

**Presented by:**  
**Abby Coleman**  
**David Nino**

# **Engineering the Future: Parametric Design, Immersive Tech and AI**

# Presenters



**David Nino**

Structural Engineering Innovation Specialist  
IMEG



**Abby Coleman**

Innovation Extended Reality Specialist  
IMEG

**WHO IS EXCITED ABOUT THE  
FUTURE?**





# **FUTURE READY ENGINEERS**

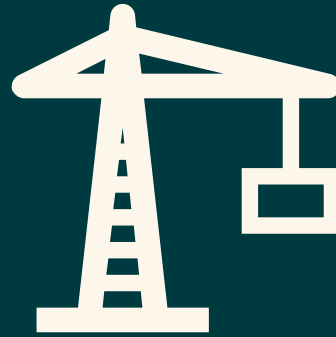
**WHY CHANGE?**

# AEC INDUSTRY TREND



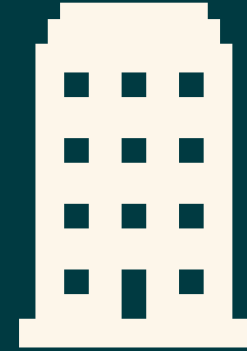
**33%** of construction projects come in **over budget**

[1]



**\$280B** industry annual **rework cost** caused by poor project data and communication

[1]



**39%** of carbon come from buildings

[2]

# Billions are wasted from inefficient design review collaboration



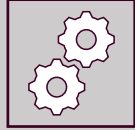
2.6T ft

(one New York City)  
of new buildings will  
be **built every**  
**month** until 2060 <sup>[1]</sup>





