

# Building Information Modeling for Construction Safety

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Autodesk

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# Class summary

This class introduces the integration of **Construction Safety** and **BIM** for efficient **hazard identification and prevention**.



# Key learning objectives

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

- Discover effective BIM for Safety **best practices** throughout project lifecycle
- Learn how to use BIM for **fall protection**
- Learn how to facilitate **job hazard analysis** using BIM
- Learn how to integrate **safety inspection and reporting** into BIM-project workflow



# Outline

- Motivation
- BIM for Safety Lifecycle
- *Planning*: Fall protection
- *Pre-construction*: Job hazard analysis
- *Construction*: Safety checklist and reporting
- Discussion on opportunities and challenges

# Outline

## ■ Motivation

- BIM for Safety Lifecycle
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# Motivation

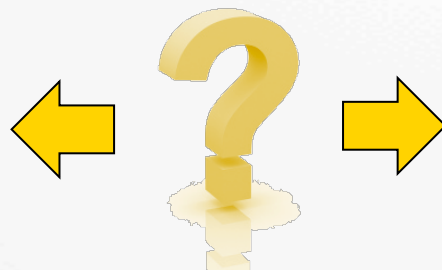
- Construction industry account for **1 out of 5** of the total workplace deaths annually in U.S.
- **75%** likelihood of experiencing a lost-time injury and a **1/200 chance** of being fatally injured



- Manual observations-based safety planning is labor-intensive, time-consuming, and thus highly inefficient.

# Motivation

- Improved safety - importance to improve BIM's *Return On Investment (ROI)*: High
- Improved safety: 7%
  - Only 2% in US (lowest region)
- Safety planning/training as a top 3 activity leverages BIM in pre-construction planning: 6%
- Missing link between safety management and BIM



Tuttle Courthouse Annex. Image courtesy of Stevens & Wilkinson.



Electronic Library of Construction  
Occupational Safety & Health

## Percentage of Contractors Citing BIM Benefit as One of Top Three for Their Organization

Source: McGraw Hill Construction, 2013

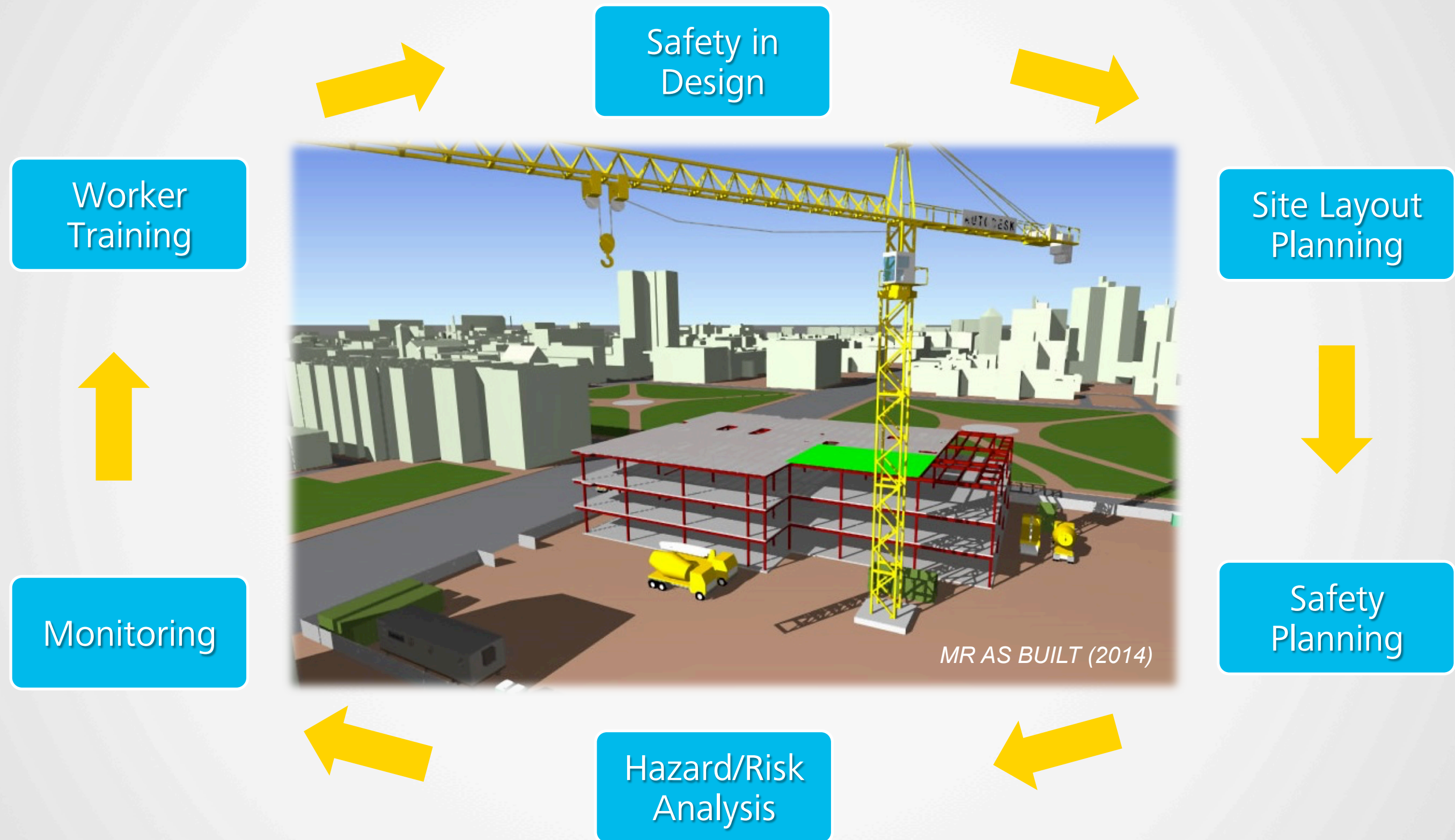




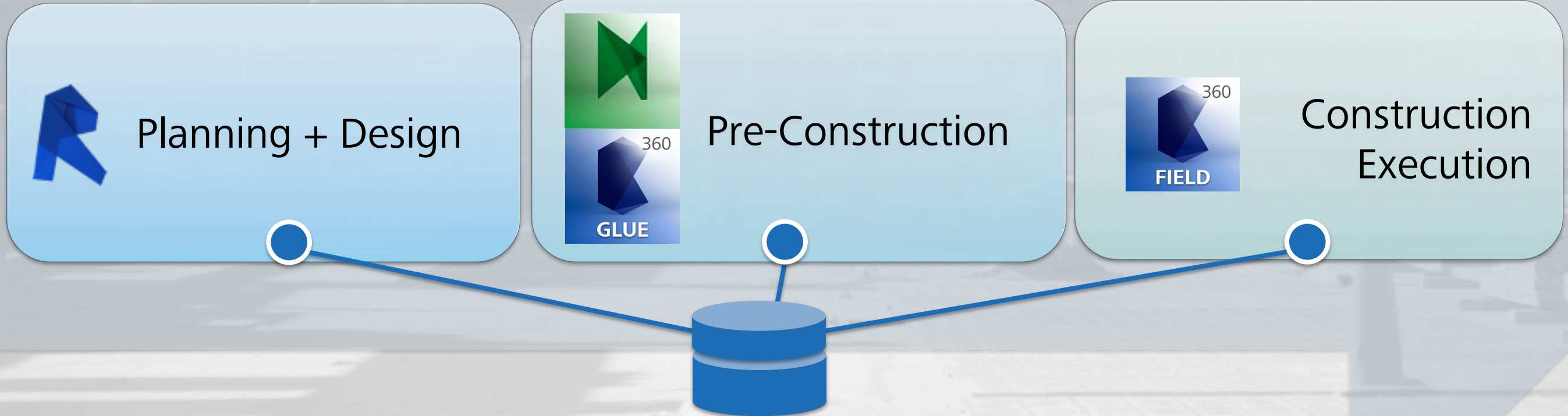
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# BIM for Safety







