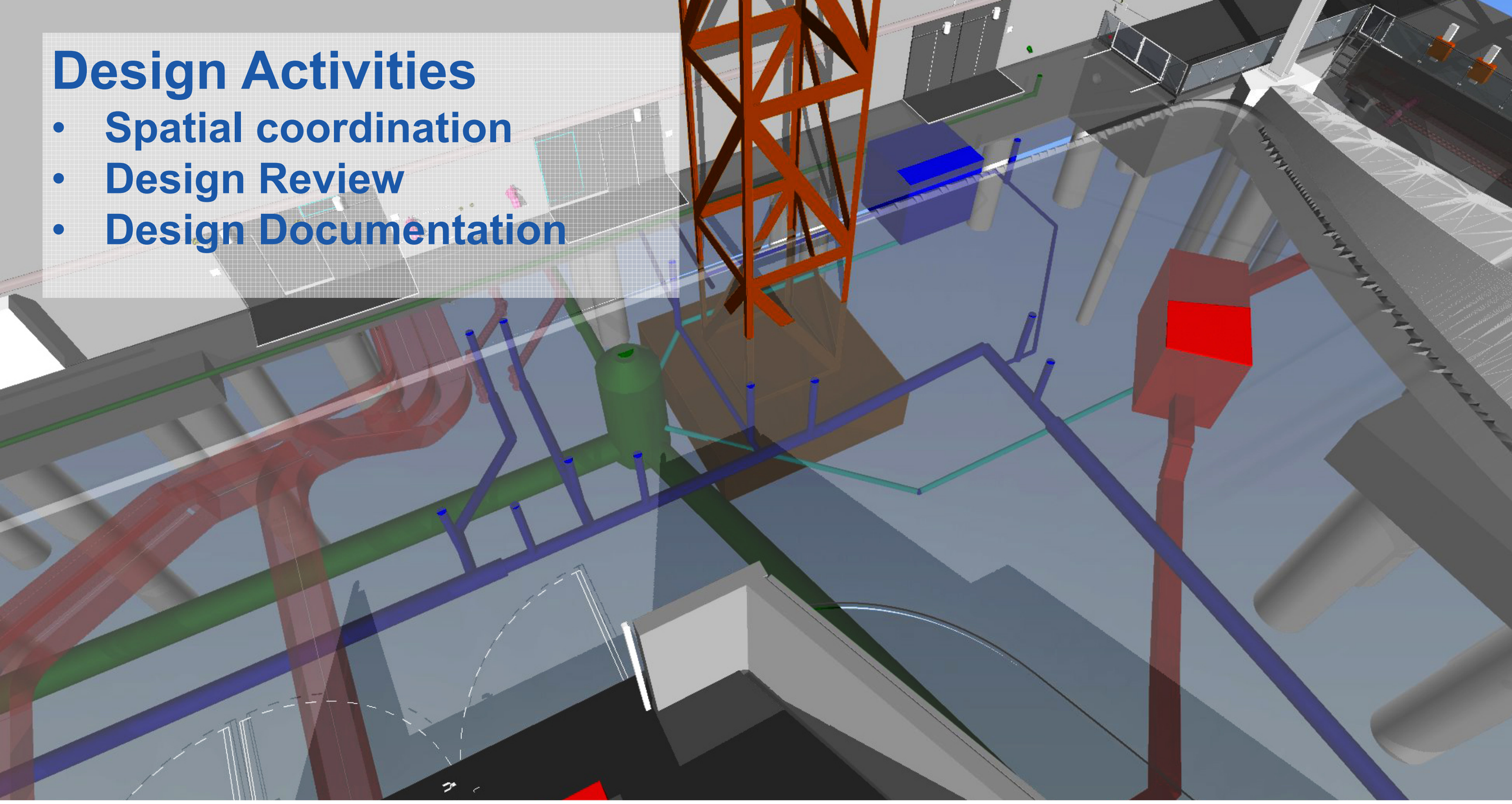

Existing Conditions
• LiDAR Scanning
• As-built modeling
• Coordinate Tie-in

Enabling and Planning

- Analysis
- Sequencing
- Visualization

Design Activities

- Spatial coordination
- Design Review
- Design Documentation

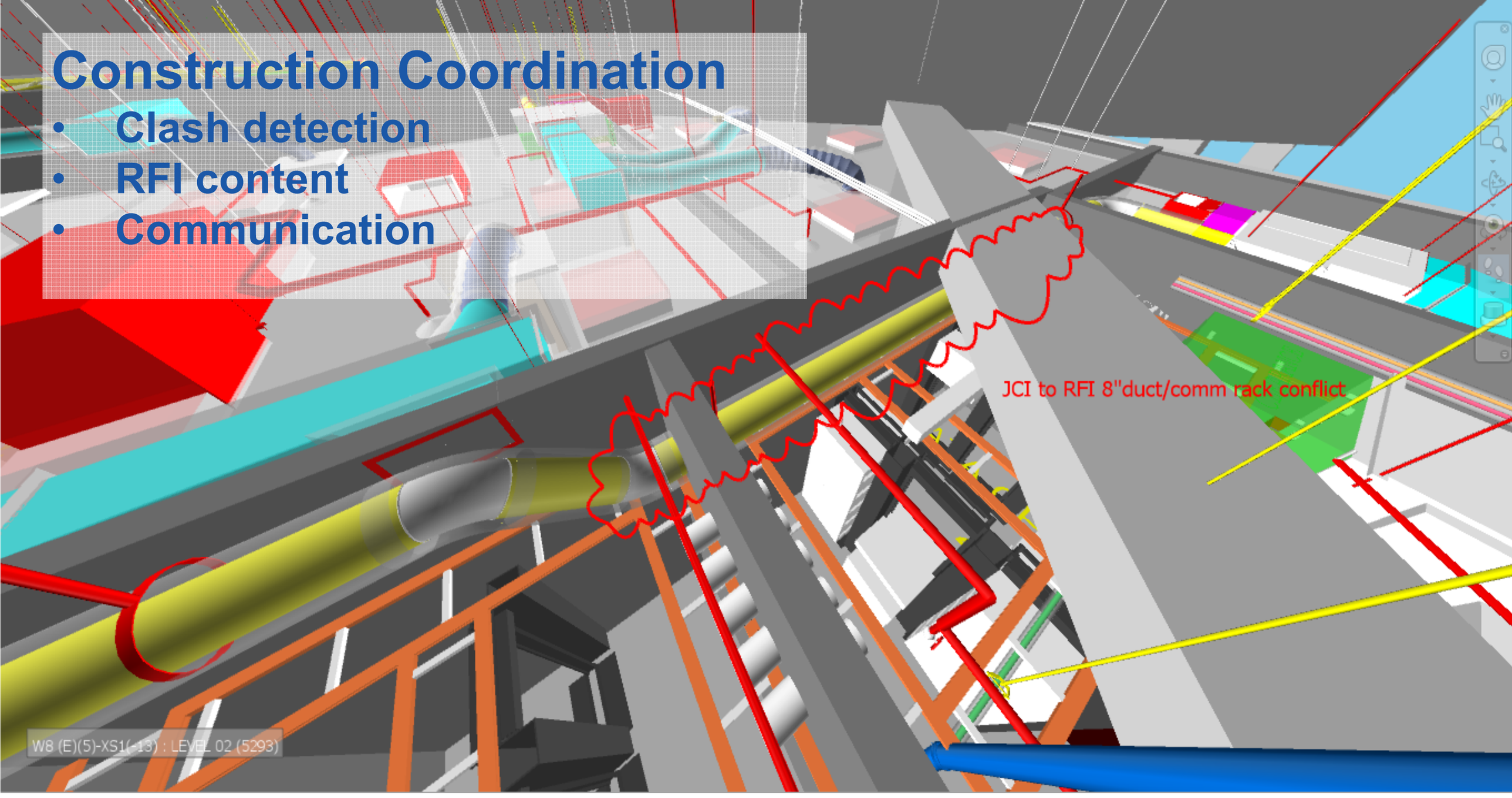


Construction Activities

- Issue tracking
- Document access
- Commissioning

Construction Coordination

- Clash detection
- RFI content
- Communication



Clearly specifying deliverables

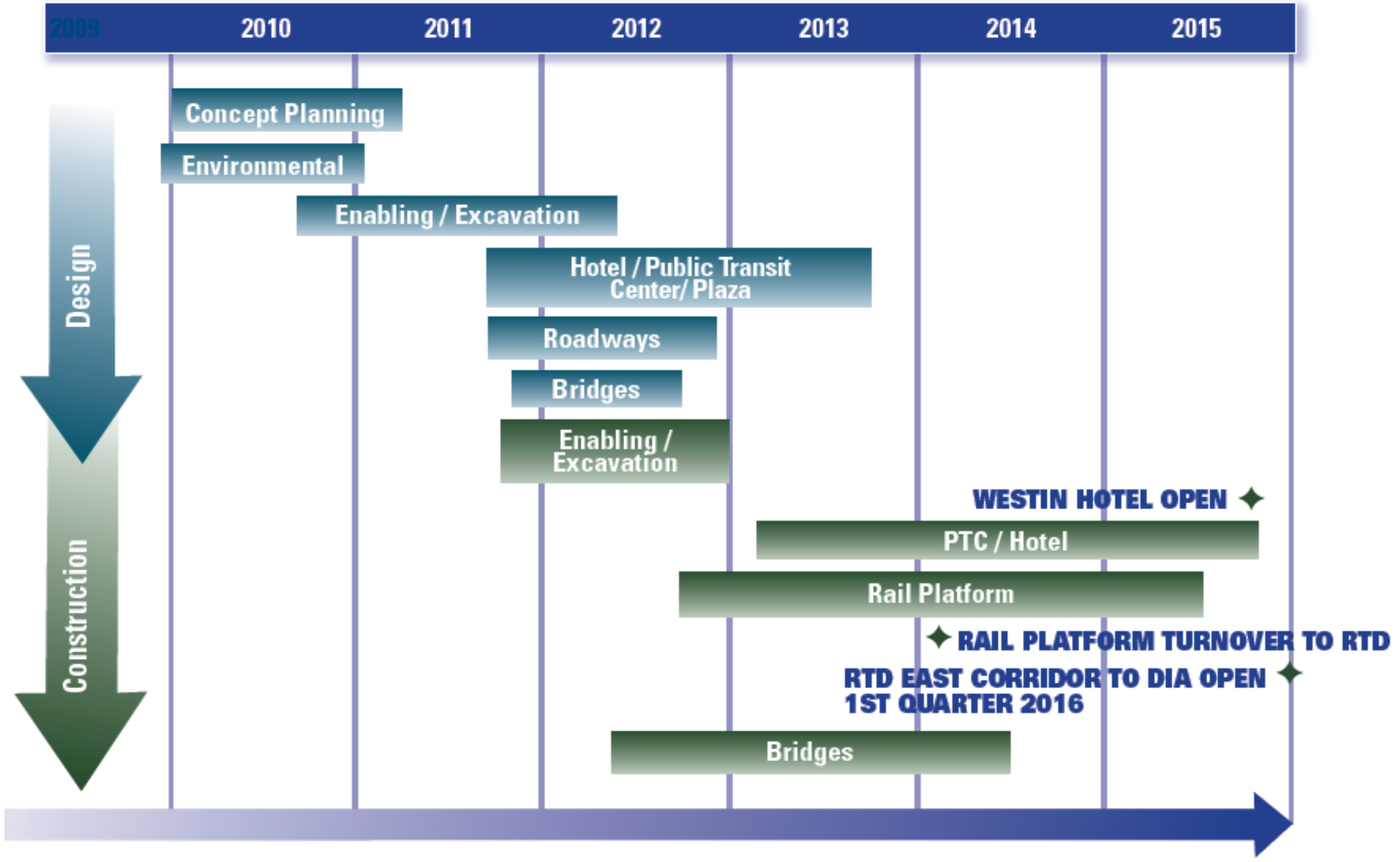
Figure 1 - ASTM UNIFORMAT II
Classification of Building Elements (E1557-97)