# OUTLINE



Understand the role of parametric design in early-stage structural engineering



Explore the impact of immersive technologies (VR/AR/XR) on project collaboration



Examine the integration of AI and data analytics in design

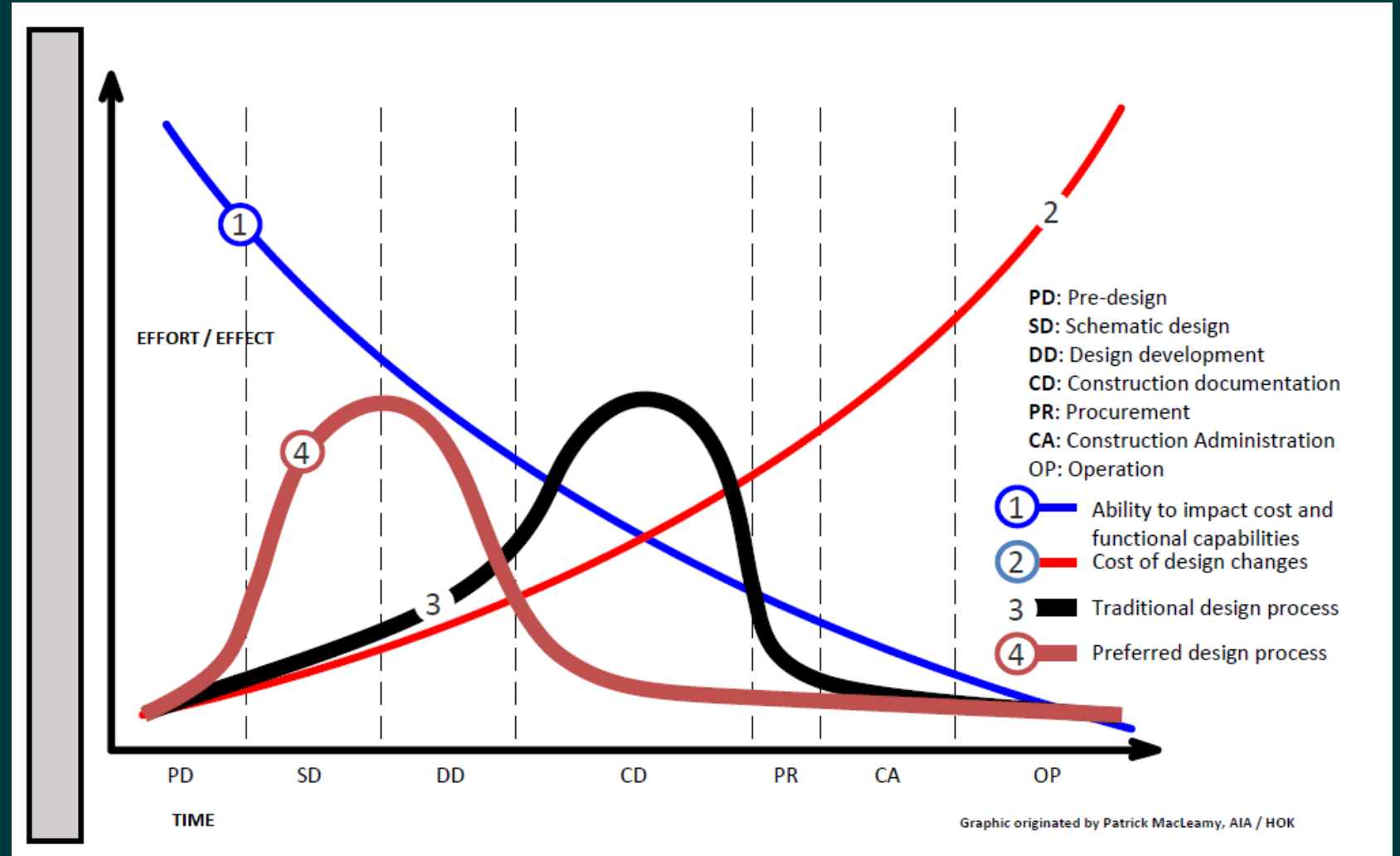


Evaluate the combined benefits of parametric design, immersive tech, and AI for sustainable and cost-effective building solutions

# Parametric Engineering

The background of the image is an abstract, three-dimensional visualization of a grid. The grid lines are thin and dark blue, set against a lighter blue gradient. The grid is warped and curved, creating a sense of depth and movement, resembling a tunnel or a complex, flowing surface. The overall color palette is various shades of blue, from deep navy to a light, airy cyan.