# BIM for Construction Safety

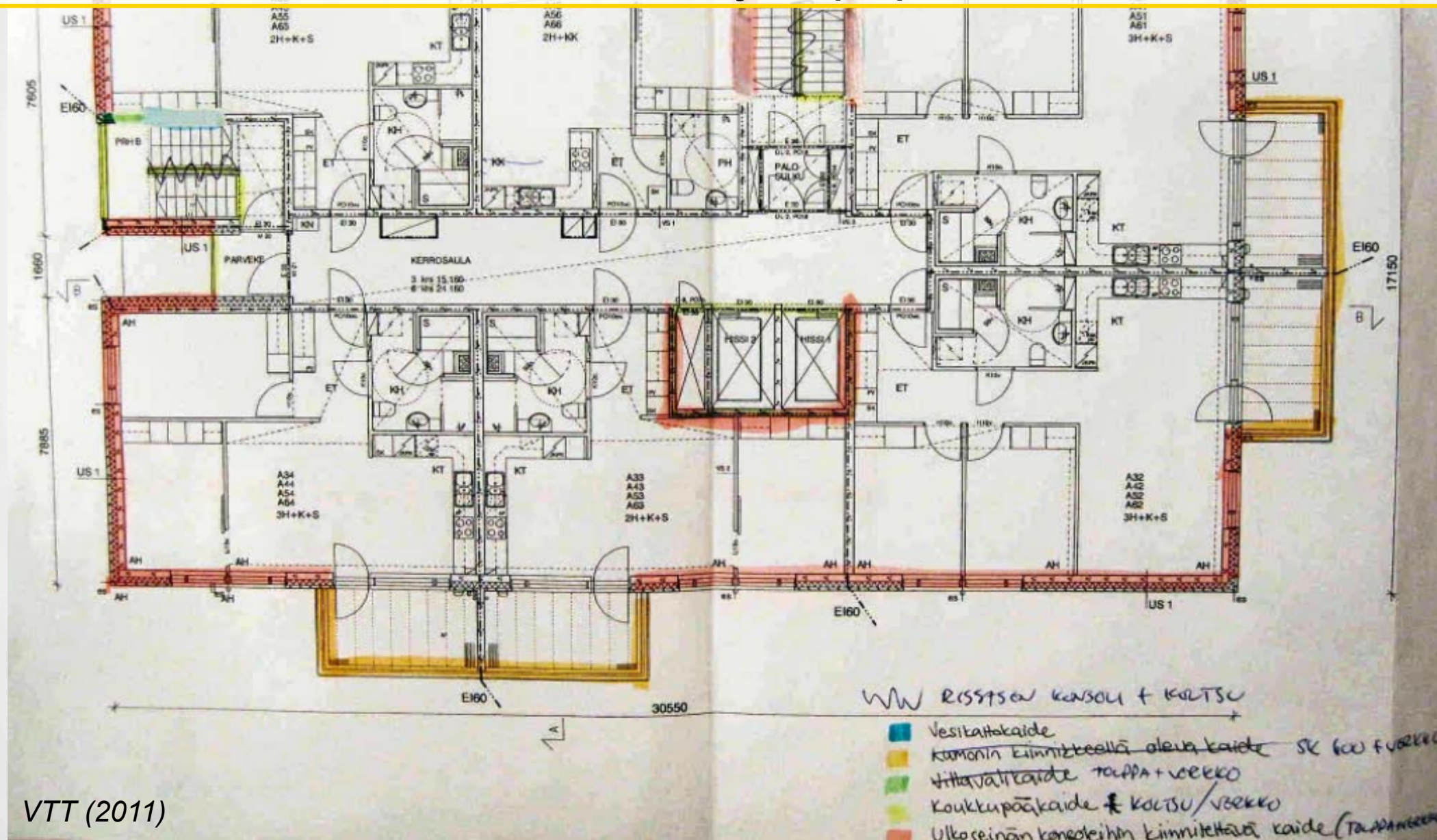
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- Motivation
- BIM for Safety Lifecycle
- *Planning: Fall protection*
- *Pre-construction: Job hazard analysis*
- *Construction: Safety checklist and reporting*
- Discussion on opportunities and challenges



# 1. Safety Planning – Fall Protection

- ? How many holes are in the drawing?
- ? When do they need to be protected?
- ? What and how much safety equipment is needed?



# Revit-ETO for Safety Planning and Automation

- A new solution combining the best features of two industry leading platforms
  - Autodesk Revit
    - Recognized industry-leading BIM Platform
  - Autodesk ETO (Engineer-to-Order)
    - Best-of-breed rules based environment



REVIT

+



AUTODESK®  
ENGINEER-TO-ORDER

=

**REVIT-ETO**



# What is Autodesk ETO?

## Proven Technology and Expertise

- Heathrow Terminal 5

The ETO system produces all 3500 drawings in only 8 hours and typically only require a validation check from an architect.

- Evans Consoles

A control room configuration tool used by their sales team worldwide and by over 65 distributors resulting in 46% increase of close rate and reduction of proposal time from 2 weeks to 60 minutes

- Hytrol Conveyors

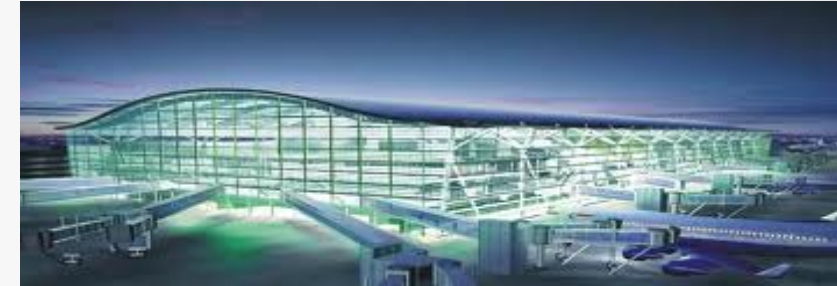
Automation of the layout of an entire conveyor system for retail warehouses used by their extensive sales and distributor network

- National Westminster Bank Refit

Production of rapid tools for each of the branch areas that would assist the user in making valid configuration choices.

- Eaton Busway

Routing busway through building walls and generation of Revit output for architects