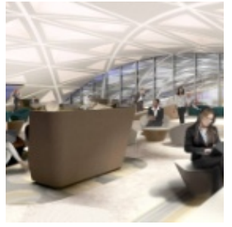
Level 1 Major Group		Level 2 Group Elements		Level 3 Individual Elements		Level 4 Sub-Elements		DESIGN MODELS								CONSTRUCTION MODELS			
								Programming / Design Analysis Report		Preliminary Design / Schematic Design		Design Development / GMP		Construction Documents (Design		Record Design Model		Construction / Fabrication Model		As-Built Model	
								LOD	MEA	LOD	MEA	LOD	MEA	LOD	MEA	LOD	MEA	LOD	MEA	LOD	MEA
A	Substructure	A10	Foundations	A1010	Standard Foundations																
						A1011	Wall Foundations	100	D - SF	200	D - SF	250	D - SF	300	D - SF	300	D - SF	400	C - GC	500	C - GC
						A1012	Column Foundations & Pile Caps	100	D - SF	200	D - SF	250	D - SF	300	D - SF	300	D - SF	400	C - GC	500	C - GC
						A1013	Perimeter Drainage & Insulation	100	D - SF	200	D - SF	250	D - SF	300	D - SF	300	D - SF	400	C - GC	500	C - GC
				A1020	Special Foundations																
						A1021	Pile Foundations	100	D - SF	200	D - SF	250	D - SF	300	D - SF	300	D - SF	400	C - GC	400	C - GC
						A1022	Grade Beams	100	D - SF	200	D - SF	250	D - SF	300	D - SF	300	D - SF	400	C - GC	400	C - GC
						A1023	Caissons	100	D - SF	200	D - SF	250	D - SF	300	D - SF	300	D - SF	400	C - GC	400	C - GC
						A1024	Underpining	100	D - SF	200	D - SF	250	D - SF	300	D - SF	300	D - SF	400	C - GC	400	C - GC
						A1025	Dewatering	100	D - SF	200	D - SF	250	D - SF	300	D - SF	300	D - SF	400	C - GC	400	C - GC
						A1026	Raft Foundations	100	D - SF	200	D - SF	250	D - SF	300	D - SF	300	D - SF	400	C - GC	400	C - GC
						A1027	Pressure Injected Grouting	0	NM	0	NM	0	NM	0	NM	0	NM	0	NM	0	NM
						A1029	Other Special Conditions	100	D - SF	200	D - SF	250	D - SF	300	D - SF	300	D - SF	400	C - GC	400	C - GC
				A1030	Slab on Grade																
						A1031	Standard Slab on Grade	100	D - A	200	D - A	250	D - SF	300	D - SF	300	D - SF	400	C - GC	500	C - GC
						A1032	Structural Slab on Grade	100	D - A	200	D - A	250	D - SF	300	D - SF	300	D - SF	400	C - GC	500	C - GC
						A1033	Inclined Slab on Grade (Sloped Surface Grading)	100	D - A	200	D - A	250	D - SF	300	D - SF	300	D - SF	400	C - GC	500	C - GC
						A1034	Trenches, Pits & Bases	100	D - A	200	D - A	250	D - SF	300	D - SF	300	D - SF	400	C - GC	0	C - GC
						A1035	Under-Slab Drainage & Insulation	0	D - A	100	D - A	200	D - P	300	D - SF	300	D - SF	400	C - GC	500	C - GC
				A2010	Basement Excavation																
						A2011	Excavation for Basements	100	D - SF	200	D - SF	200	D - SF	200	D - SF	200	D - SF	200	C - GC	500	C - GC
						A2012	Structure Back Fill & Compaction	100	D - SF	200	D - SF	200	D - SF	200	D - SF	0	D - SF	0	NM	0	NM
						A2013	Permanent Shoring	100	D - SF	200	D - SF	200	D - SF	200	D - SF	0	D - SF	0	NM	0	NM
						A2014	Temporary Shoring	100	D - SF	100	D - SF	200	D - SF	200	D - SF	0	D - SF	0	NM	0	NM
				A2020	Basement Walls																
						A2021	Basement Wall Construction	100	D - A	200	D - A	250	D - S	300	D - S	300	D - S	400	C - GC	500	C - GC
						A2022	Moisture Protection	0	D - A	100	D - A	200	D - A	300	D - A	300	D - A	400	C - GC	0	NM/ESD
						A2023	Basement Wall Insulation	0	D - A	100	D - A	200	D - A	300	D - A	300	D - A	400	C - GC	0	NM/ESD
						A2024	Interior Skin	100	D - A	200	D - A	300	D - A	300	D - A	300	D - A	400	C - GC	0	NM/ESD
B	Shell	B10	Superstructure	B1010	Floor Construction																
						B1011	Suspended Basement Floors Construction	0	NM	200	D - A	250	D - S	300	D - S	300	D - S	400	C - GC	500	C - GC
						B1012	Upper Floors Construction	100	D - A	200	D - A	250	D - S	300	D - S	300	D - S	400	C - GC	500	C - GC
						B1013	Balcony Floors Construction	0	NM	200	D - A	250	D - S	300	D - S	300	D - S	400	C - GC	500	C - GC
						B1014	Ramps	0	NM	200	D - A	250	D - S	300	D - S	300	D - S	400	C - GC	500	C - GC
						B1015	Exterior Stairs and Fire Escapes	0	NM	200	D - A	250	D - A	300	D - A	300	D - A	400	C - GC	500	C - GC
						B1016	Floor Raceway Systems	0	NM	200	D - A	200	D - A	300	D - A	300	D - A	400	C - GC	500	C - GC
						B1019	Other Floor Construction	0	NM	200	D - A	200	D - A	300	D - A	300	D - A	400	C - GC	500	C - GC
				B1020	Roof Construction																
						B1021	Flat Roof Construction	0	NM	100	D - A	200	D - S	300	D - S	300	D - S	400	C - GC	500	C - GC
						B1022	Pitched Roof Construction	0	NM	100	D - A	200	D - S	300	D - S	300	D - S	400	C - GC	500	C - GC
						B1023	Canopies (Plaza and PTC, not Train Platform)	0	NM	100	D - A/S	200	D - A/S	300	D - A/S	300	D - A/S	400	C - GC	500	C - GC
						B1029	Other Roof Systems	0	NM	100	D - A/S	200	D - A/S	300	D - A/S	300	D - A/S	0	NM/ESD	0	NM/ESD

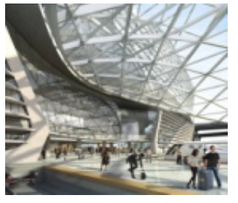
Progress Tracking

- 4D Animation
- RFI BIM Checks
- Regular Model Reviews

Program Timeline








Genie S-80X
TRUSS
TIMBERNAILERS

Deliverables for BIM Content

Mark Hughes - AECOM

End in Mind

Standards

BIM Content

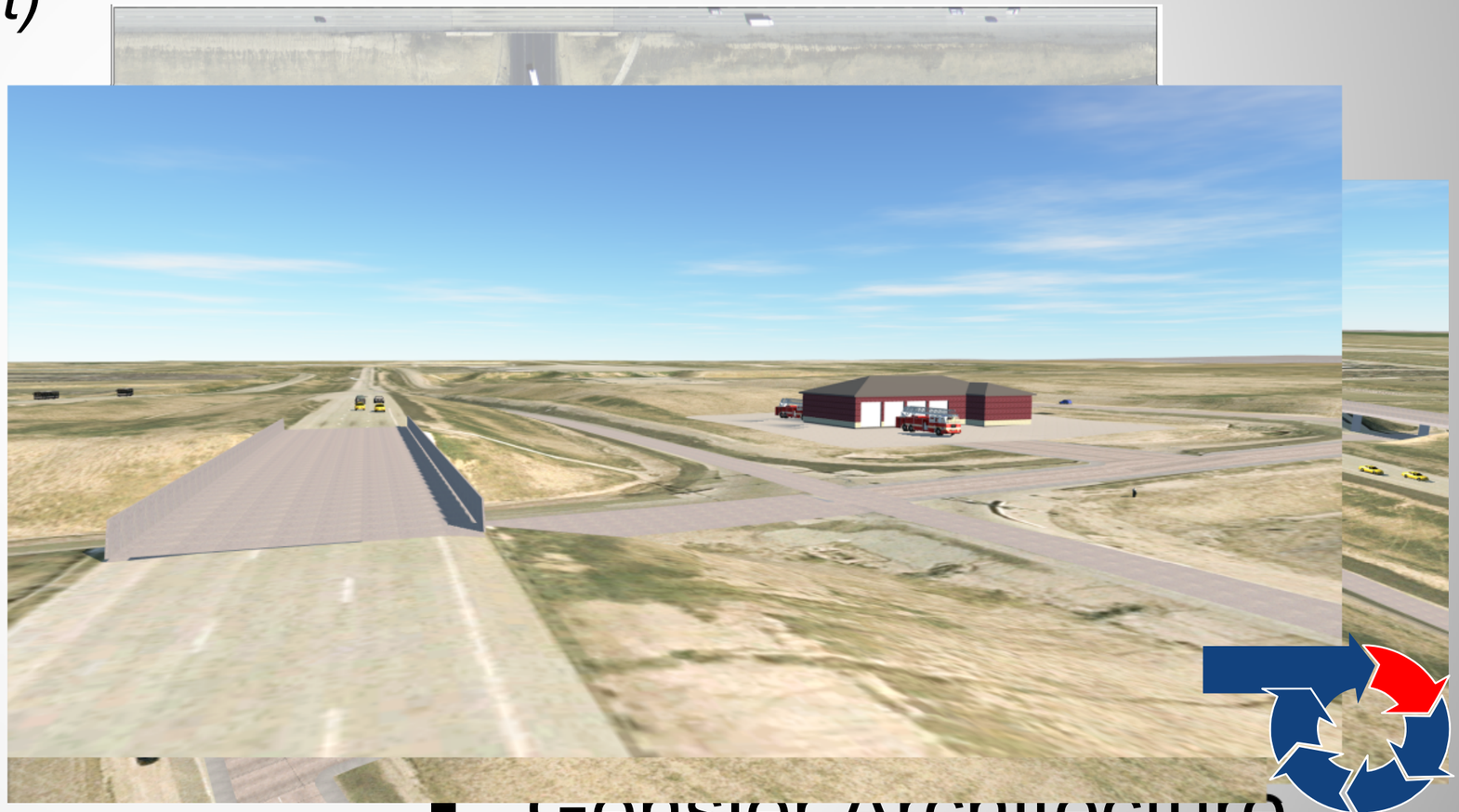
Communicate

Implement

End in Mind

- *Providing Solutions to Existing Needs before Future wants (i.e. – Low Hanging Fruit)*

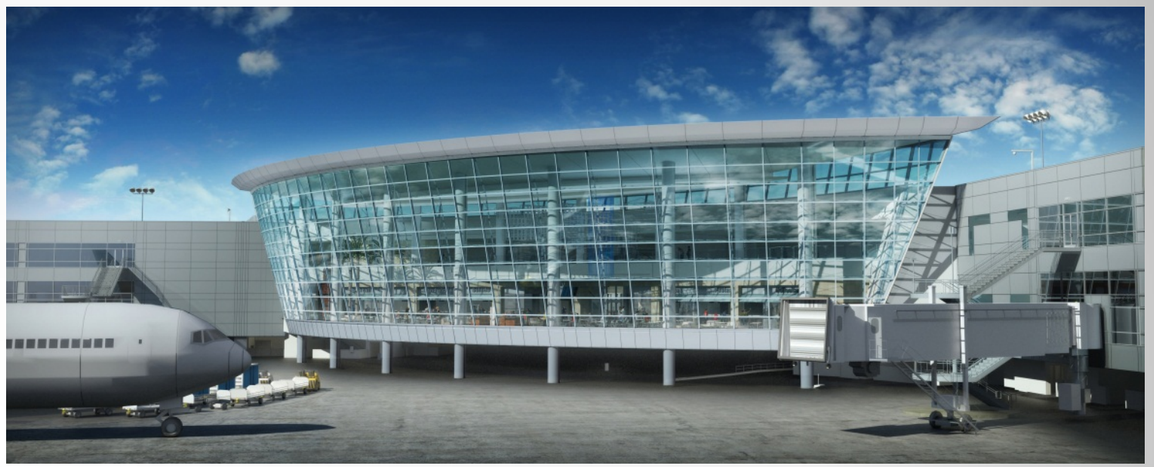
- Planning
- Visualization



- Gensler Architecture

End in Mind: Size

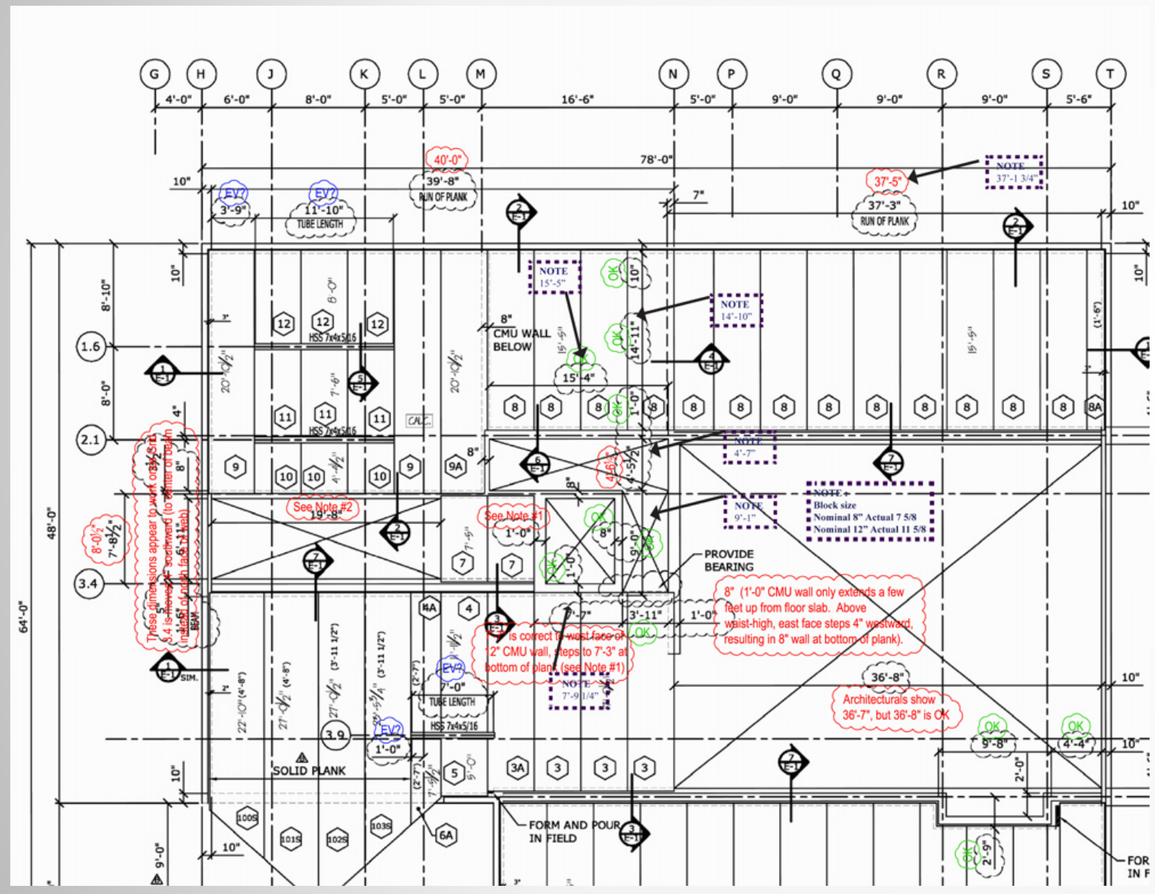
- Better Asset data Collection/Management/Flow
- Lifecycle maintenance (As-Builts to Asset Management)