# EARLY DESIGN STRUGGLE



DECISIONS AT EARLY STAGES  
ARE **CRITICAL**

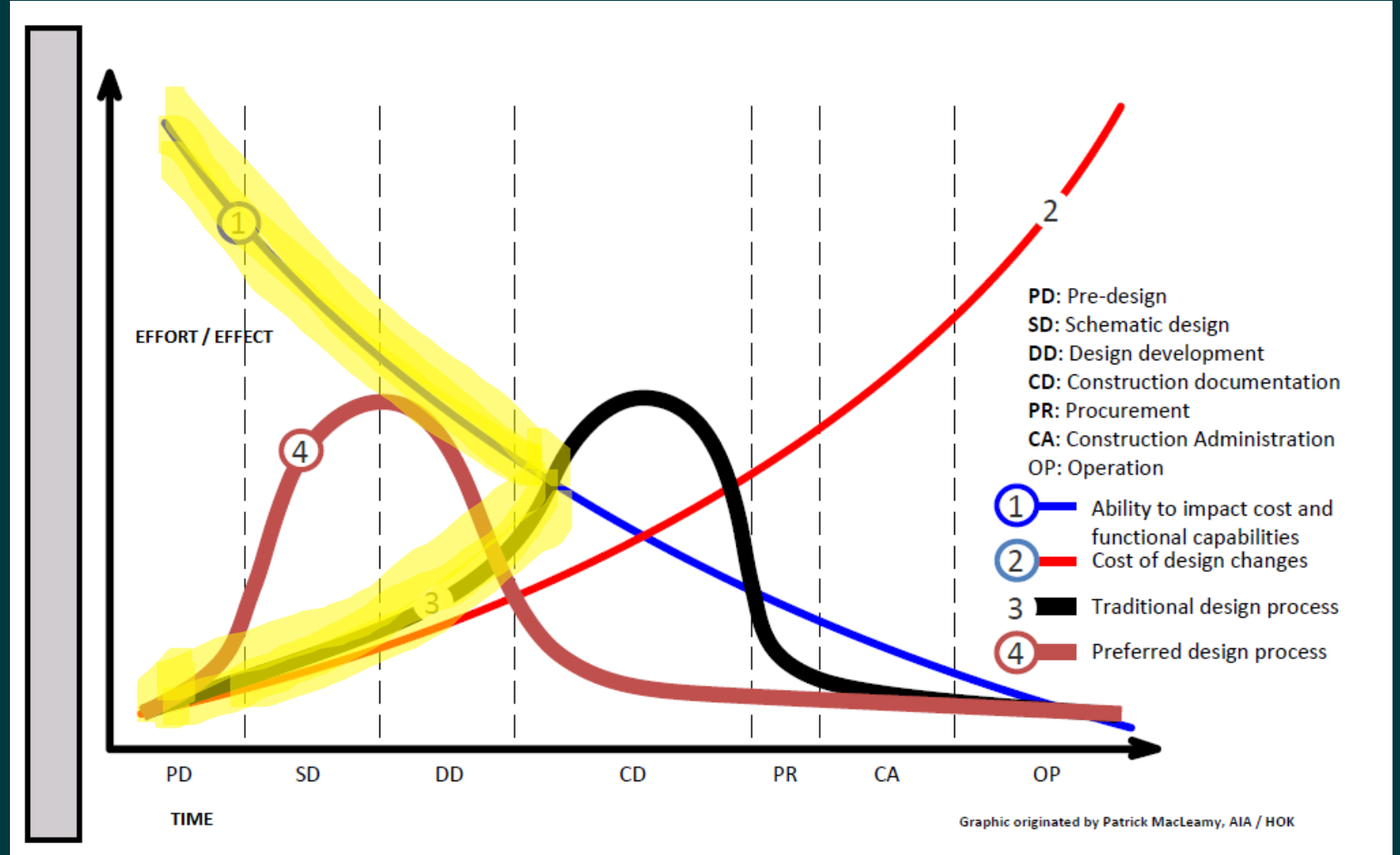