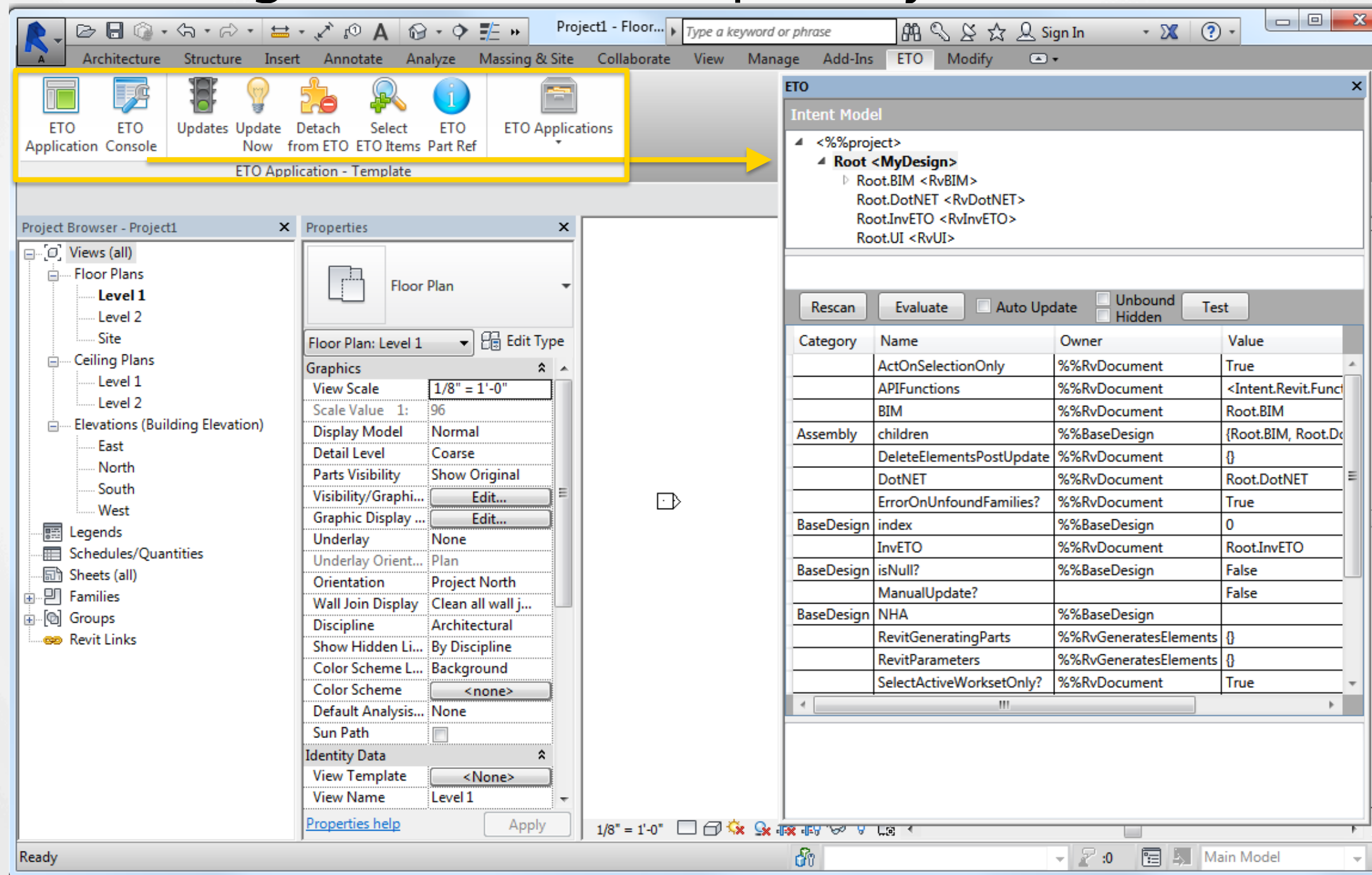




# Safety Planning and Automation

## Moving towards Best in Class

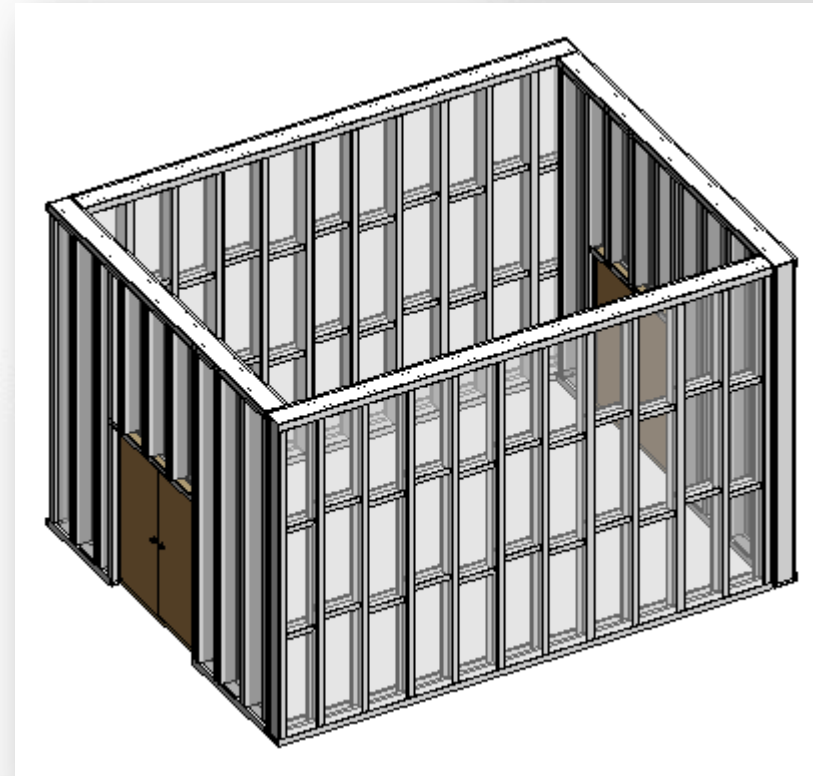
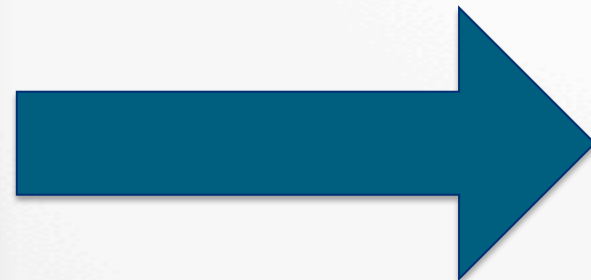
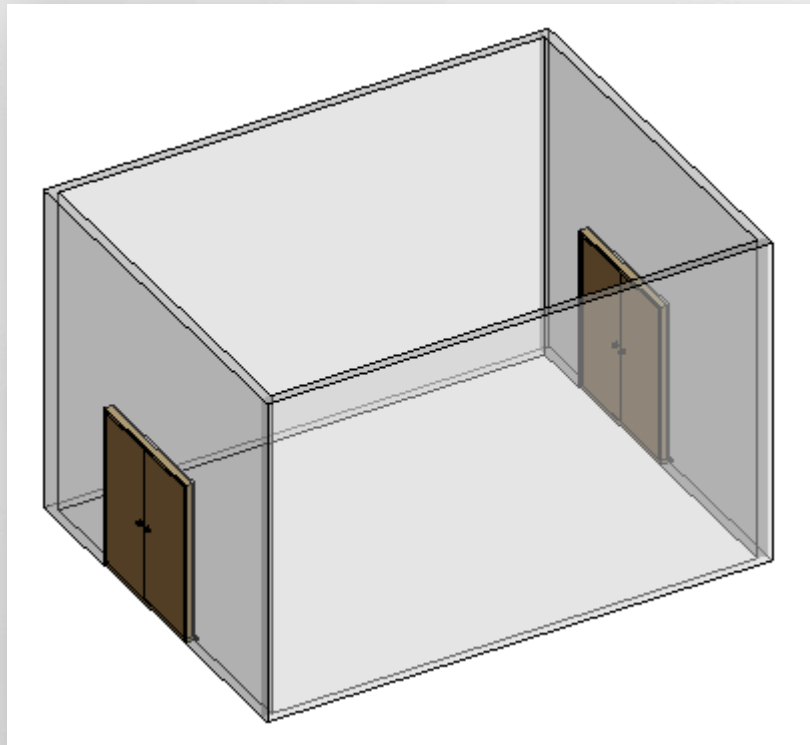
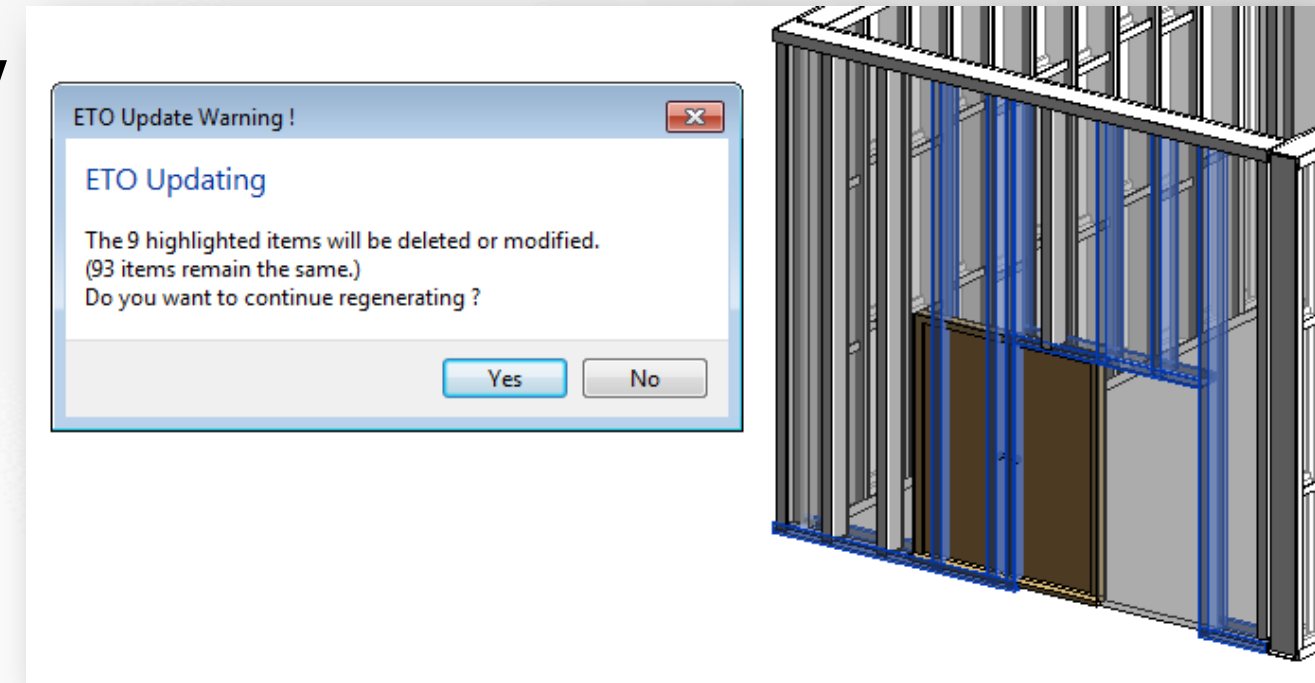
- Revit + ETO brings rules based capability to Revit



# Safety Planning and Automation

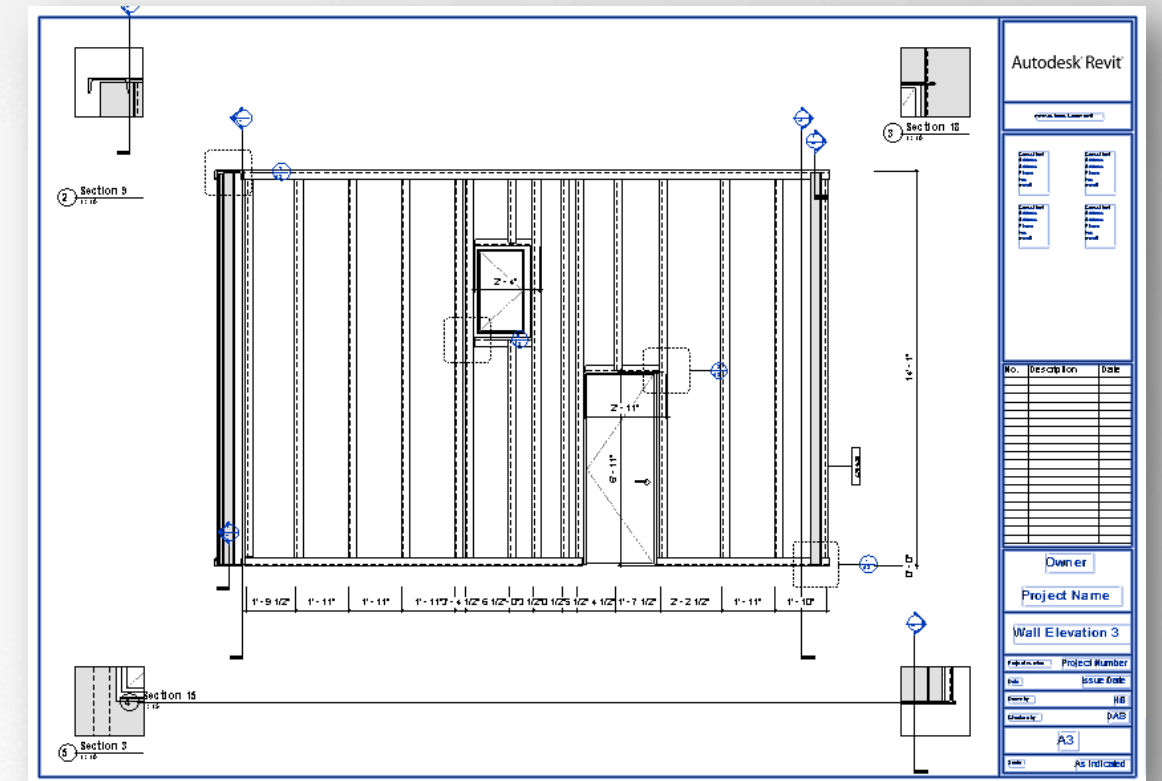
## Moving towards Best in Class

- Revit + ETO brings rules based capability to Revit
  - Rules have full access to Building Information Model
  - Automatic Generation of Families



## Moving towards Best in Class

- 
- A 3D perspective view of a building's exterior wall and roof structure. The wall is composed of vertical studs, with a brown door and a window integrated into the structure. The roof is shown with a gabled design, featuring a white fascia and a dark, textured roof surface. The perspective is from a low angle, looking up at the building.