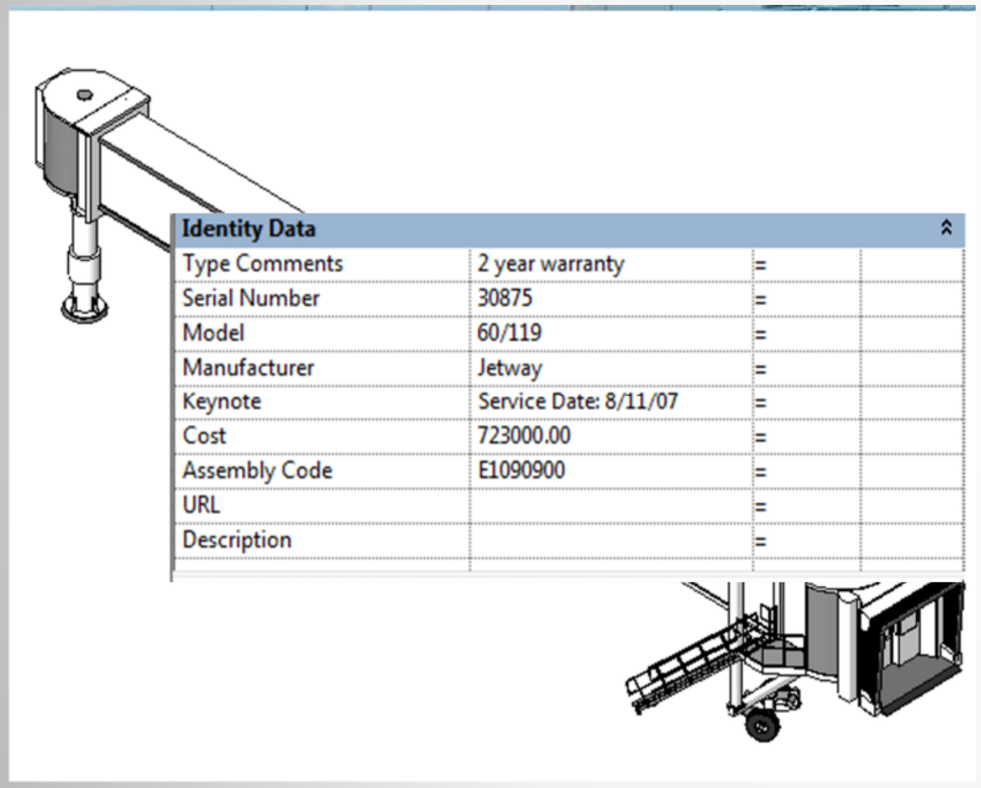
HNTB Architecture

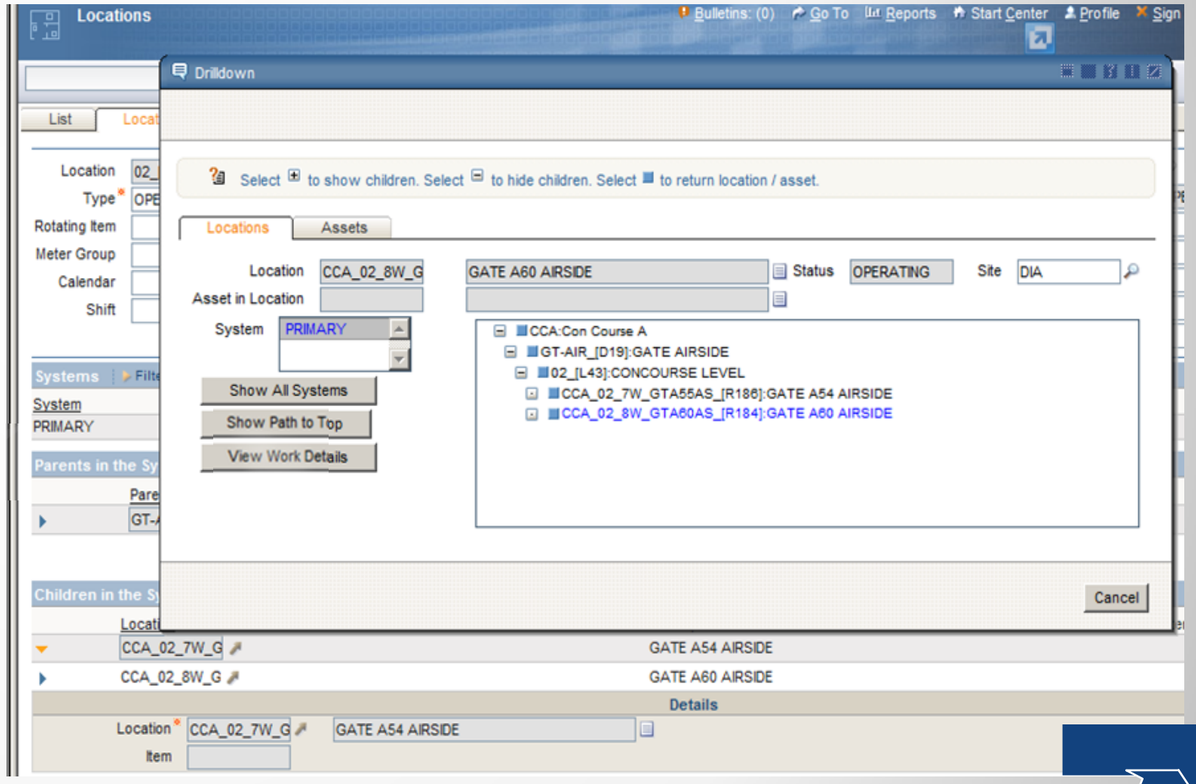
Gensler Architecture

End in Mind: As-Built

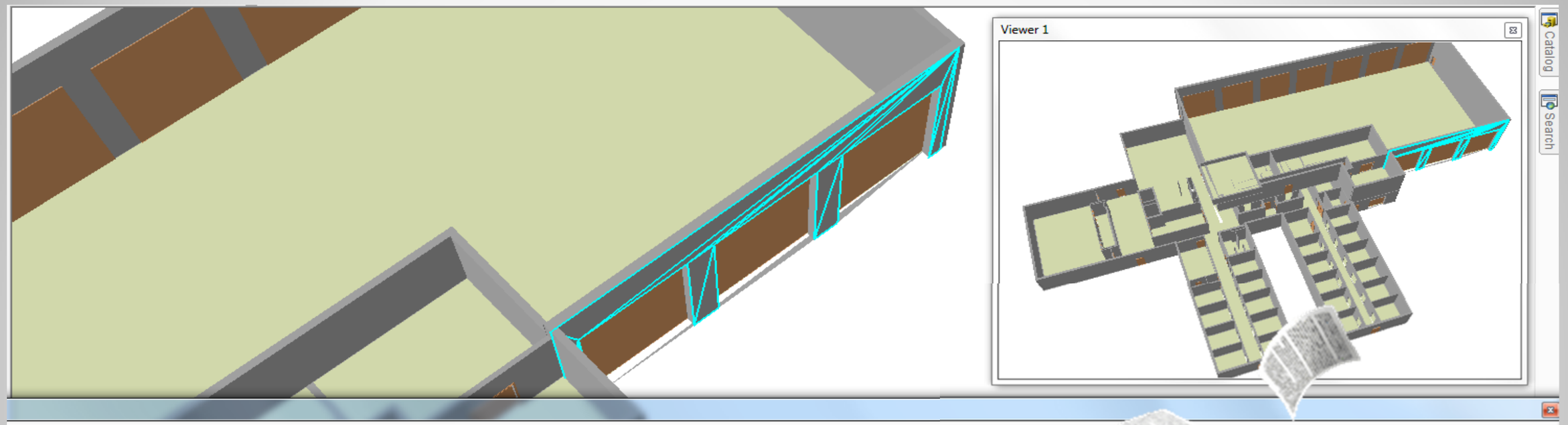


End in Mind: CMMS





End in Mind: GIS



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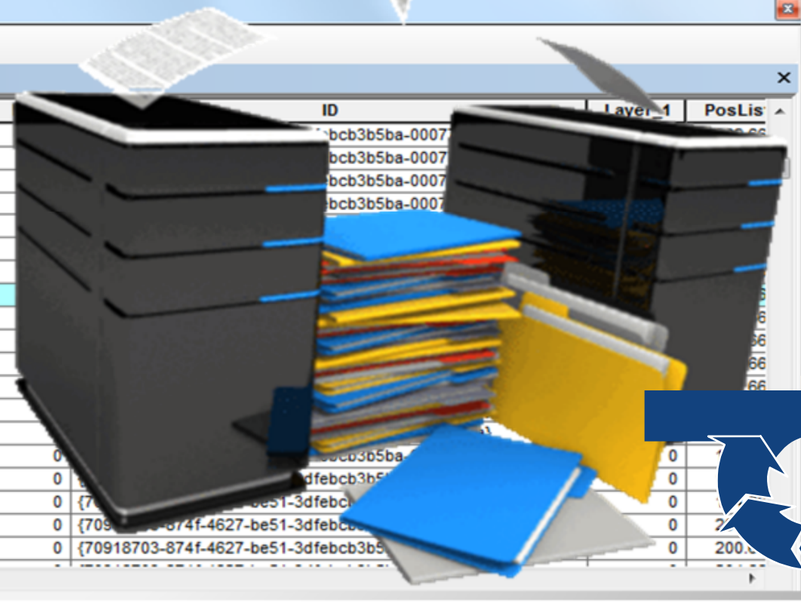
eneric - 16"	184.668015	76.002464	24	124.666667	surfaceProperty	2.666661	0	114	24	Generic - 16"	0	0	
eneric - 16"	192.668015	76.002464	21.333333	124.666667	surfaceProperty	34.666597	21.333248	115	21.333333	Generic - 16"	0	0	
eneric - 16"	200.668015	76.002464	24	124.666667	surfaceProperty	2.666661	0	116	24	Generic - 16"	0 {70918703-874f-4627-be51-3dfebcb3b5	0	200.



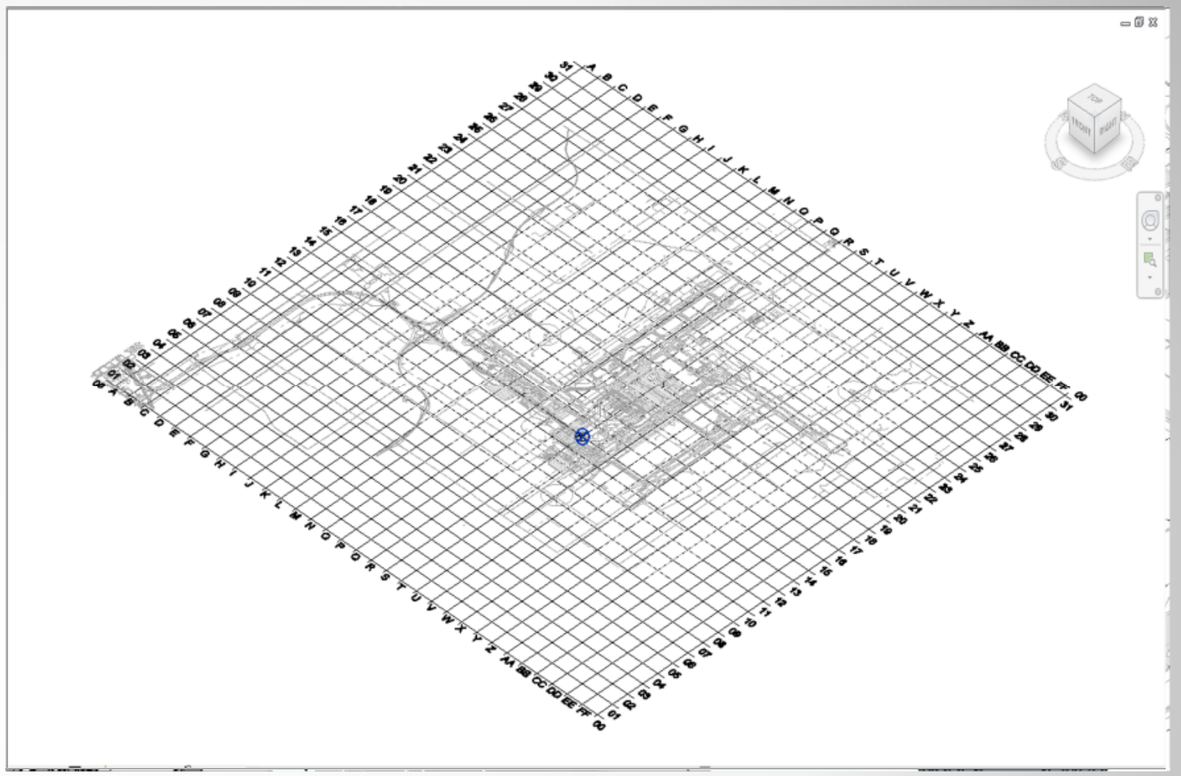
Standards:

- “The approach to standards has to change. A global intergalactic interoperability super standard that all data somehow adheres to will never work.”

Source: Phillip G. Bernstein, FAIA, RIBA, LEED AP
Vice President, Strategic Industry Relations, Autodesk, Inc.