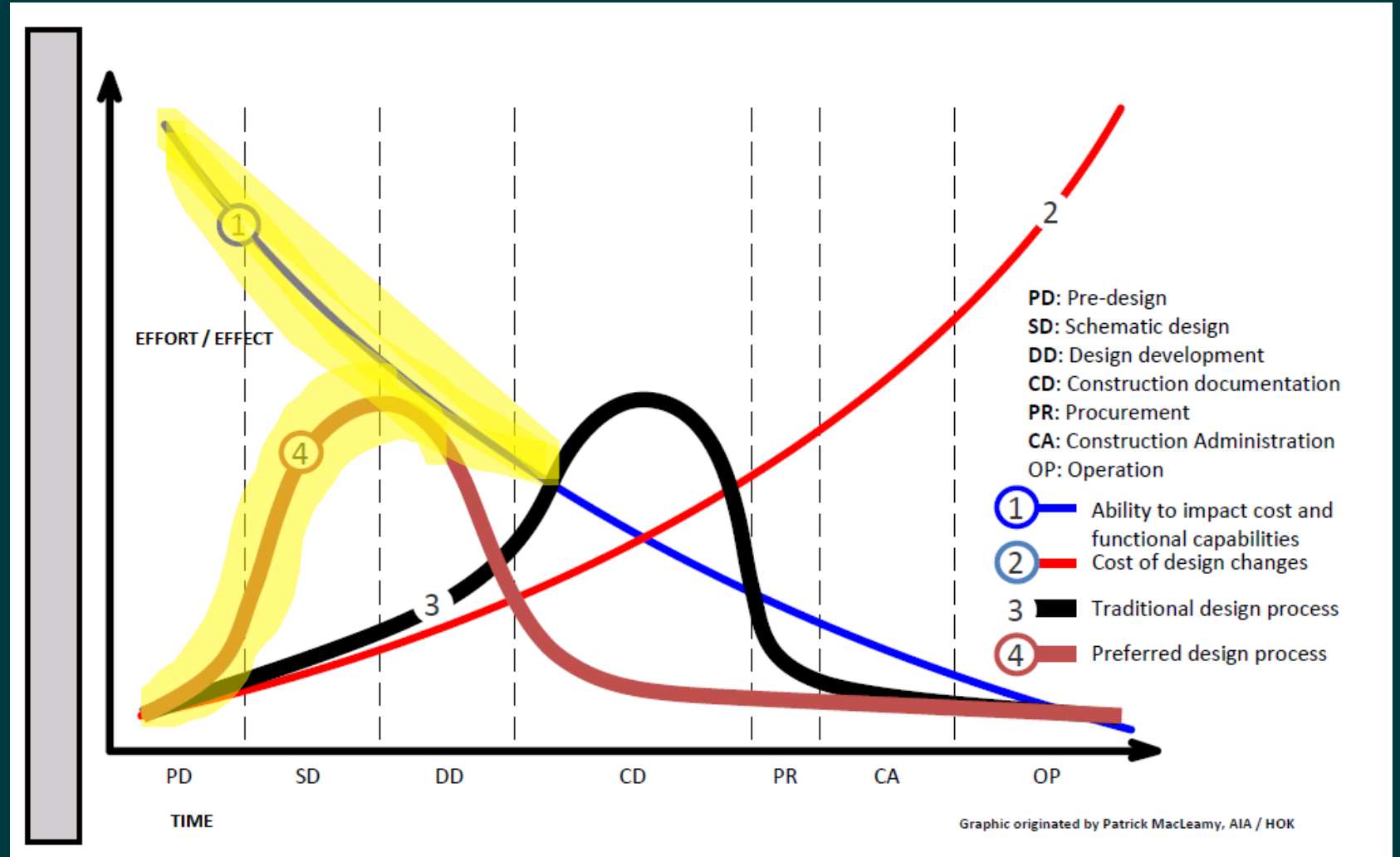
# HOW DO WE MAKE INFORMED DECISIONS AT THE EARLY STAGES?