	Schedule: Multi-Category Schedule - Autodesk_Hospital_Architectural				
<Multi-Category Schedule>					
A	B	C	D	E	F
Comments	Count	AD	Family	Height	Manufacturer
10_Stall Panel					
	1		10_Stall Panel		
			10_Stall Panel		
	1		10_Stall Panel		
			10_Stall Panel		
	1		10_Stall Panel		
			10_Stall Panel		
	1		10_Stall Panel		
			10_Stall Panel		

	Schedule: Safety Barrier - Autodesk_Hospital_Architectural				
<Safety Barrier>					
A	B	C	D	E	F
Assembly Code	Comp	Count	Family	Image	Manufacturer
B2020210		1	Rectangular Mullion		
B2020210		1	Rectangular Mullion		
B2020210		1	Rectangular Mullion		
B2020210		1	Rectangular Mullion		Technical Glass
B2020210		1	Rectangular Mullion		
B2020210		1	Rectangular Mullion		
B2020210		1	Rectangular Mullion		
B2020210		1	Rectangular Mullion		
					Technical Glass

	Schedule: Panel Schedule - Autodesk_Hospital_Architectural						
<Panel Schedule>							
A	B	C	D	E	F	G	H
Area	Count	Description	Company_ID	Family	Finish	Manufacturer	Specification
15 SF	1	The Pilkington Pr	Pilkington - Profil	Pilkington - Profil	Pilkington		
15 SF	1	The Pilkington Pr	Pilkington - Profil	Pilkington - Profil	Pilkington		
15 SF	1	The Pilkington Pr	Pilkington - Profil	Pilkington - Profil	Pilkington		Technical Glass
15 SF	1	The Pilkington Pr	Pilkington - Profil	Pilkington - Profil	Pilkington		
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15 SF	1	The Pilkington Pr	Pilkington - Profil	Pilkington - Profil	Pilkington		Technical Glass
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15 SF	1	The Pilkington Pr	Pilkington - Profil	Pilkington - Profil	Pilkington		Technical Glass
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15 SF	1	The Pilkington Pr	Pilkington - Profil	Pilkington - Profil	Pilkington		Technical Glass
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15 SF	1	The Pilkington Pr	Pilkington - Profil	Pilkington - Profil	Pilkington		
15 SF	1	The Pilkington Pr	Pilkington - Profil	Pilkington - Profil	Pilkington		Technical Glass
15 SF	1	The Pilkington Pr	Pilkington - Profil	Pilkington - Profil	Pilkington		



# Rule Interpretation

*From OSHA Standard 1910.23(a) to Table-based Rule:*

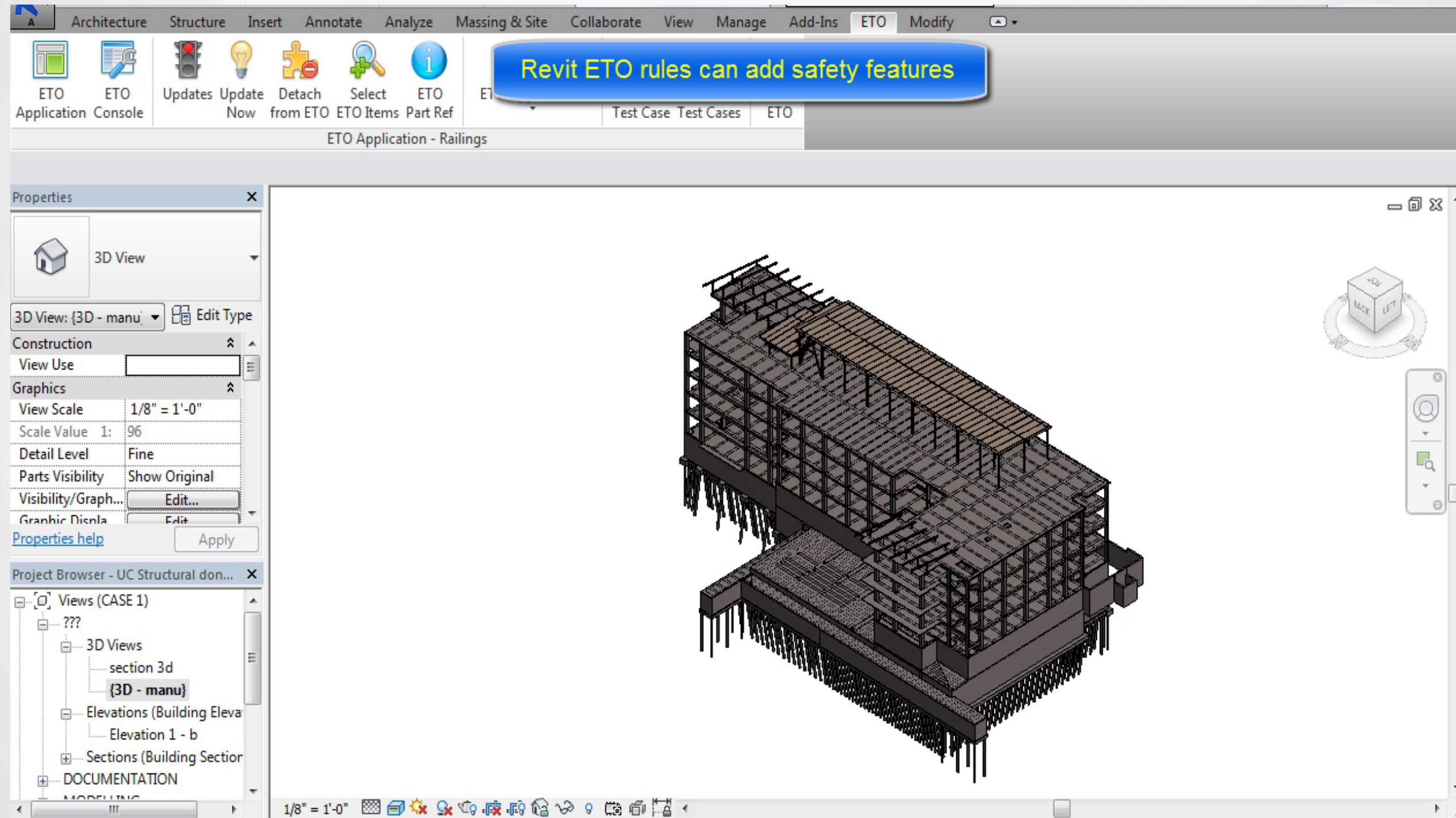
- **Hole** means a gap or void 2 inches (5.1 cm) or more in its least dimension in a floor, roof or other walking/working surface.
- **"Holes."** Each employee on walking/working surfaces shall be protected from falling through holes (including skylights) more than 6 feet (1.8 m) above lower levels, by personal fall arrest systems, covers, or guardrail systems erected around such holes.



**Green**—building objects  
**Orange**—object attributes  
**Red**—prevention system

Opening (least dimension)	Prevention Method
< 0.05 m	No action required
0.05 m < x < 1 m	Apply cover
Otherwise	Apply guardrail system

# Revit ETO – Safety Planning and Automation



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# Job Hazard Analysis

- 90% of workplace injuries can be traced to unsafe work practices and behaviors
- Job Hazard Analysis (JHA)

[illegible]

# Navisworks Job Hazard Analysis Add-in

JHA Advisor

File Model Organizer

WBS Simulate

Review date: 08/22/2013 02:12 PM

<< >> 10 Day

Object representation 4d Task-Delivery

Refresh

Ongoing activities:

Strip\_Column  
Place\_Rebar  
Frame\_Column  
Column\_Bracing  
Pour\_Column

Job Steps:

Remove\_Pins  
Break\_Forms\_Loose  
Place\_Form\_At\_Designated\_Area

Potential Hazards:

Unexpected\_Form\_Rel  
Strain  
Sprain

Mitigations:

1. Barricade off the area to  
2. Break one side loose prior  
3. Have a coworker hold the

Resources:

Stripping\_Zone

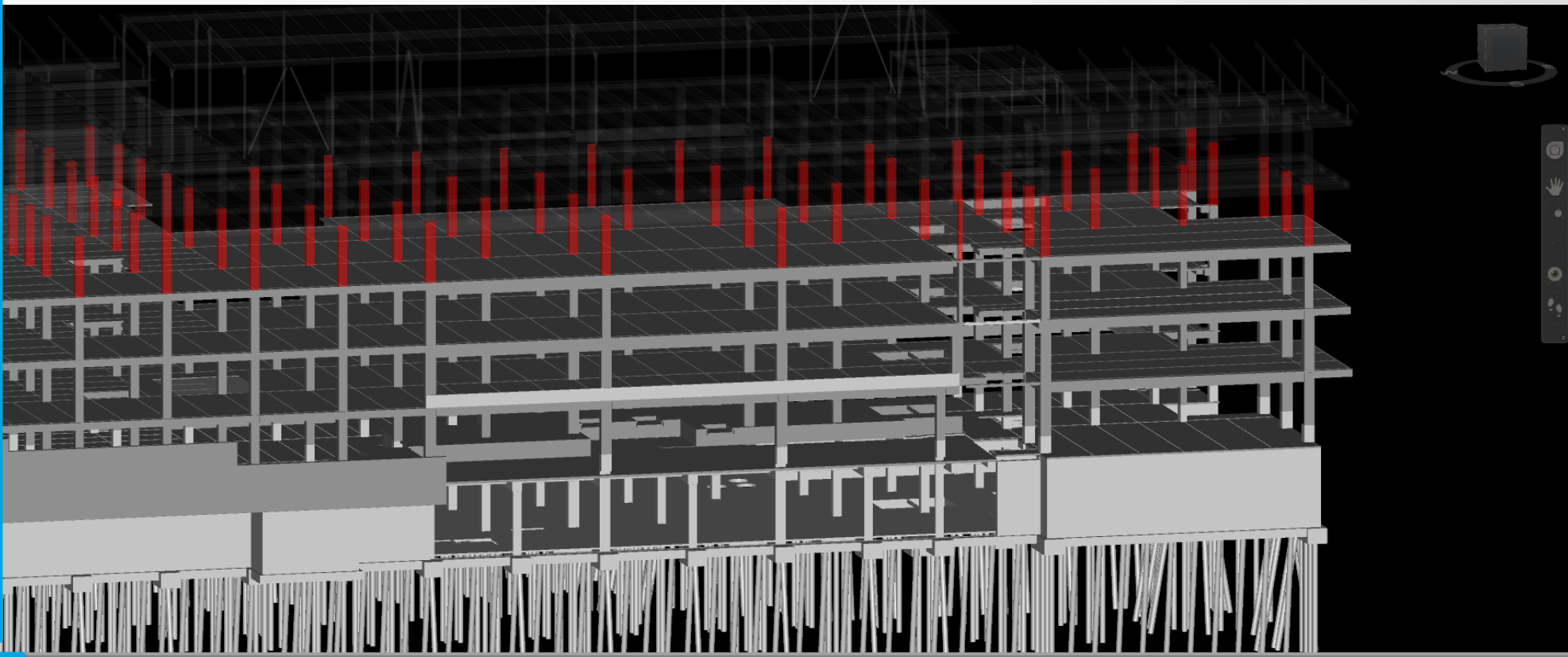
Ongoing Activities

Job Steps

Hazards

Mitigations

RES



JHA Advisor

File Model Organizer

WBS Simulate

Review date: 08/22/2013 02:12 PM

<< >> 10 Day

Object representation 4d Task-Delivery

Refresh

Ongoing activities:

Strip\_Column  
Place\_Rebar\_Cage  
Frame\_Column  
Column\_Bracing  
Pour\_Column

Job Steps:

Remove\_Pins  
Break\_Forms\_Loose  
Place\_Form\_At\_Designated\_Area

Potential Hazards:

Unexpected\_Form\_Rel  
Strain  
Sprain

Mitigations:

1. Barricade off the area to  
2. Break one side loose prior  
3. Have a coworker hold the

Resources:

Stripping\_Zone

TimeLiner

Tasks Data Sources Configure Simulate

Add Task Attach

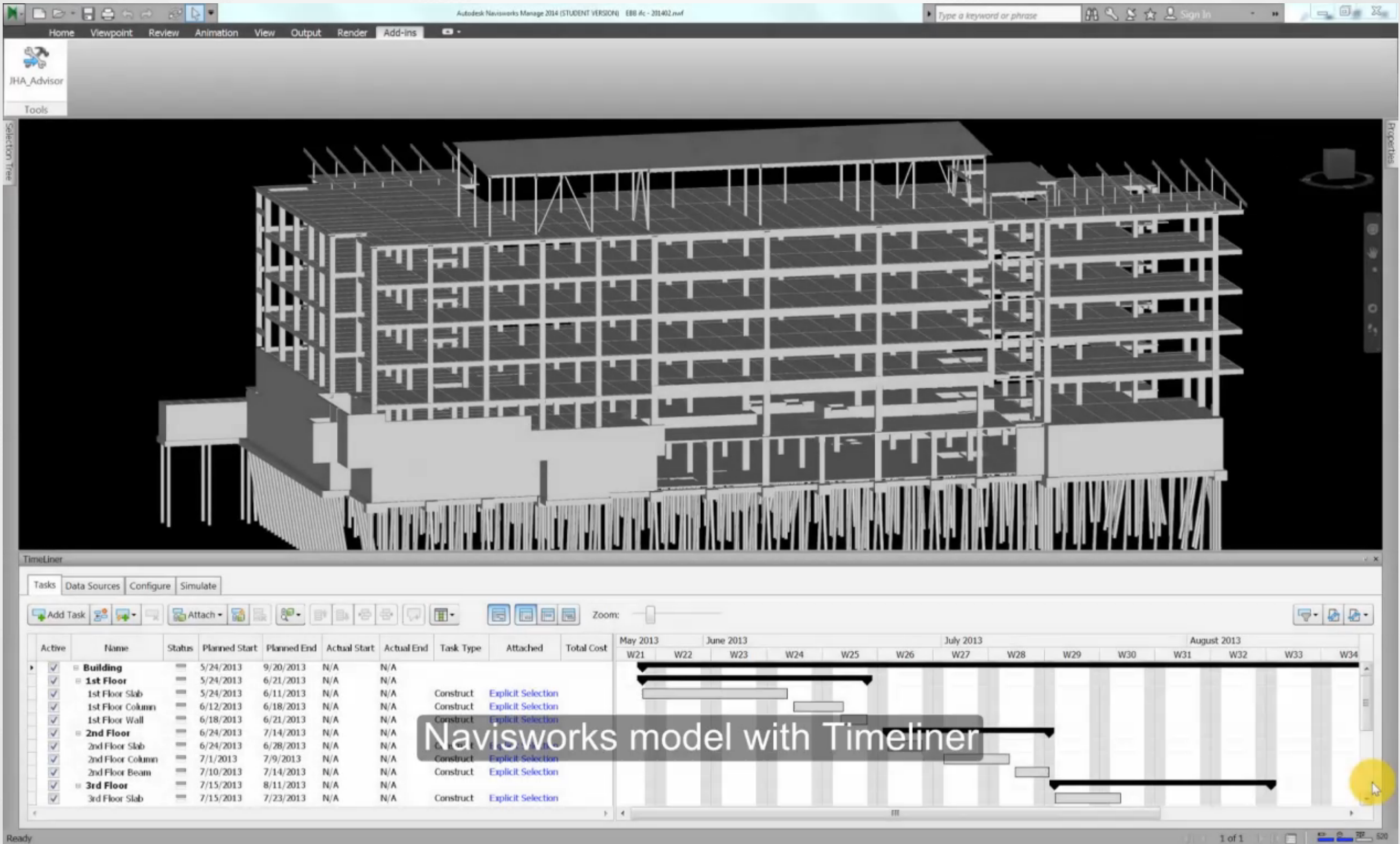
Active Name Status Planned Start Planned End Actual Start Actual End Ta

3rd Floor  
3rd Floor Slab  
3rd Floor Column  
3rd Floor Beam  
4th Floor  
4th Floor Slab  
4th Floor Column  
4th Floor Beam  
5th Floor  
5th Floor Slab  
5th Floor Column

7/15/2013 8/11/2013 N/A N/A  
7/15/2013 7/23/2013 N/A N/A  
7/29/2013 8/8/2013 N/A N/A  
8/9/2013 8/11/2013 N/A N/A  
8/12/2013 8/31/2013 N/A N/A  
8/12/2013 8/21/2013 N/A N/A  
8/22/2013 8/28/2013 N/A N/A  
8/29/2013 8/31/2013 N/A N/A  
9/1/2013 9/15/2013 N/A N/A  
9/1/2013 9/6/2013 N/A N/A  
9/10/2013 9/13/2013 N/A N/A