Standards: Platforms

- *Templates / Data Normalization*
  - Continuous Data & Process Management
    - FM/OM ready BIM and Current Relational Data Structures.
  - Collecting & Validating Data
    - **real** “As-Built” deliveries that transcend typical O&M Deliveries

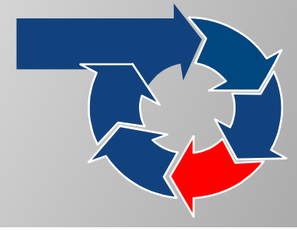


Standards:

Know your platforms
Know the integrations
Know the quirks
Know the Data Structures

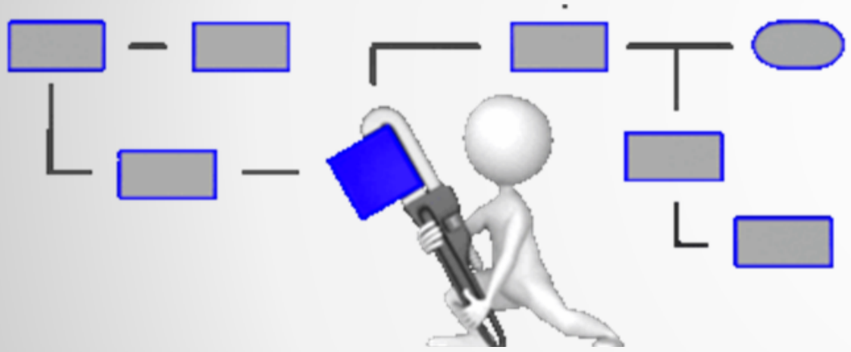
Implement:

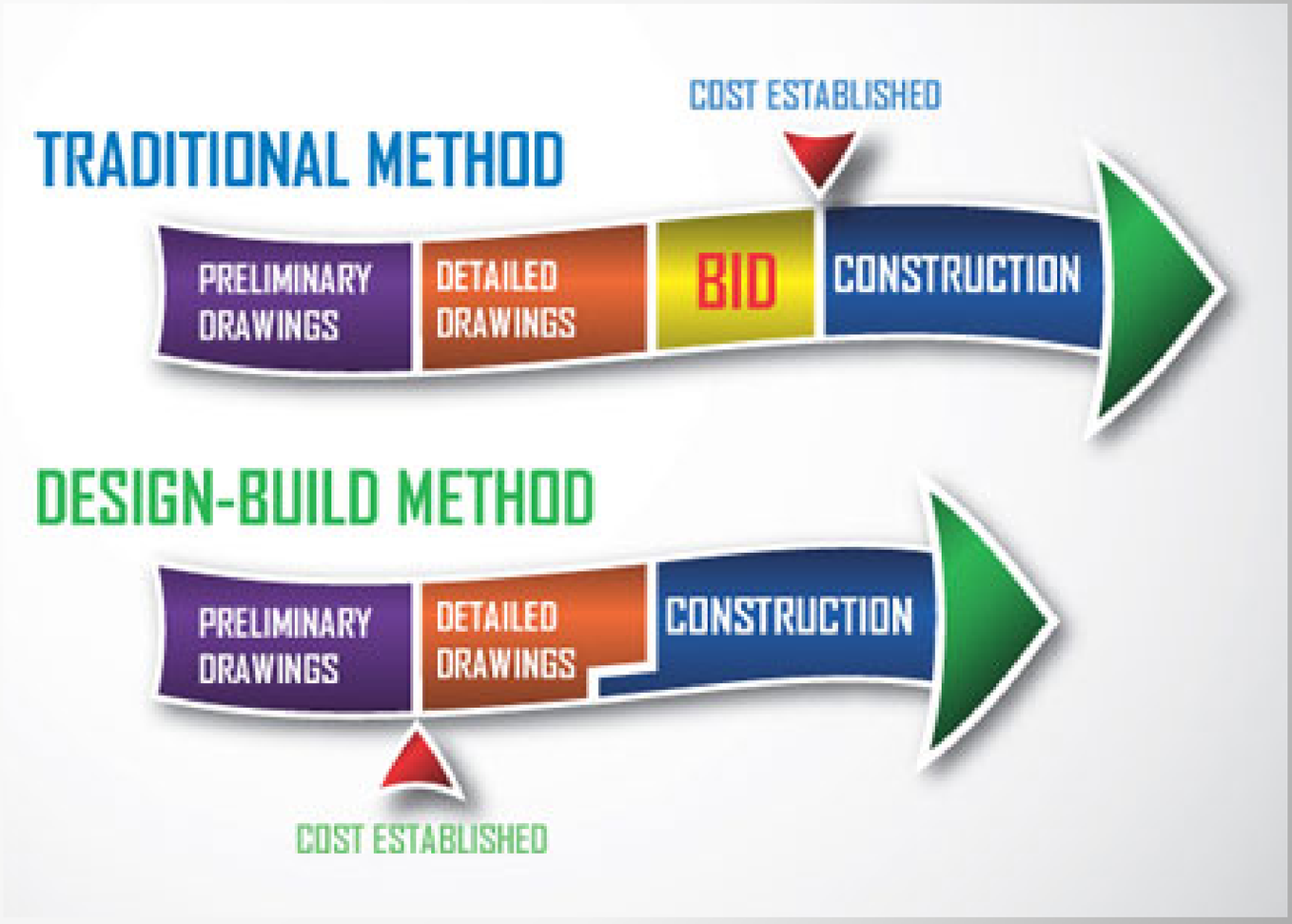
- What size project requires a comprehensive BIM Process?
- What Delivery method is best for a BIM Process?
- Is it only for Vertical Projects?
- Change Management Plan - starts with Management and managing the fear of change



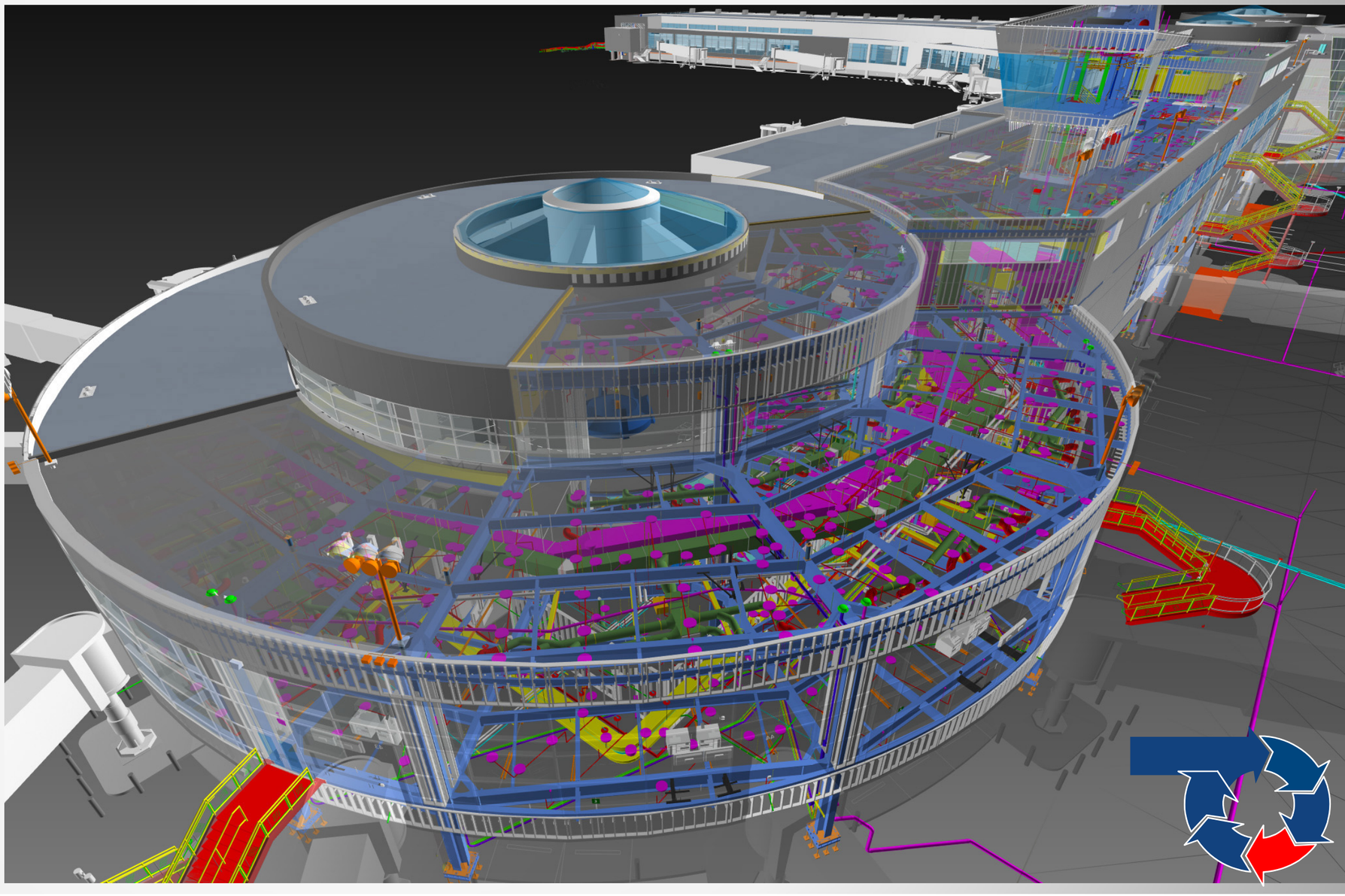
Implement: Delivery Method

- Contract / Specification Language: Building a better process



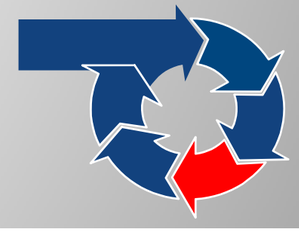


Implement: Vertical



Implement: Civil

- Flat CADD
- .imx Data source
- GIS Data source
- Civil 3D content

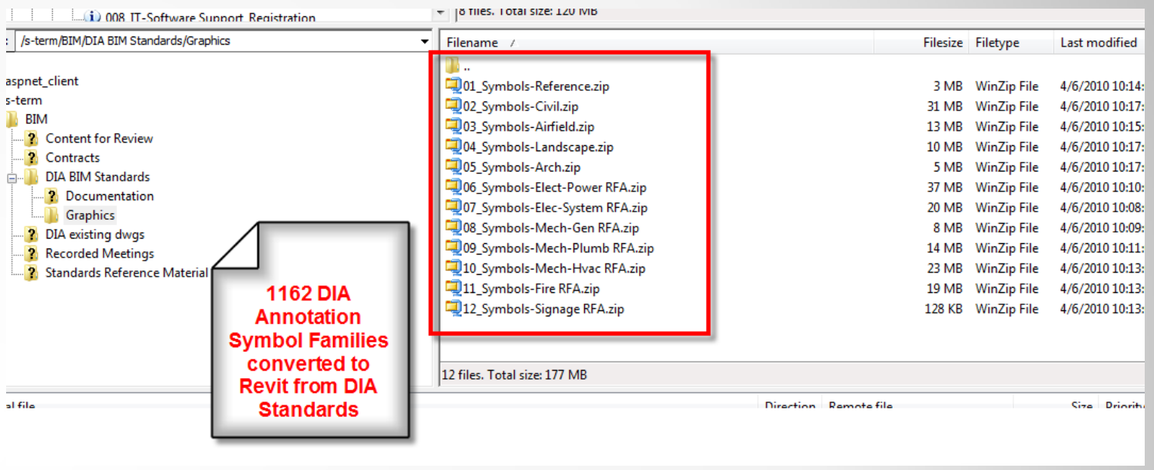


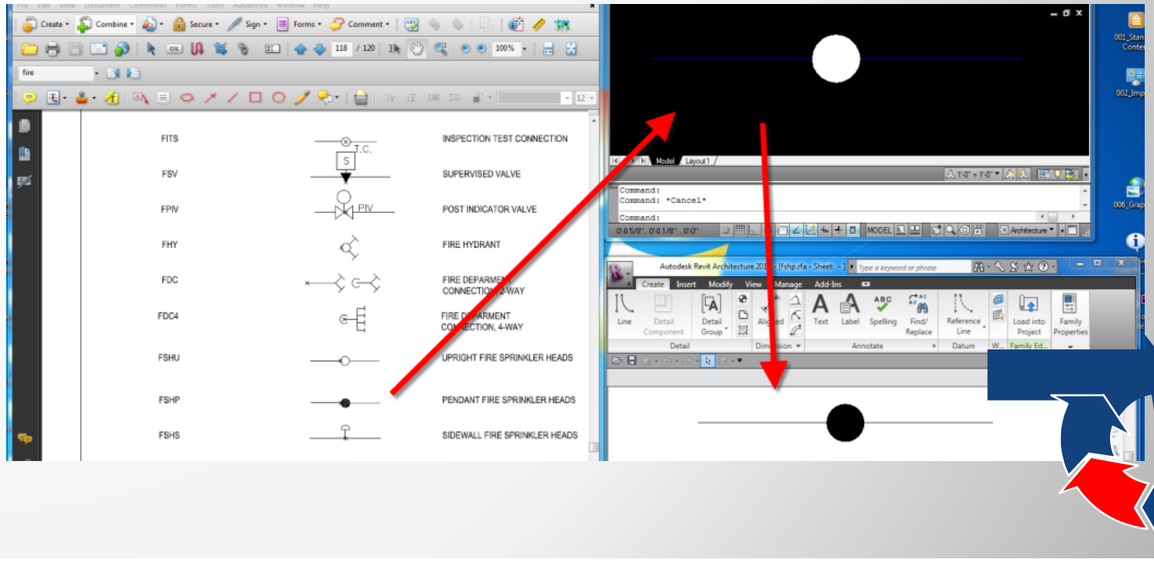
Communicate: Training

- *Implementation must be Cross-Cultural*
  - Top Down – bottom up support
  - Internal - department to department
  - External - discipline to discipline

Communicate: Outreach

- Implementing a *technological solution as a cultural change*
  - Provide guidance and access to templates
  - Inform consultants of the reasons for compliance