# EARLY DESIGN STRUGGLE



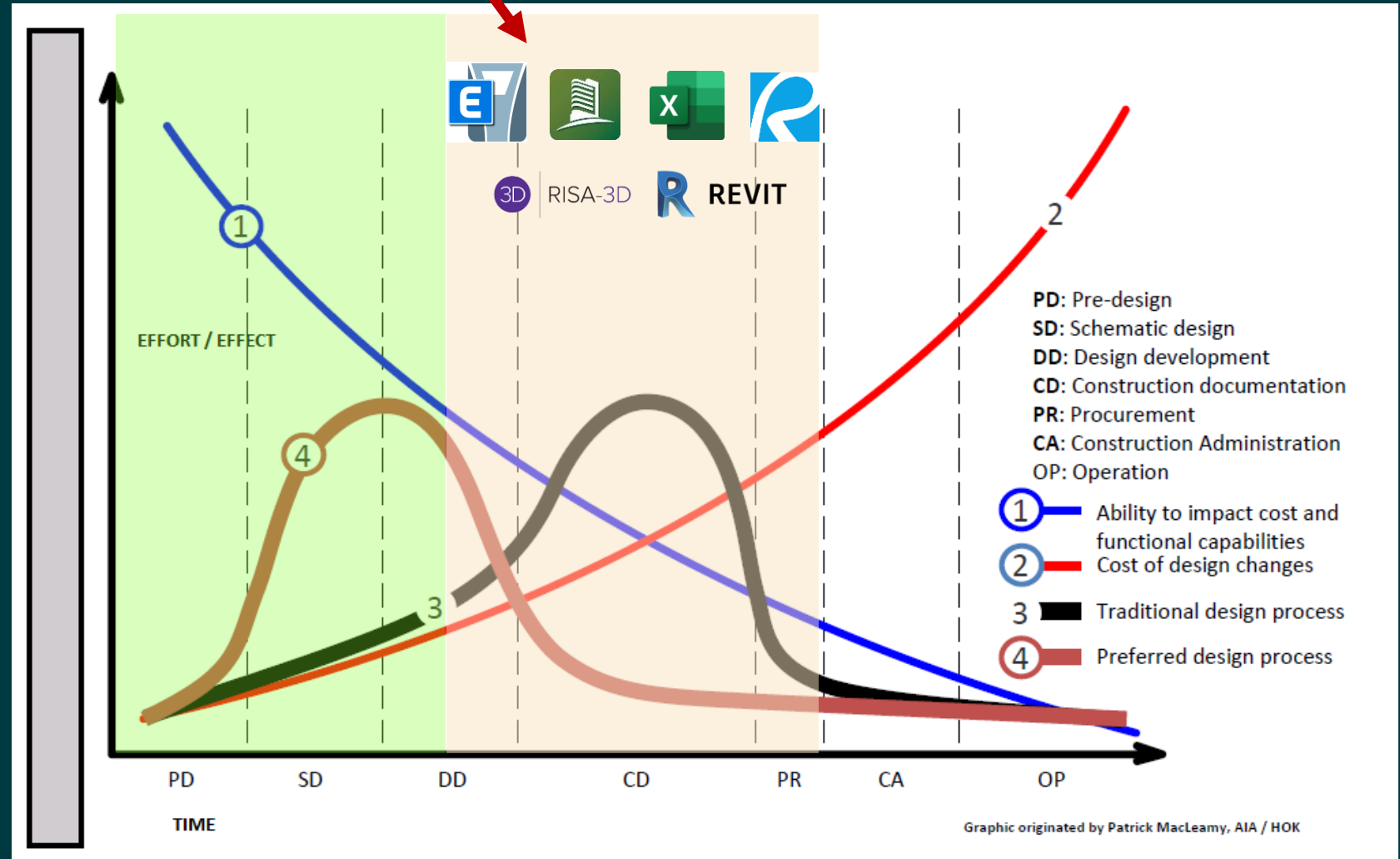
# EARLY DESIGN STRUGGLE



**HOW?**

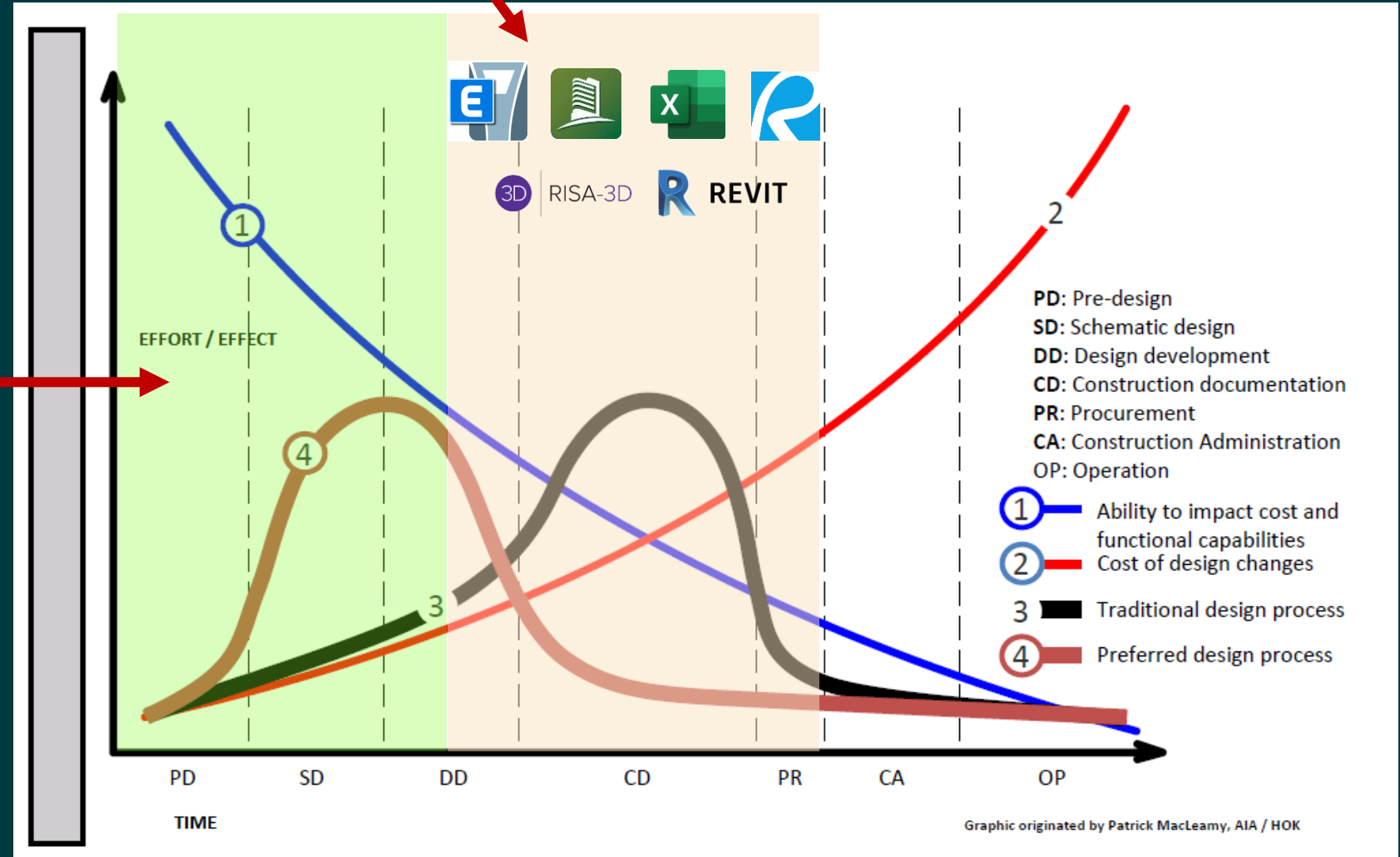


# CONVENTIONAL TOOLS



# CONVENTIONAL TOOLS

WE NEED  
TOOLS THAT  
CAN HANDLE  
THE EARLY  
STAGES



# CONVENTIONAL TOOLS

## PARAMETRIC ENGINEERING

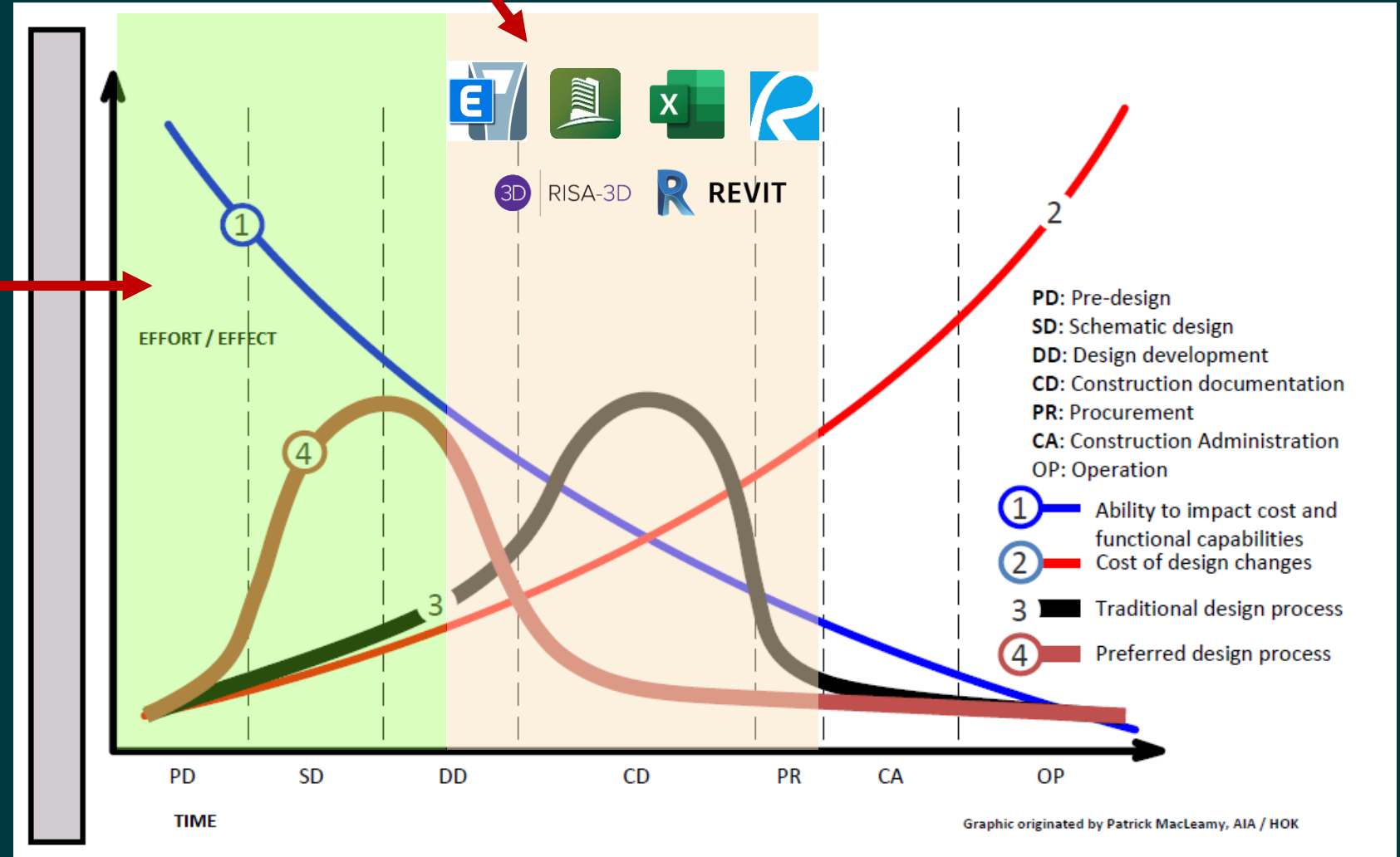


RhinoCeros