May 2013 June 2013 July 2013  
W21 W22 W23 W24 W25 W26 W27 W28 W29 W30

# Demo: JHA Advisor

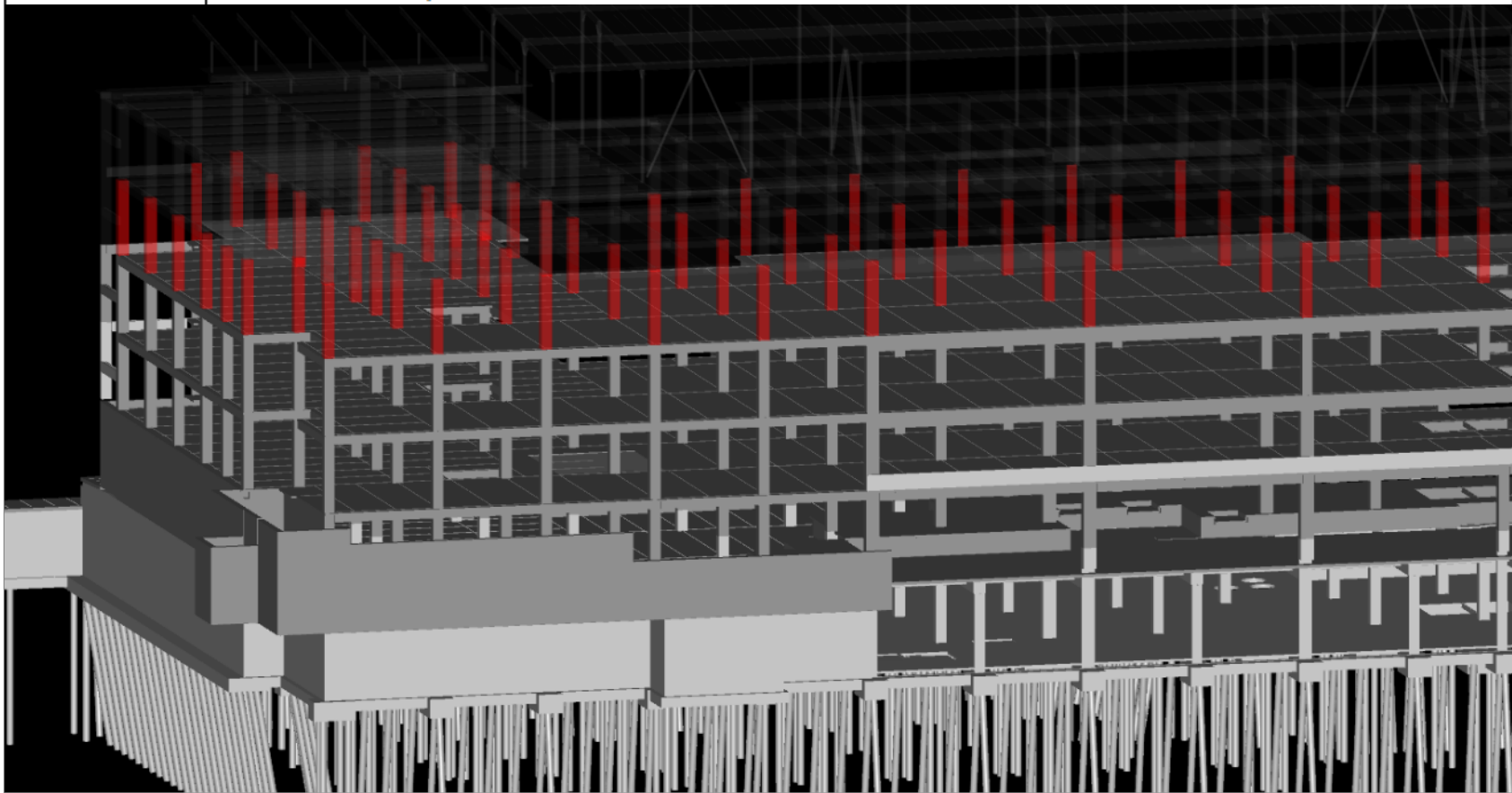


Navisworks model with Timeliner



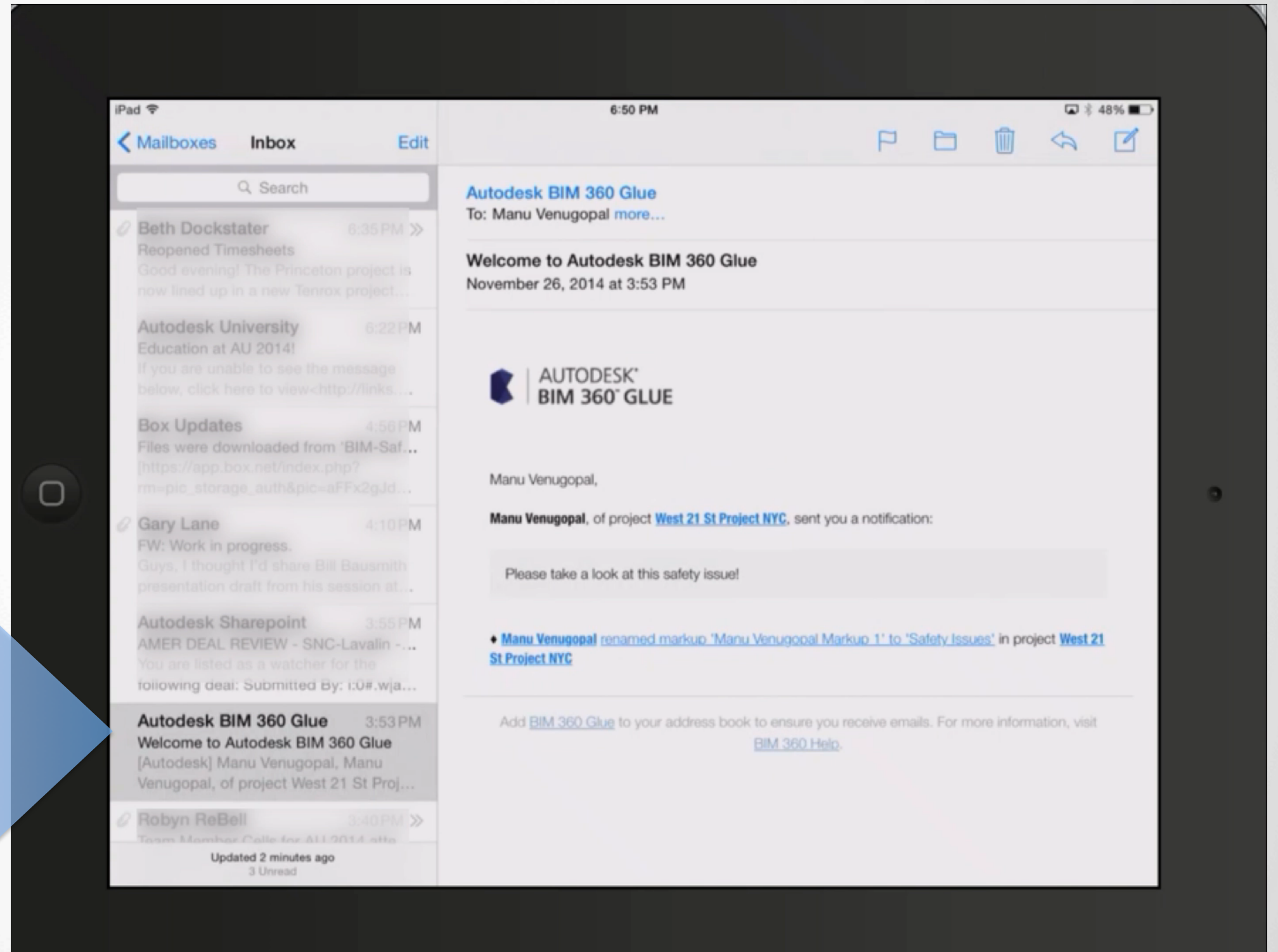
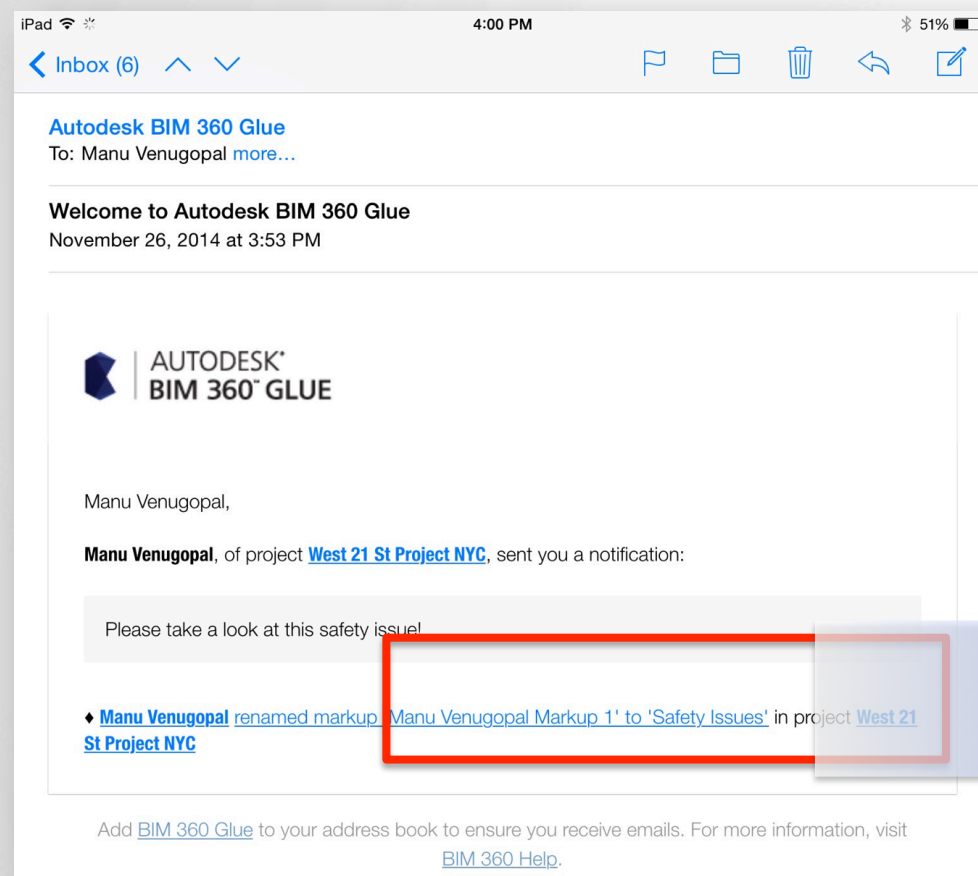


# Automated JHA Reporting

Job Hazard Analysis		
<b>Project Name:</b> Concrete project XYZ	<b>Analyst:</b> Safety Manager A	<b>Date:</b> 1/4/2014 2:30:59 PM
<b>Review Time:</b> 1/14/2014 10:20:00 AM		
<b>Task Name:</b> Column	<b>Activity:</b> Frame_Column	
<b>Job Step:</b> Stand_Form_Into_Place		
<b>Protential Hazard:</b> Fall		
<b>Recommended Procedures:</b>		
	1. Use platform or scaffold	
	2. Ensure area around platform/scaffold is clear of debris and flat	
<b>Safety Resources:</b>		
	1. Platform or scaffold	
	2. Retractable lanyard	
	3. Scaffold inspection	
		

# Working with extended team

- One-click to Safety!