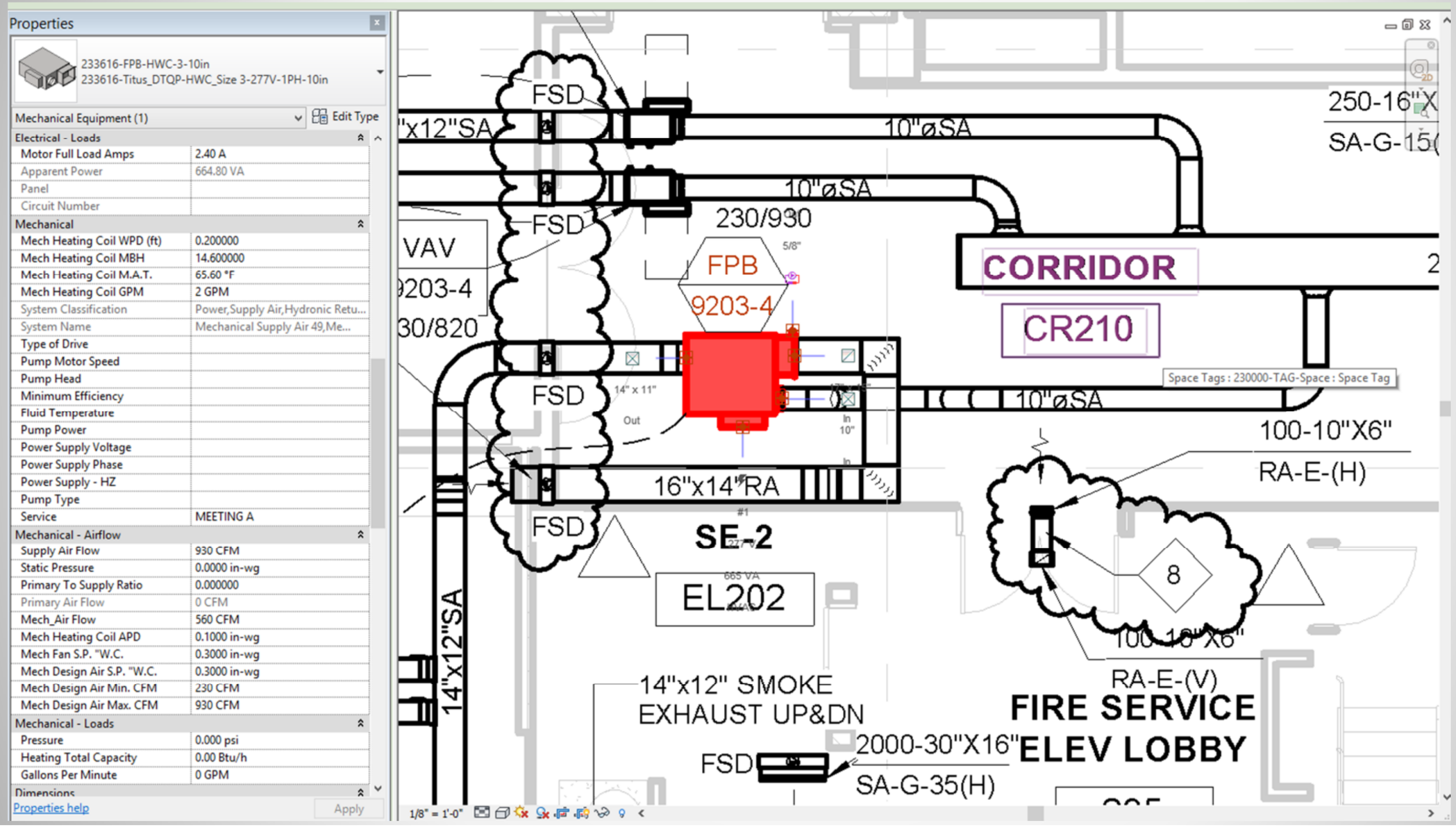




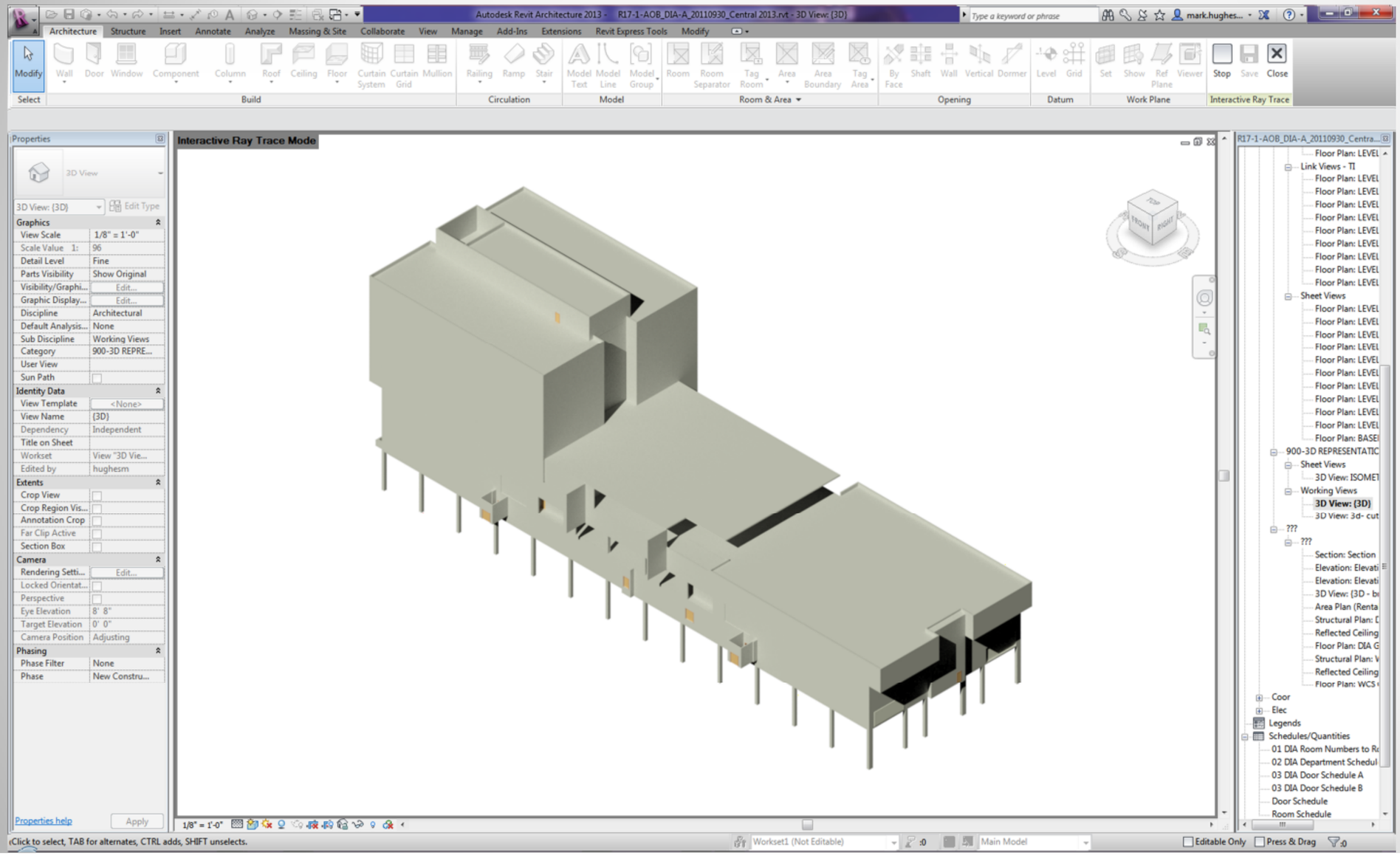
Communicate: Check and Re-Check

- *Provide clear direction for compliance*
  - Provide guidance and access to templates
  - Inform consultants of the reasons for compliance