python™

Karamba 3D





Perspective

☒ GRAVITY COLUMNS SYSTEM

CONCRETE SQ COLUMNS

STEEL WF COLUMNS

STEEL HSS COLUMNS

☒ LATERAL SYSTEM

CONCRETE SHEAR WALLS

STEEL BRACED FRAMES BRBS

STEEL BRACED FRAMES HSS

☒ ANALYSIS AND EXPORT

☐ BEAMS GIRDERS

☐ GRAVITY COLUMNS

☐ LATERAL SYSTEM

☐ FOUNDATION

EXPORT\_TO\_ETABS

☒ DISPLAY

☐ 3D MODEL

☐ ONLY LATERAL

☐ SECTION TAGS

☐ 3D SECTIONS

☐ MESH MODEL

☐ BAKE GRIDS

3D BAKE

☒ GRAVITY RESULTS

☐ DEFLECTION

☐ LIVE REACTIONS

☐ DEAD REACTIONS

☒ LATERAL RESULTS

☐ X REACTIONS

☐ Y REACTIONS

☐ X DRIFT AND TORSION

☐ Y DRIFT AND TORSION

1 SCALE FACTOR X 100

☒ SHEAR WALLS DESIGN

☒ ANALYSIS PARAMETERS

BENDING BOOST FACT 152 DR CO...

BENDING BO 1000 CTR FOR BA...