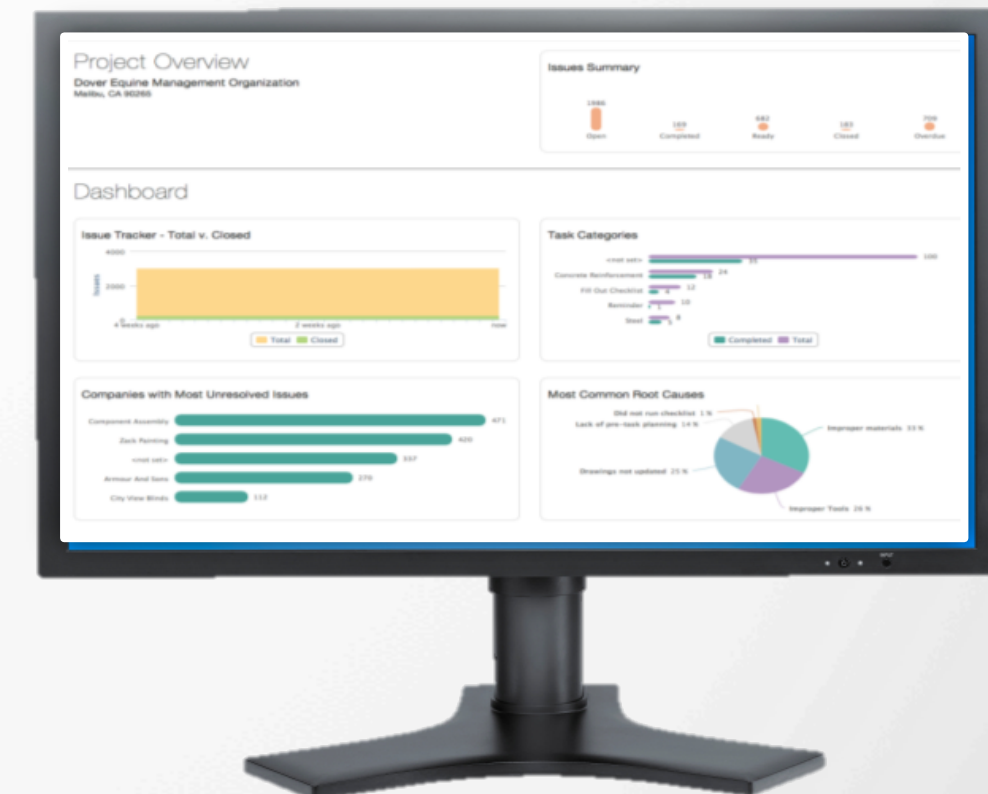


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# BIM 360 Field Safety Workflows

- Rapid, thorough, Checklist based inspections, Issue-tracking and resolution
- Enable model-based workflows on the job site, and link field data to models
- Get real-time project insight through analytical reporting and dashboards
- Designed for the entire project team





# BIM 360 Field: iPad App for Safety

1. Lookup any construction document for reference.
2. Complete a safety checklist and document issues with photos.
3. Note issues during a site walk using markers on plans.
4. Close completed items or comment on work left to finish.
5. Assign and Manage Tasks for Work



Checklists Find Checklists

Choose Checklist

Tap 'List >' to list existing checklist locations.  
Tap checklist name to create a new checklist.

## Safety

**OHSAS - HEALTH AND SAFETY INDUCTION TRAINING - FORM IND1**

32 items

**OSHA 2209 - EXITING OR EGRESS (0)**

14 items

**OSHA 2209 - FIRE PROTECTION (0)**

17 items

**OSHA 2209 - GENERAL WORK ENVIRONMENT (0)**

17 items

**OSHA 2209 - PERSONAL PROTECTIVE EQUIPMENT AND CLOTHING**

19 items

**OSHA 2209 - SAFETY AND HEALTH PROGRAM (0)**

7 items

**OSHA 29 CFR 1910.134 - RESPIRATORY PROTECTION STANDARD**
















11 items

**OSHA 29 CFR 1910.95 - HEARING CONSERVATION STANDARD (0)**

et started



**OSHA 29 CFR 1926 P - EXCAVATION - PROTECTIVE SUPPORT SYSTEMS**

 Issue	<b>Materials and/or equipment selected on soil analysis, expected loads, and trench parameters.</b>		-	N/A
	 Tap to enter comments			
 Issue	<b>Materials and equipment inspected and in good condition.</b>		-	N/A
	 Tap to enter comments			
 Issue	<b>Materials and equipment not in good condition must be removed from service and not returned until repaired, inspected, and approved by a Registered Professional engineer.</b>		-	N/A
	 Tap to enter comments			
 Issue	<b>Protective systems installed without exposing employees to hazards of cave-ins, collapses, or from being struck by materials of equipment. Install from the top, down, and from the bottom up.</b>		-	N/A
	 Tap to enter comments			
 Issue	<b>Members of Protective Support System must be securely fastened.</b>		-	N/A
	 Tap to enter comments			



	<b>Issue</b>	Members of Protective Support System must be securely fastened.		-	N/A
	<b>1 Issue</b>	Adjacent structures must be securely supported.	+		N/A
	<b>Issue</b>	Excavations below the footing of base must be approved by a Registered Professional Engineer.	+	-	N/A
	<b>Issue</b>	The backfill process must progress with the removal of the support system.	+	-	N/A
	<b>Issue</b>	Material excavated to a level no greater than 2' from the bottom of the Protective Support System, and only if system is designed to support the calculated loads.	+	-	N/A
	<b>Issue</b>	Shield system placed to prevent lateral movement.	+	-	N/A

Checklists

&lt; Issues

New Issue



Adjacent structures must be securely supported.

! Issue

! 1 Issue

! Issue

! Issue

! Issue

Attachments (0)



Comments (0)



Issue type

Safety : Safety



Company



Priority



Status

Open



Date created

Sun 11/23/2014

Author

AVA...



Header

fastened.

+

-

N/A

by a Registered Professional

+

-

N/A

e support system.

+

-

N/A

ottom of the Protective  
rt the calculated loads.

+

-

N/A

Shield system placed to prevent lateral movement.

+

-

N/A





Checklists

&lt; New Issue

Attachments



VA...



Header

Issue

1 Issue

Issue

Issue

Issue



Add attachment

stened.

+

-

N/A

+

-

N/A

by a Registered Professional

+

-

N/A

support system.

+

-

N/A

bottom of the Protective  
the calculated loads.

+

-

N/A

Shield system placed to prevent lateral movement.

+

-

N/A



Close

Slab-hole-inspection.jpg



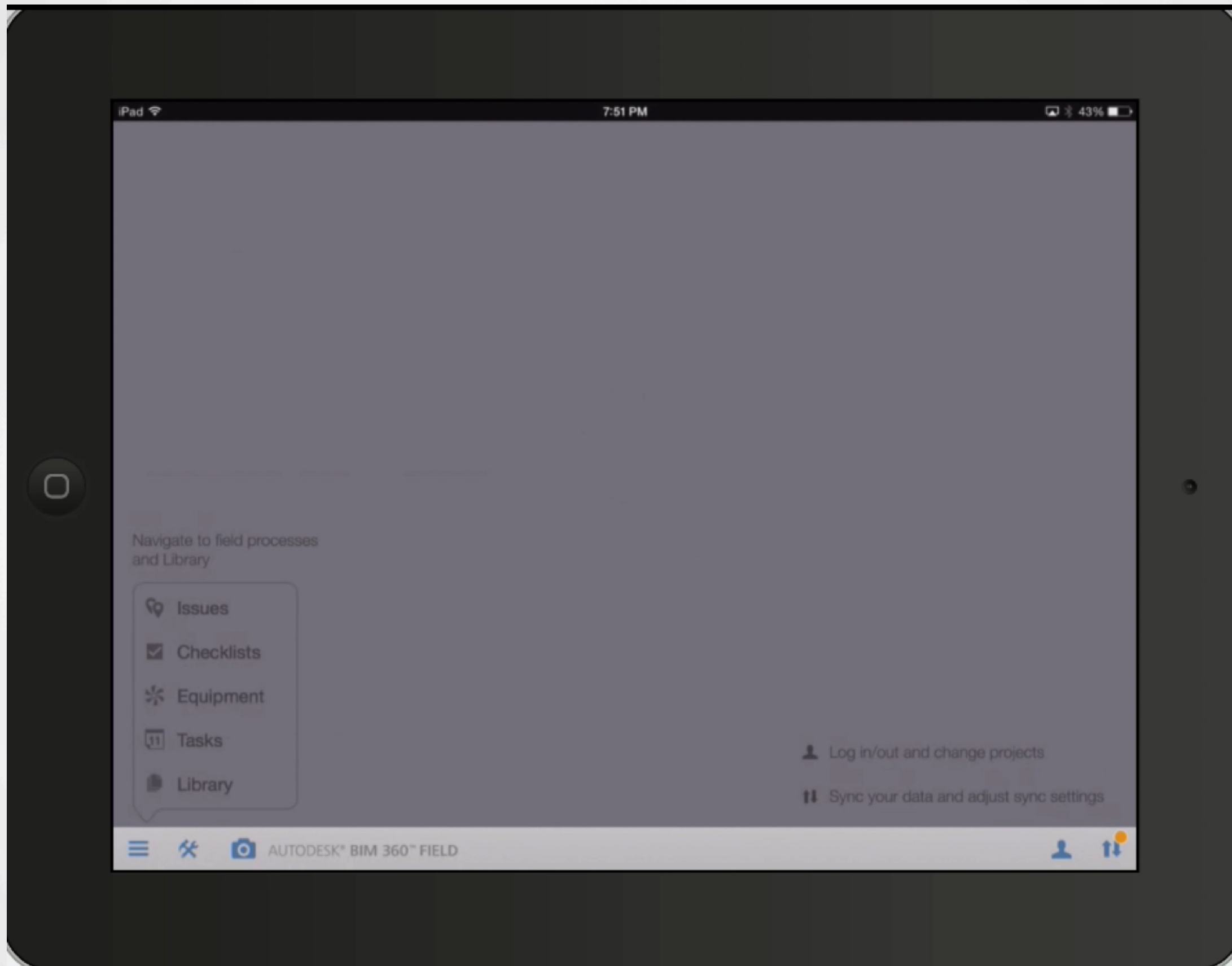
Uncovered hole

Enter tags



appears on report







# Tasks and Scheduled Reports

AUTODESK® BIM 360™ FIELD

BIM 360 Field Training Center

Reports

6

Manu Venugopal

Recent

Scheduled

Saved

Issues

Tasks

Checklists

Equipment

Account

Autodesk Executive

Custom

Task Details

• Printable task form includes any attached comments, images, signatures, issues, or checklists