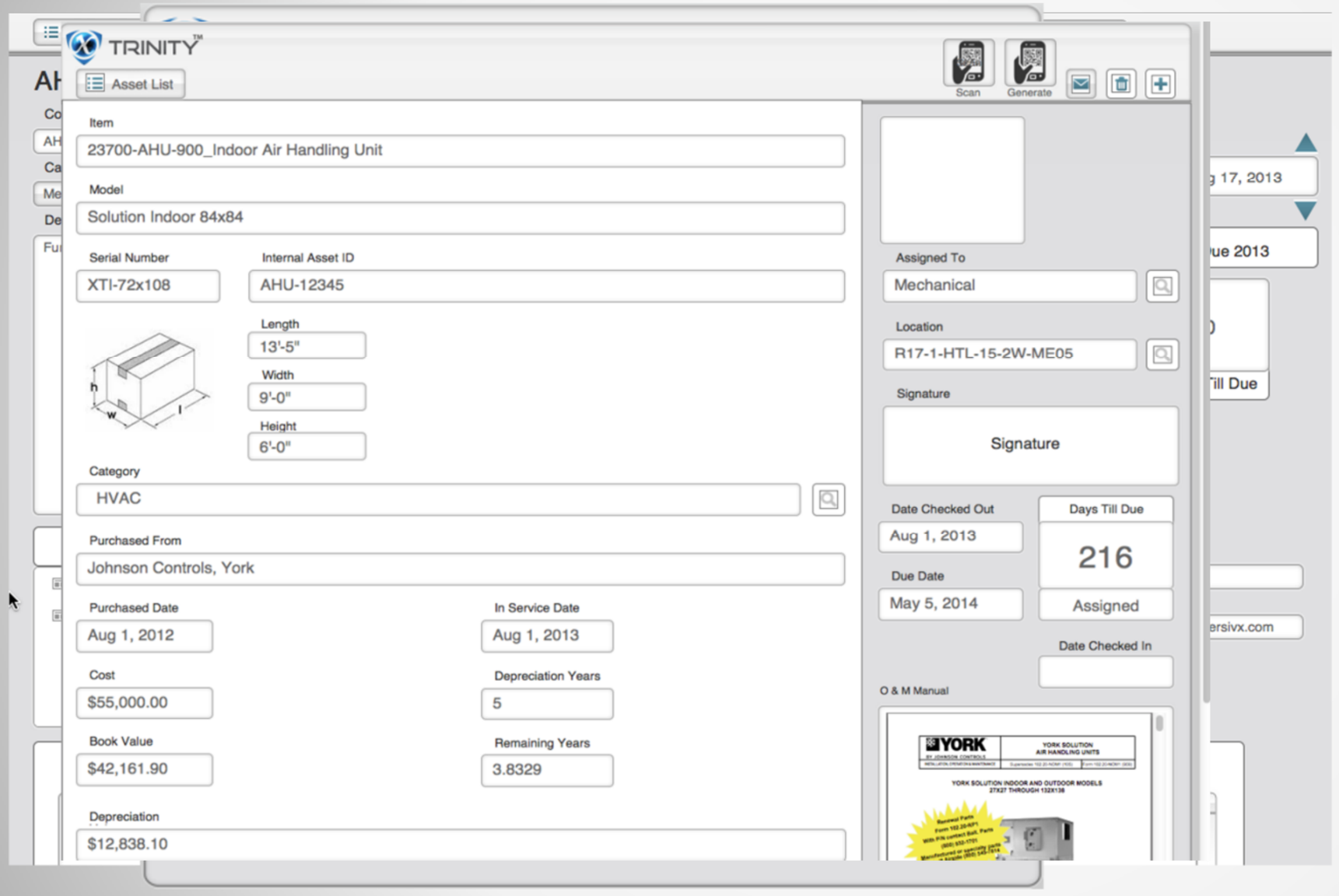
BIM Content: Design Model



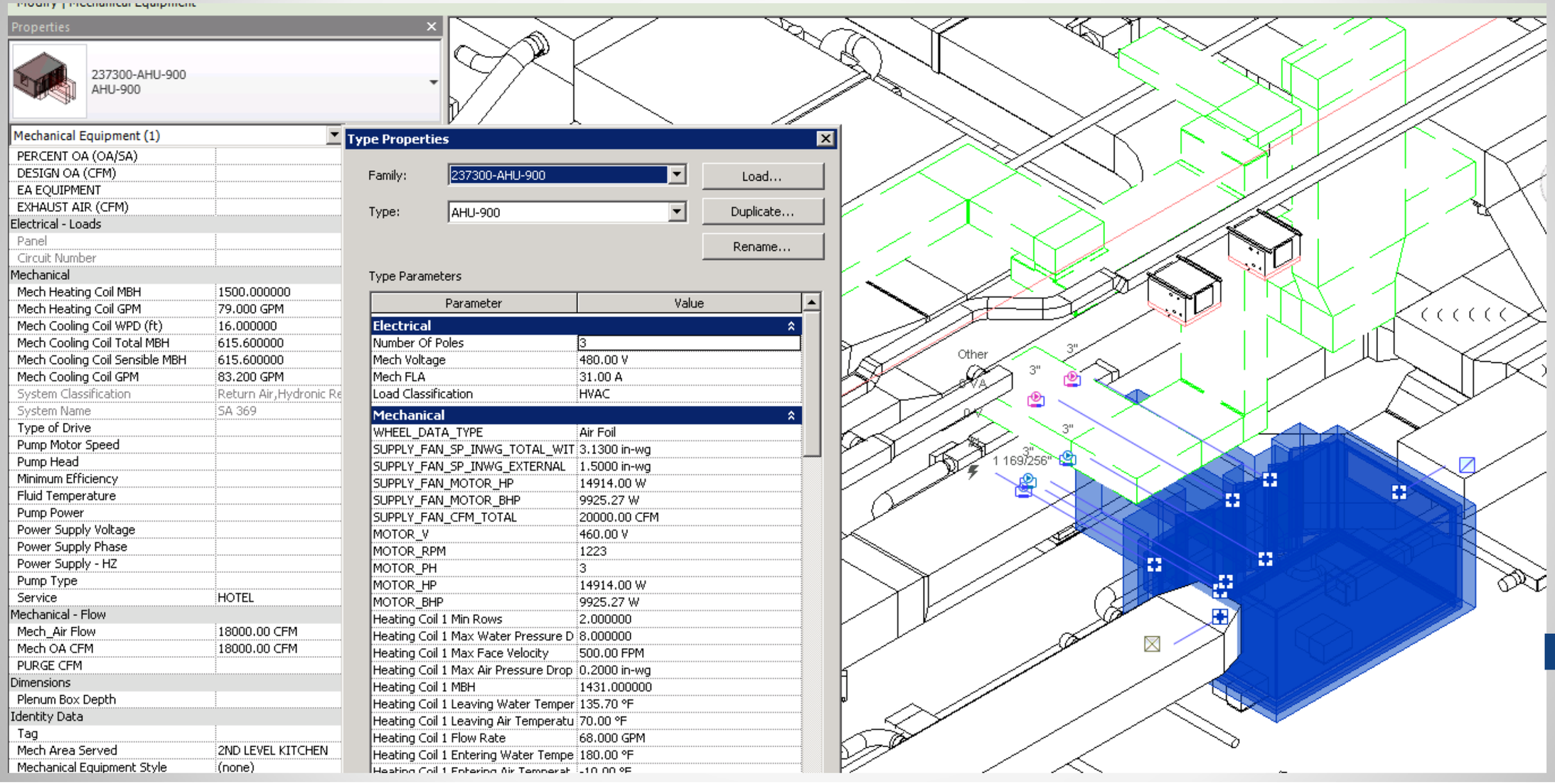
BIM Content: Extraction



BIM Content: CxDMa



BIM Content: DATA



BIM Content

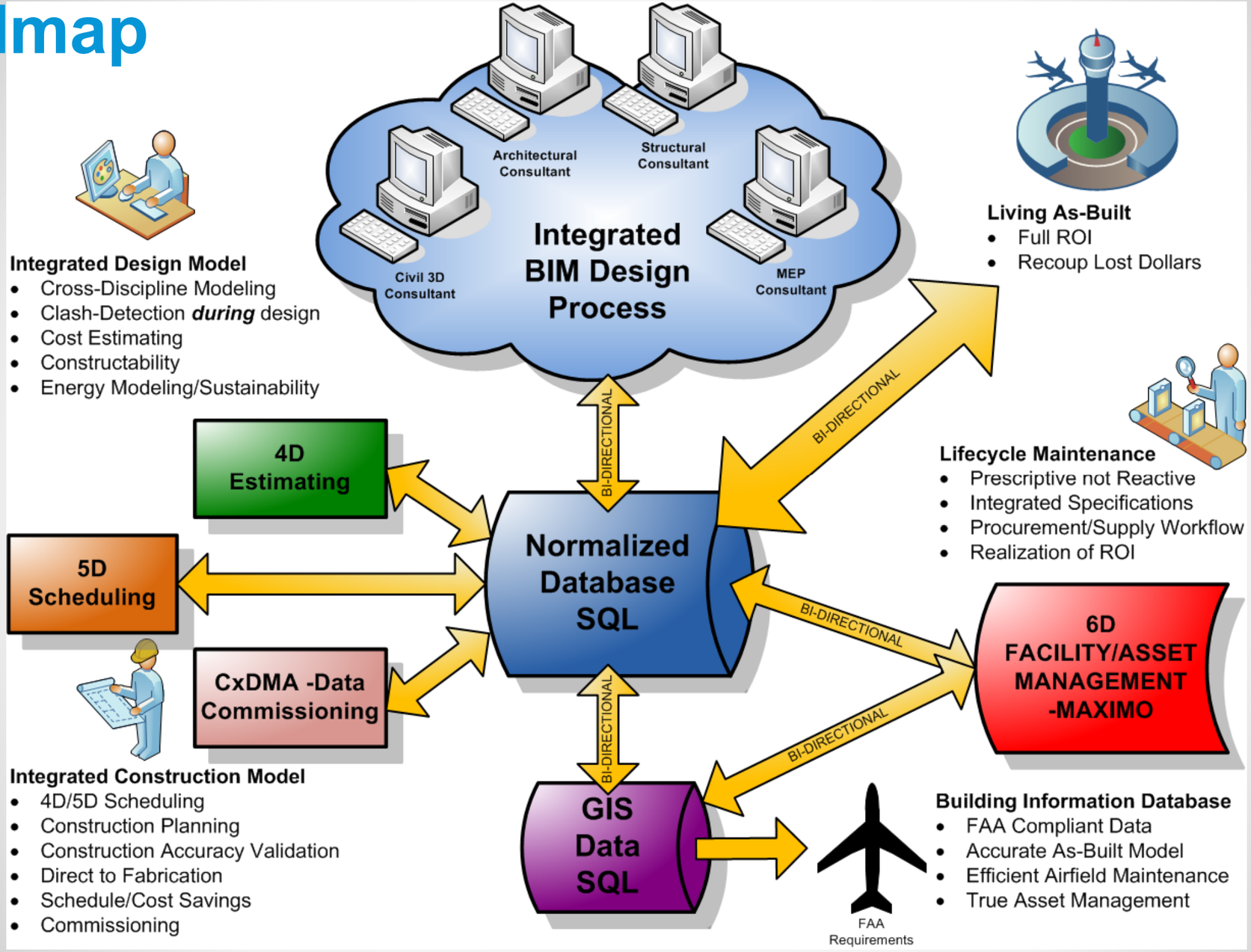
- End in Mind
- Standards
- Implement
- Communicate

Planning with a BIM Process
Chris Herrera - Kiewit

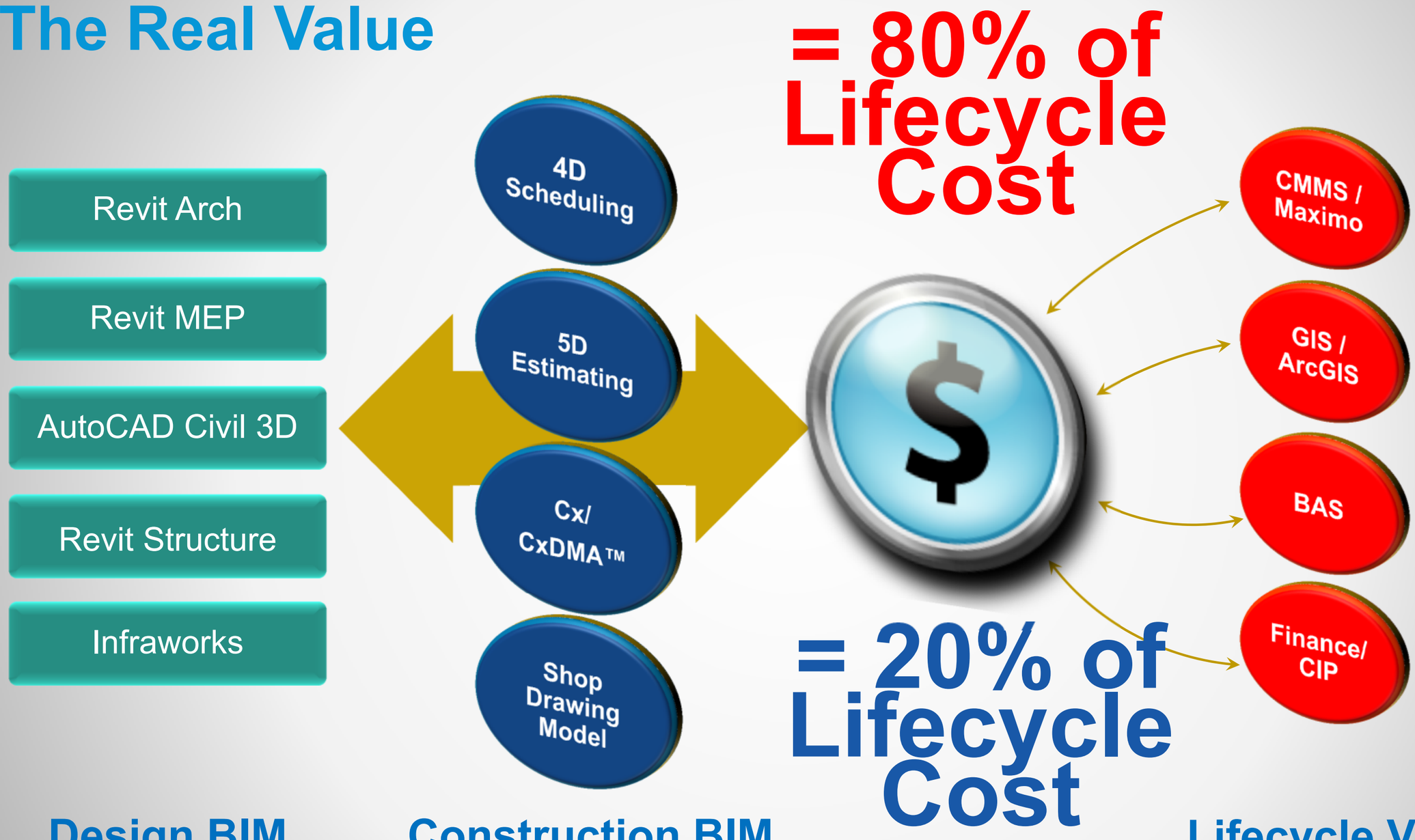
- Not out of the box
- What your end use is
- Electronically capture data
- Integrate Data from multiple sources
- New planning tools
- New As-built

The Value of the Owner's data
Dennis Rodriguez - AECOM

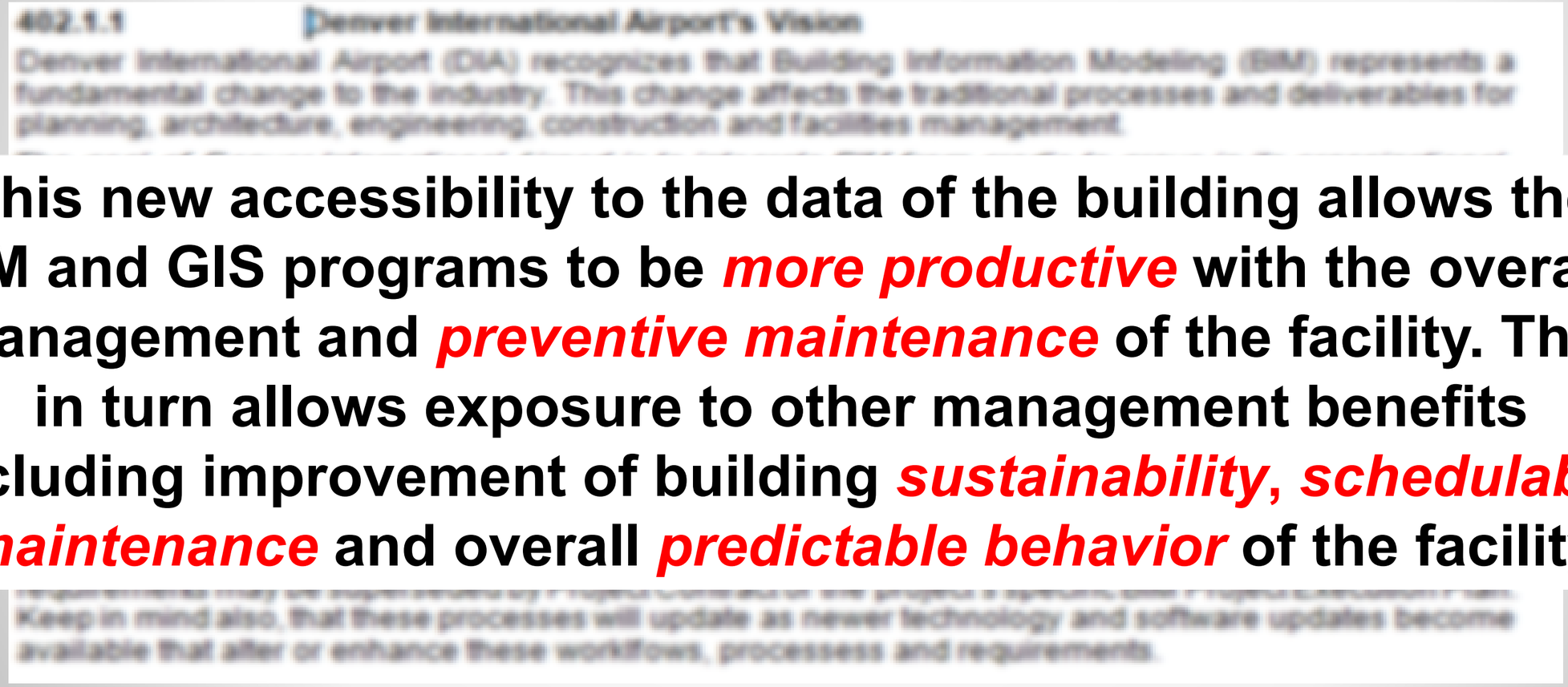
A Roadmap


Architectural Consultant
Structural Consultant
Civil 3D Consultant
MEP Consultant
Integrated BIM Design Process
Integrated Design Model
• Cross-Discipline Modeling
• Clash-Detection *during* design
• Cost Estimating
• Constructability
• Energy Modeling/Sustainability
Living As-Built
• Full ROI
• Recoup Lost Dollars
BI-DIRECTIONAL
BI-DIRECTIONAL
4D Estimating
5D Scheduling
CxDMA -Data Commissioning
Normalized Database SQL
Lifecycle Maintenance
• Prescriptive not Reactive
• Integrated Specifications
• Procurement/Supply Workflow
• Realization of ROI
BI-DIRECTIONAL
6D FACILITY/ASSET MANAGEMENT -MAXIMO
BI-DIRECTIONAL
BI-DIRECTIONAL
GIS Data SQL
Integrated Construction Model
• 4D/5D Scheduling
• Construction Planning
• Construction Accuracy Validation
• Direct to Fabrication
• Schedule/Cost Savings
• Commissioning
FAA Requirements
Building Information Database
• FAA Compliant Data
• Accurate As-Built Model
• Efficient Airfield Maintenance
• True Asset Management

The Real Value



Guidance of a Standard

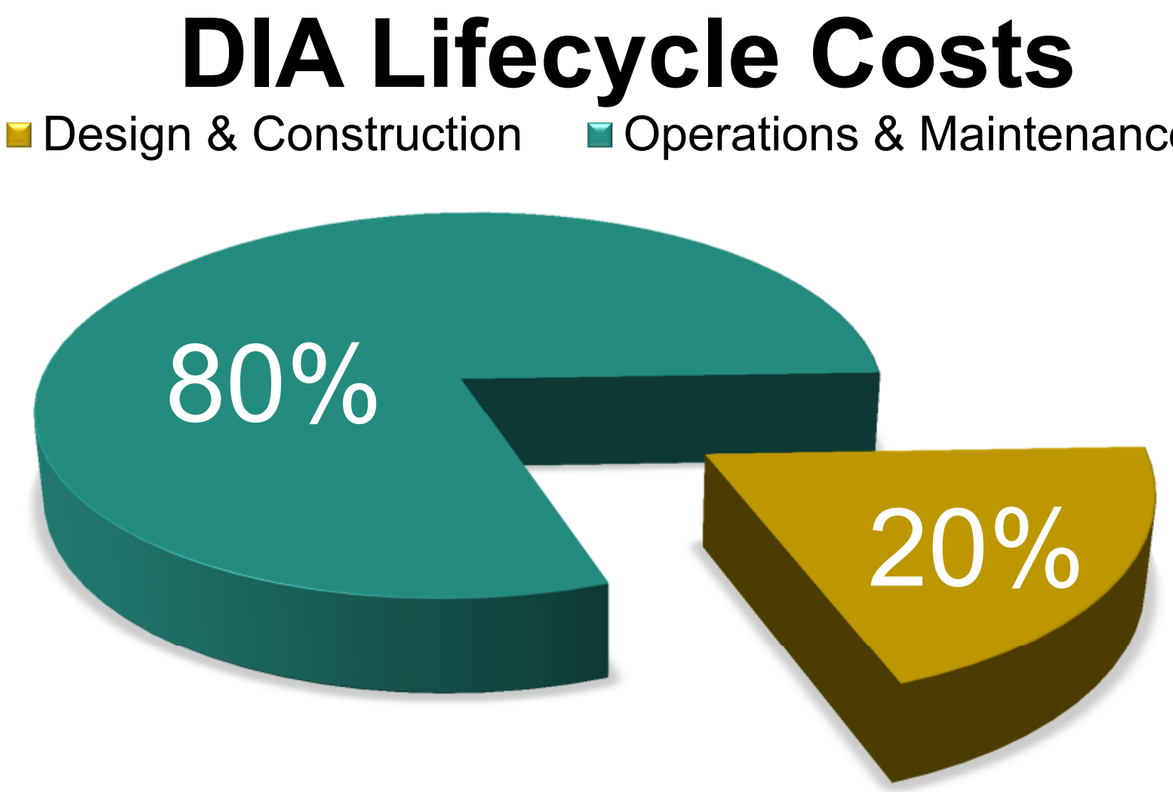

402.1.1 Denver International Airport's Vision

Denver International Airport (DIA) recognizes that Building Information Modeling (BIM) represents a fundamental change to the industry. This change affects the traditional processes and deliverables for planning, architecture, engineering, construction and facilities management.