Run now

Unschedule

Save scheduled report

History

Report

Report name

Safety Inspection Details

Sort by

Task ID

Sort direction

Output format

PDF

Filters

Include tasks scheduled for timeframe or between dates

All

All dates

Task types

Inspect Work

Fire Safety Inspection Request

Task statuses

all

Schedule

Schedule name

Safety Inspection Details

Description

Run

every week

On these days

☐ Sun ☒ Mon ☐ Tue ☐ Wed ☐ Thu ☐ Fri ☐ Sat

Run report at

7:00am (GMT+01:00) Berlin

Send report to

Venugopal, Manu <manu.venugopal@autodesk.com>

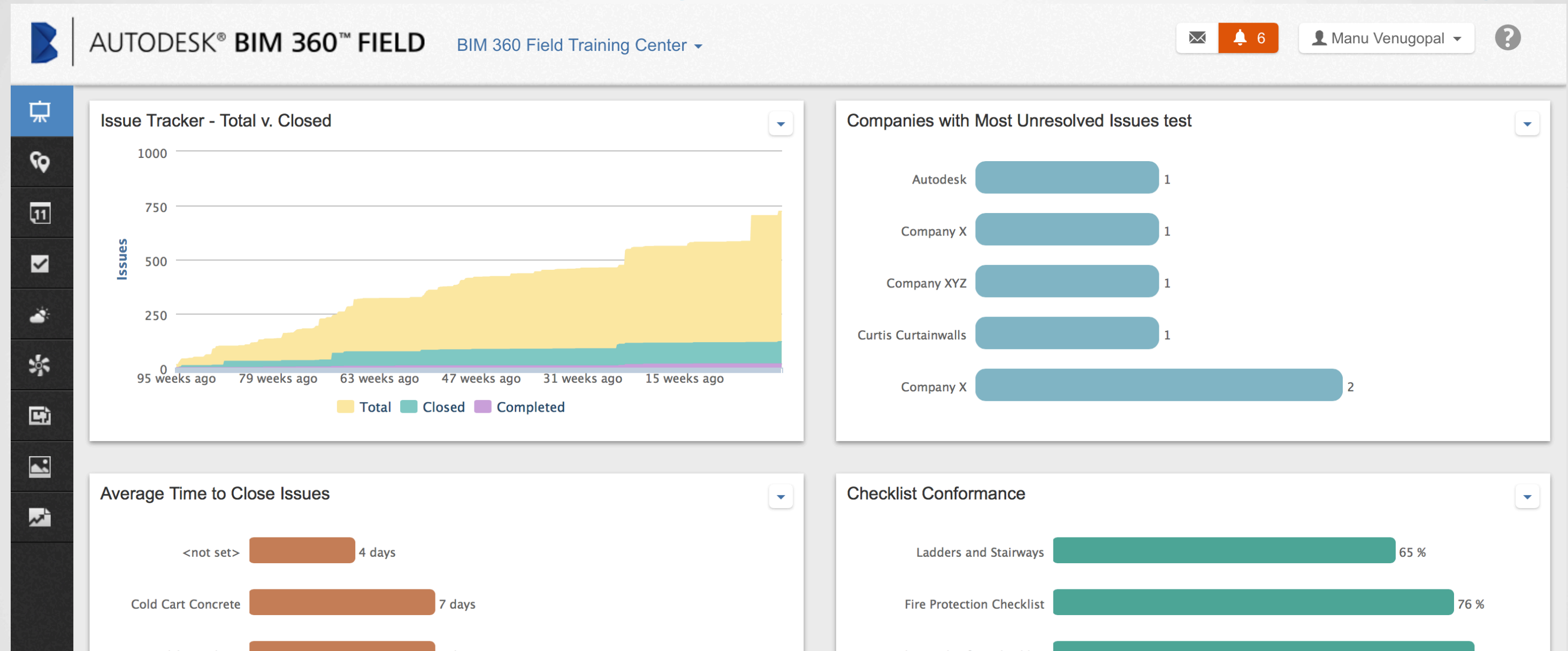
Subject

Task Details

Message

Please take appropriate action based on the attached report. Contact me with any questions you might have or if you have issues opening the attached file.

# BIM 360 Field: Reporting and Dashboards for Safety



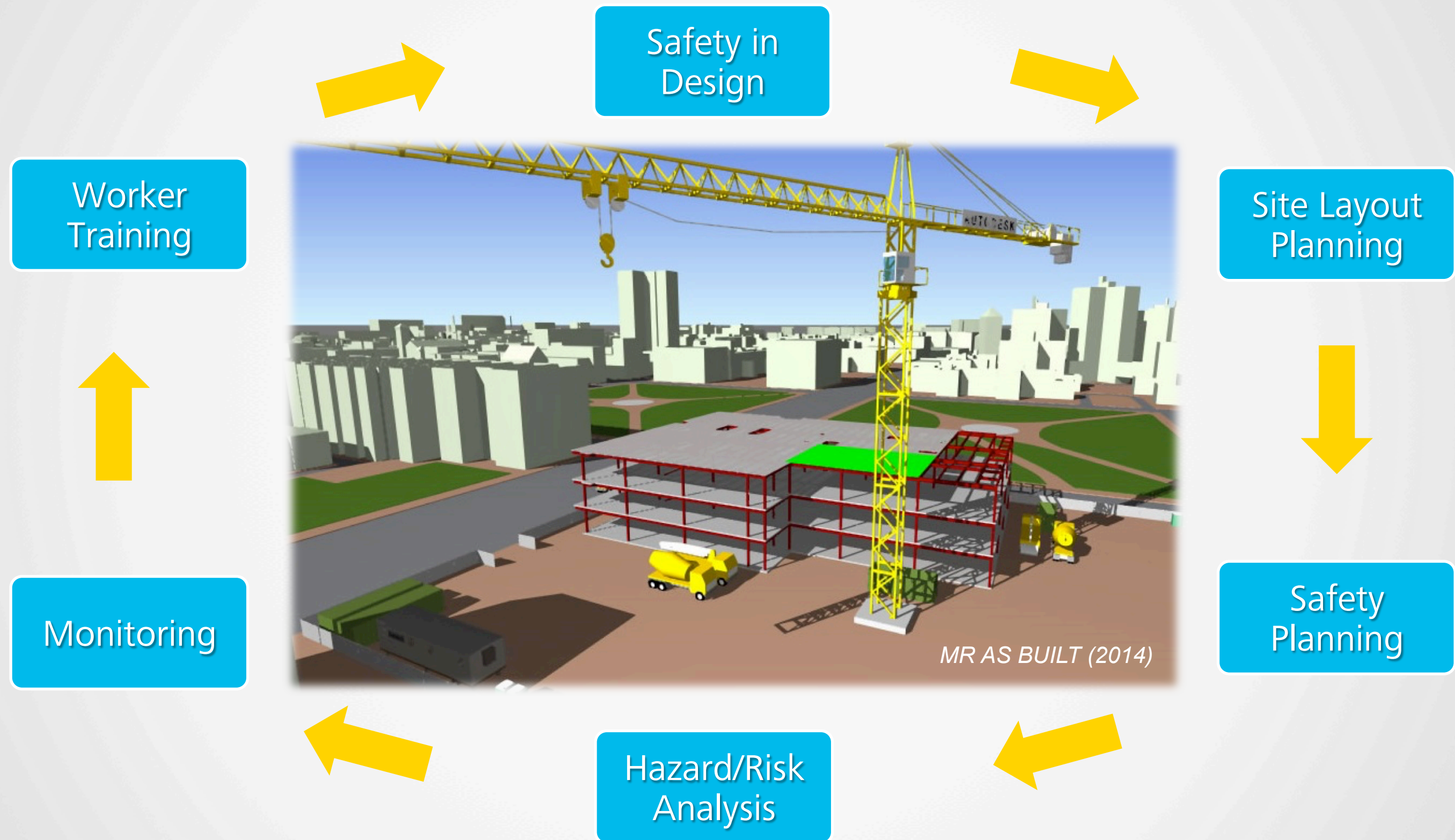
BIM 360 reporting provides project performance transparency to executives and project managers

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# BIM for Safety



# Opportunities/Challenges

- Detailed mapping of safety planning process and procedures
- Formalize checklists and routines
- Maintain schedule!
- More interaction and feedback