Keep in mind also, that these processes will update as newer technology and software updates become available that alter or enhance these workflows, processess and requirements.

This new accessibility to the data of the building allows the FM and GIS programs to be *more productive* with the overall management and *preventive maintenance* of the facility. This in turn allows exposure to other management benefits including improvement of building *sustainability*, *schedulable maintenance* and overall *predictable behavior* of the facility

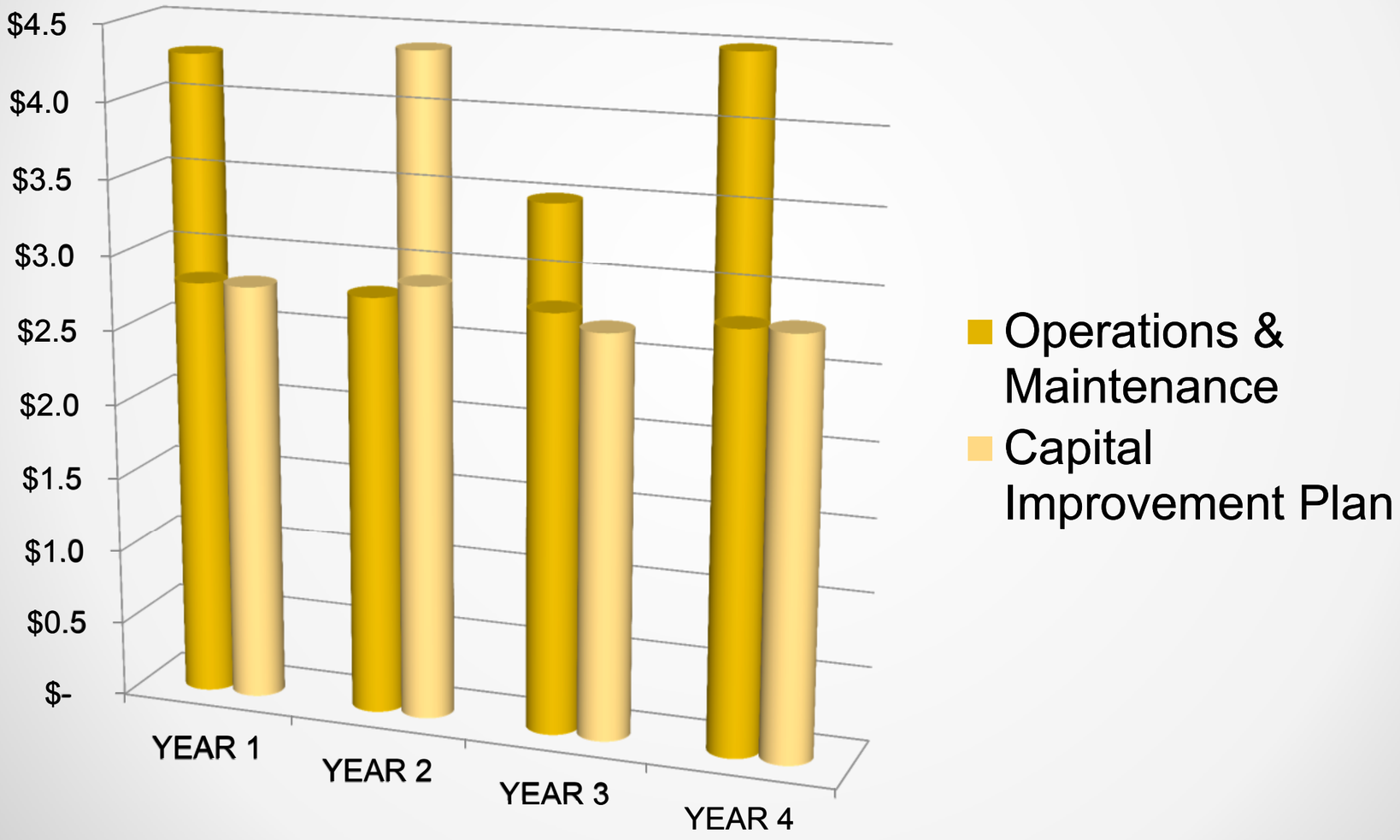
The Difference in Cost = Value



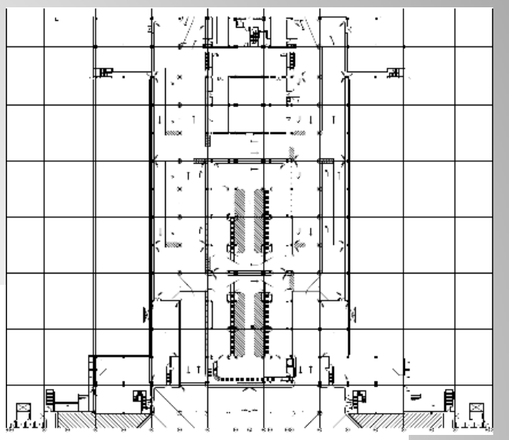
* Source: 2008 Buildings Energy Data Book, Buildings Technologies Program, Energy Efficiency and Renewable Energy, U.S. Department of Energy, page 3-12.

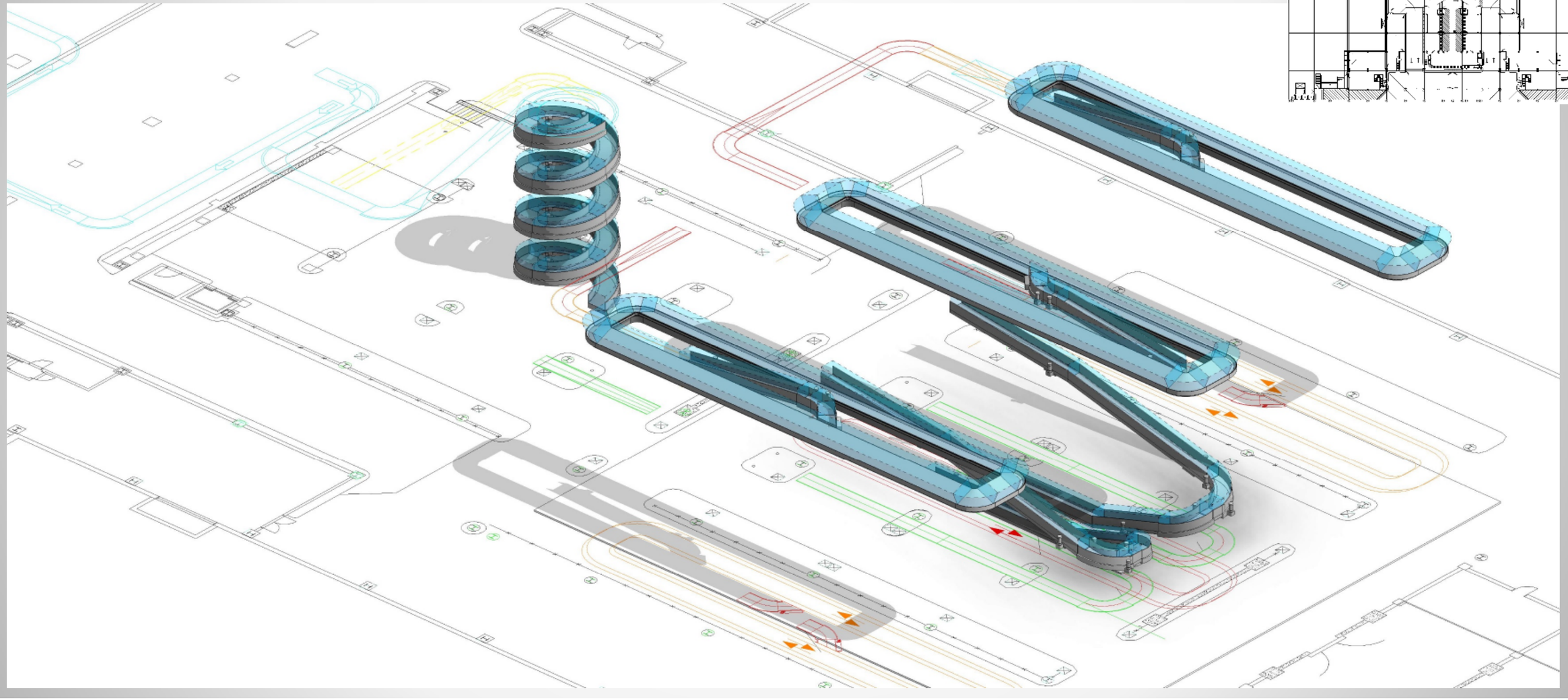
The median lifespan of a typical office building is 73 years.* However, at a 24/7, critical functioning facility such as an airport, the high usage factor is more likely to push the lifecycle cost past 80%.

The Difference in Vision = Predictable Cost

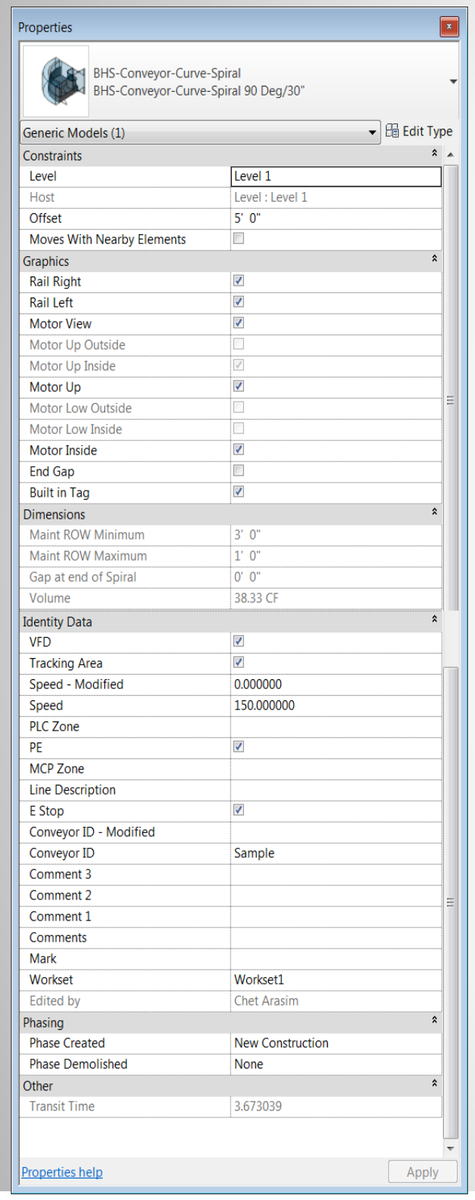


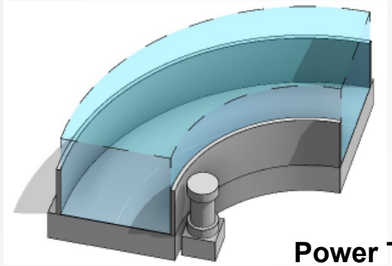
Critical Assets



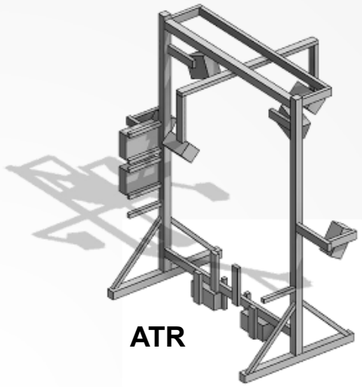


Critical Assets

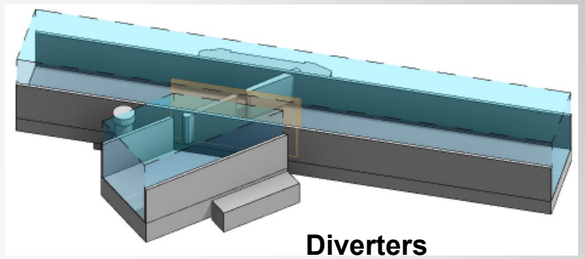




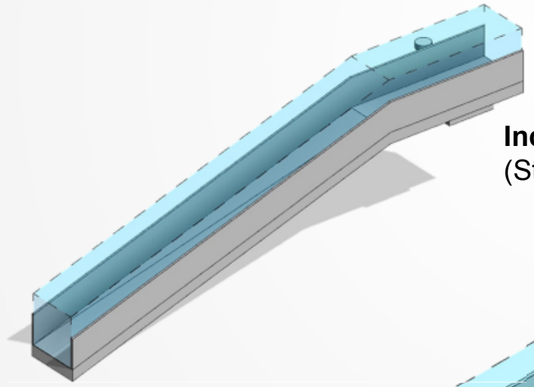
Power Turns
30, 45, 60, 90 degrees
(Standard & Oddsize)



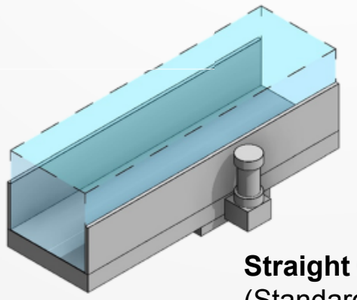
ATR



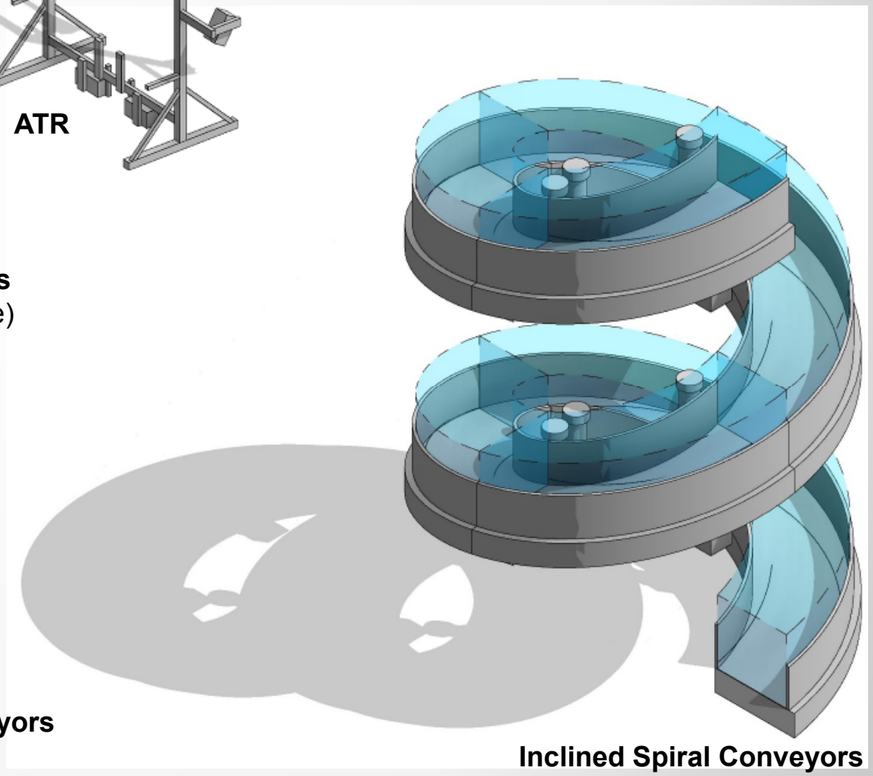
Diverters
(Standard & Oddsize)



Inclined Breakovers
(Standard & Oddsize)

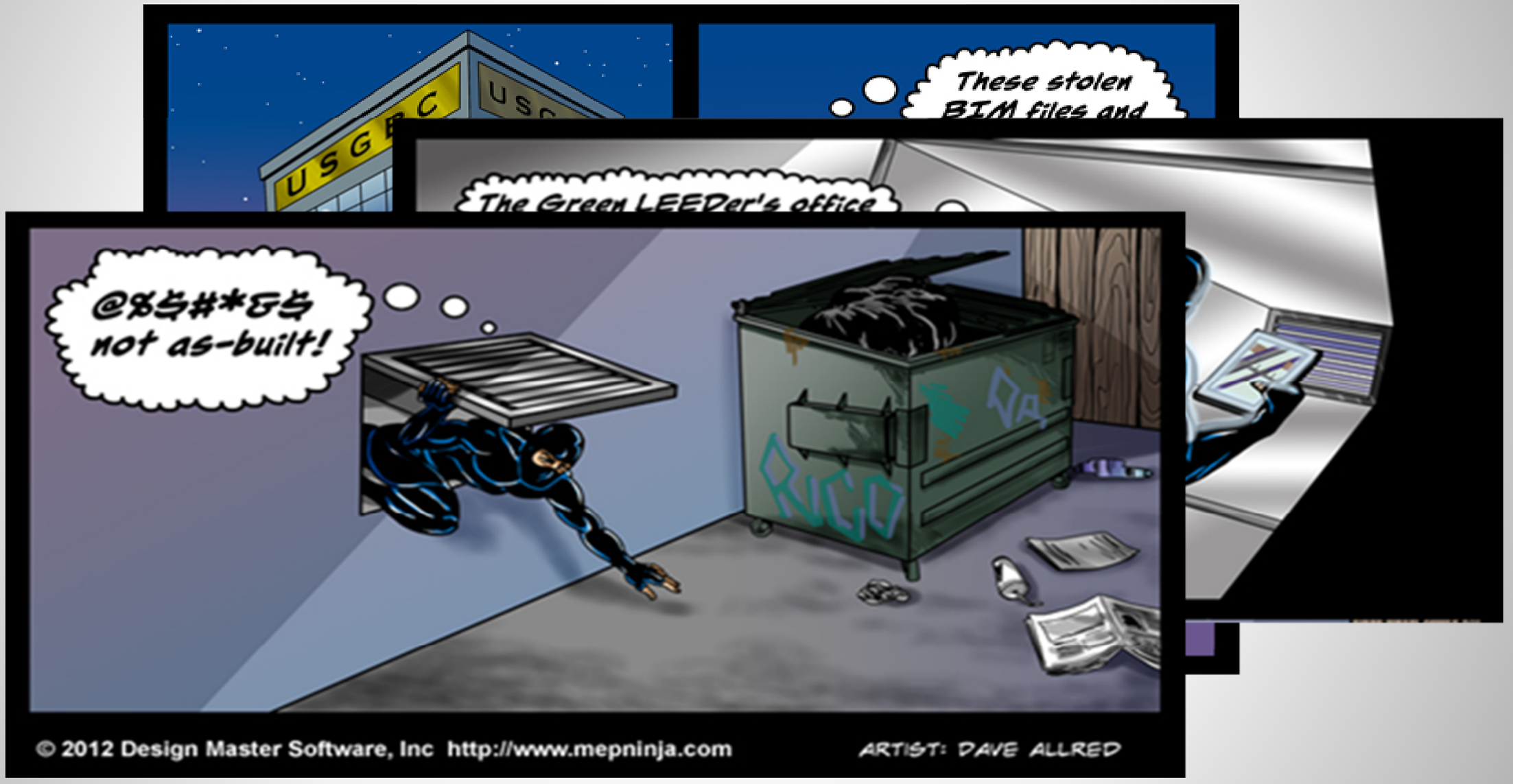


Straight Conveyors
(Standard & Oddsize)

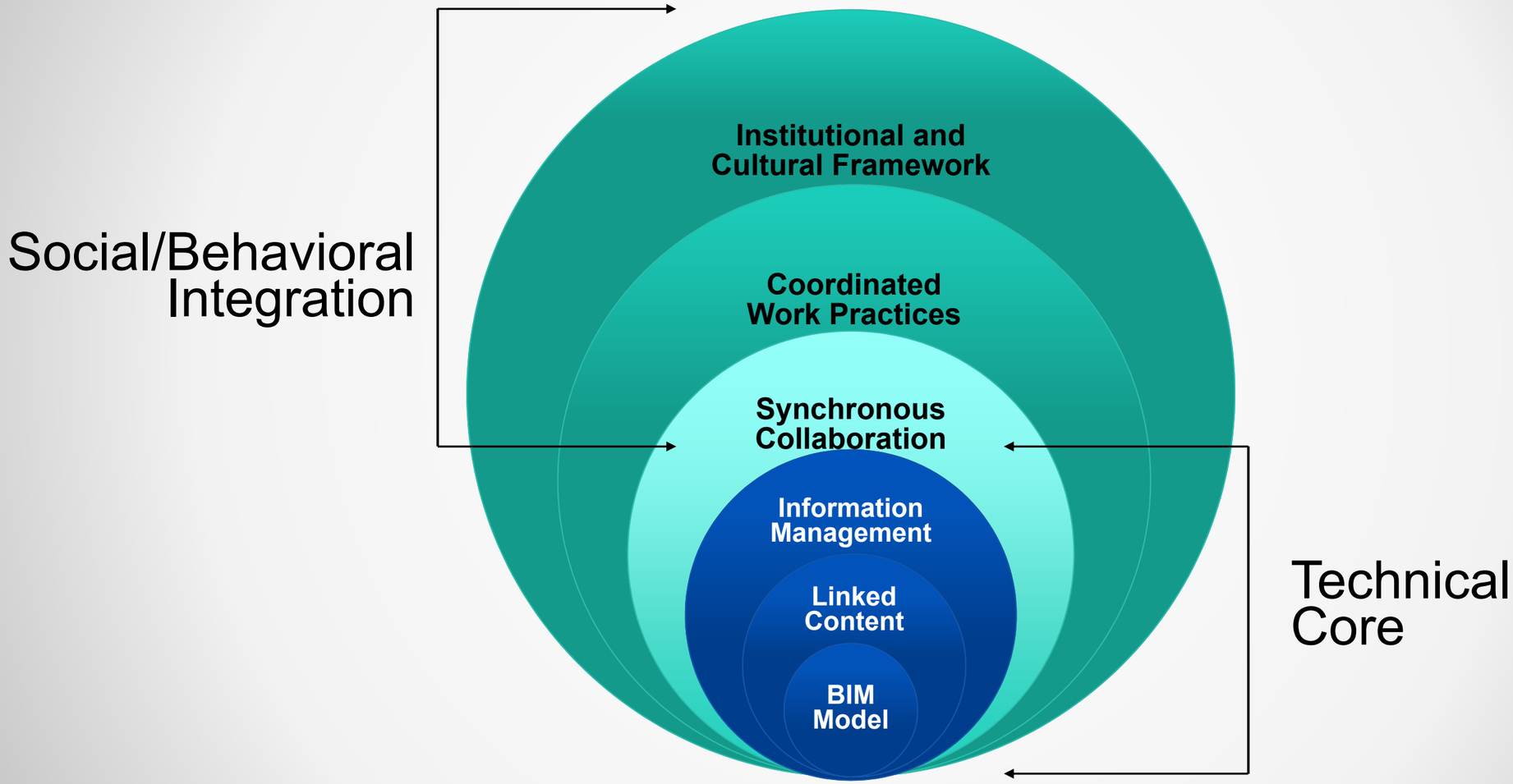


Inclined Spiral Conveyors
30, 45, 60, 90 degrees
(Standard & Oddsize)

The Effort to Change

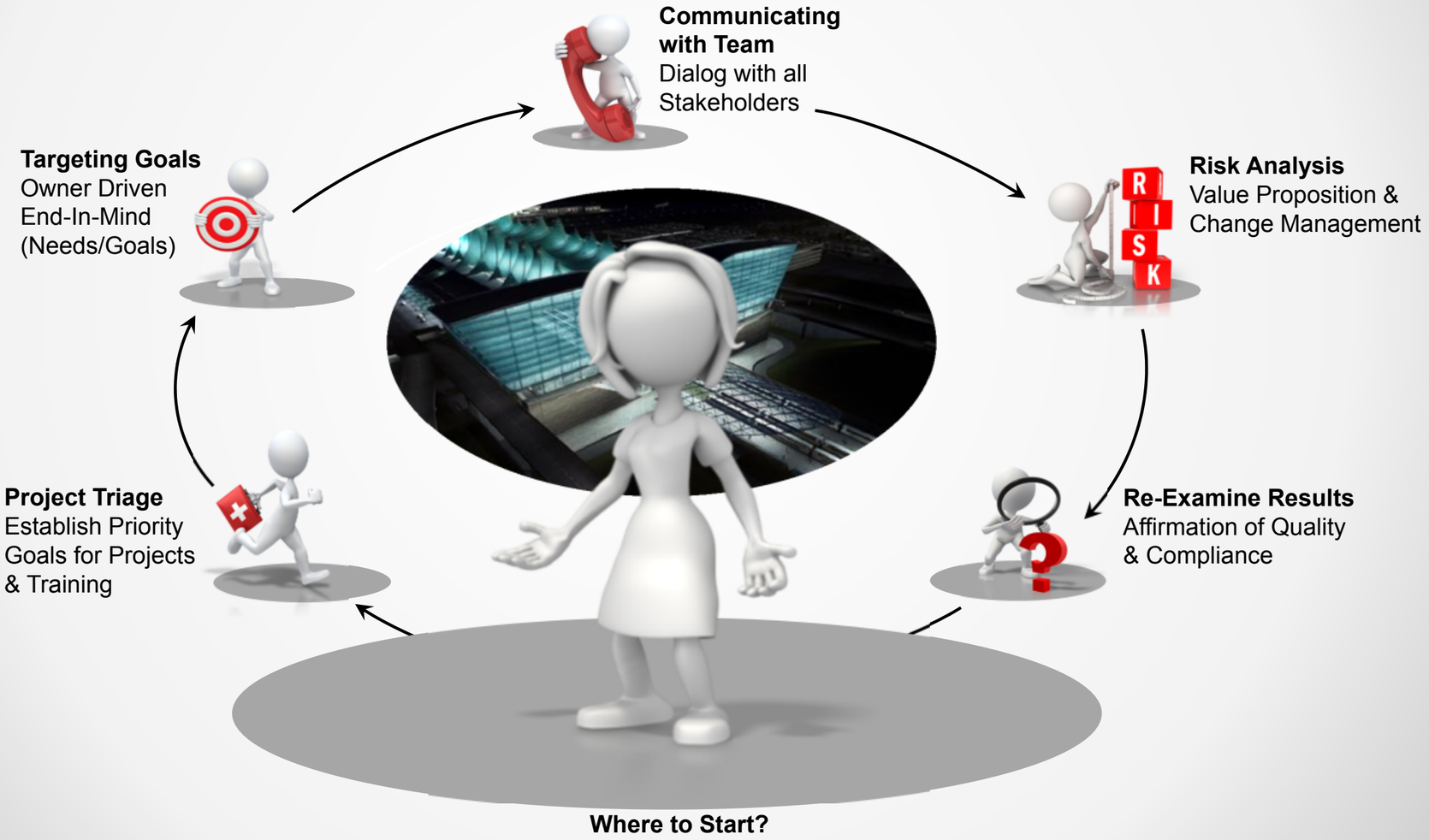


Technology vs. Psychology



BIM Implementation as a Sociotechnical System

Implementation: It's a Process



Answer and Questions

ANSWER: 8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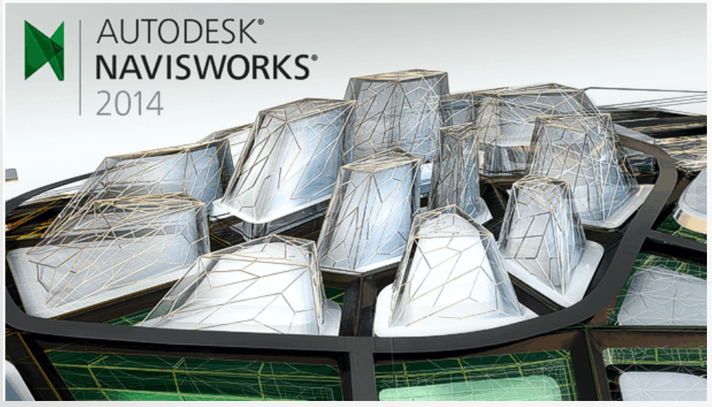
Autodesk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FIELD


Synchro
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PROJECT MANAGEMENT