BLDG AREA

 **COST**  **CO2**

LATERAL CHECKS

STRENGTH ☐

DRIFT ☐

TORSION ☐



BEAMS ORIENTATION  
VERTICAL  
HORIZONTAL

FOUNDATION  
COST  
CO2

SUPERSTRUCTURE  
COST  
CO2  
STEEL  
CONCRETE

SEISMIC MASS: 0 kips  
SEISMIC COEFFICIENT (CS): 1

GENERAL USE OFFICE/COMMERCIAL

LOCATION REDWOOD CITY

BLDG HEIGHT

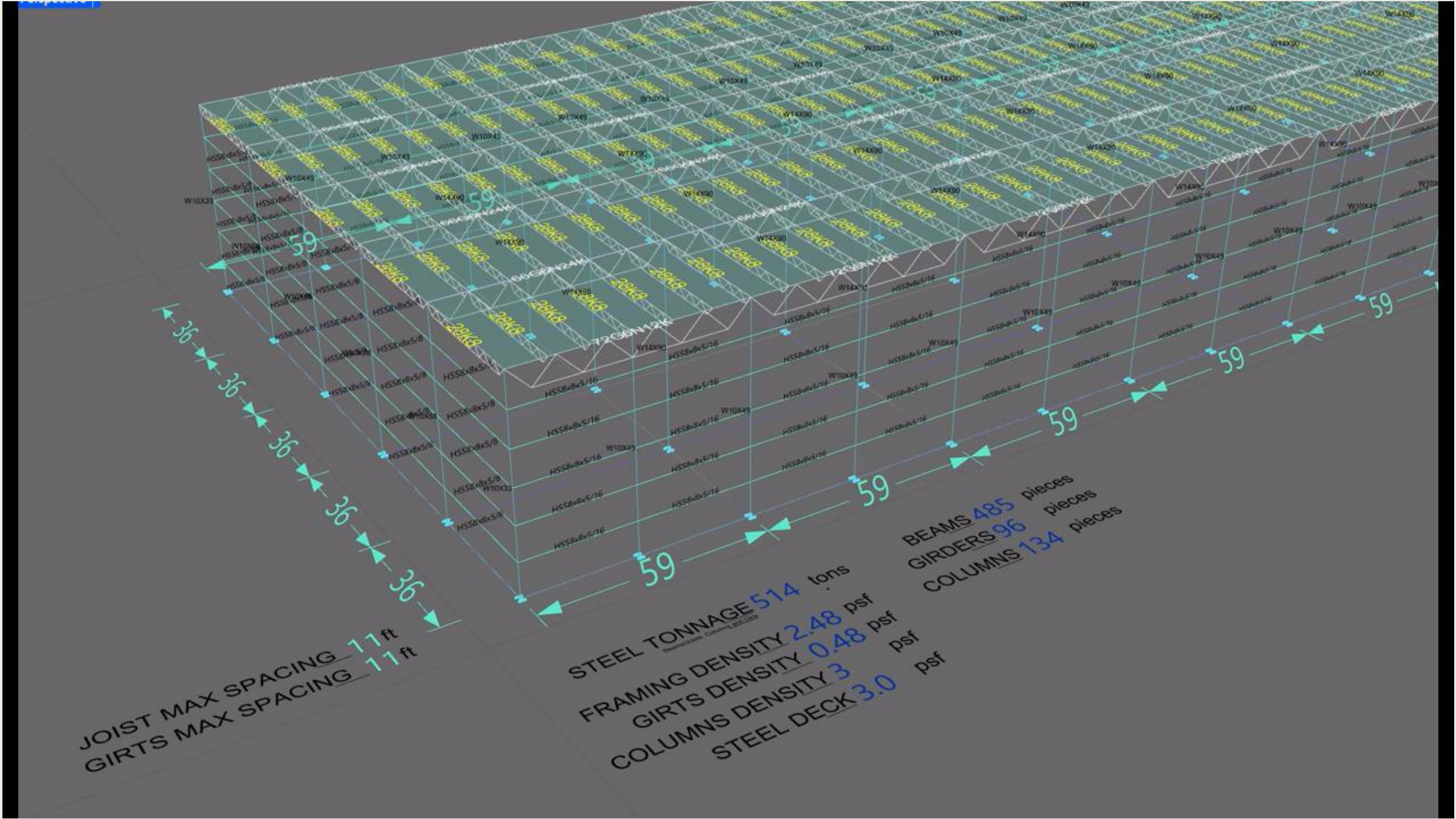
STEEL GRAVITY SYSTEM

FRAMING DENSITY 0

COLUMNS DENSITY

STEEL TONNAGE

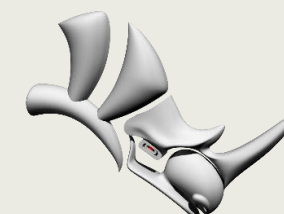
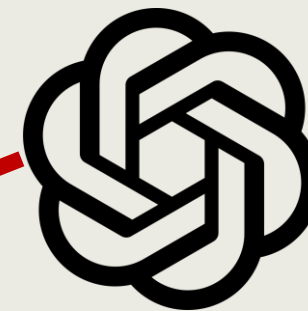
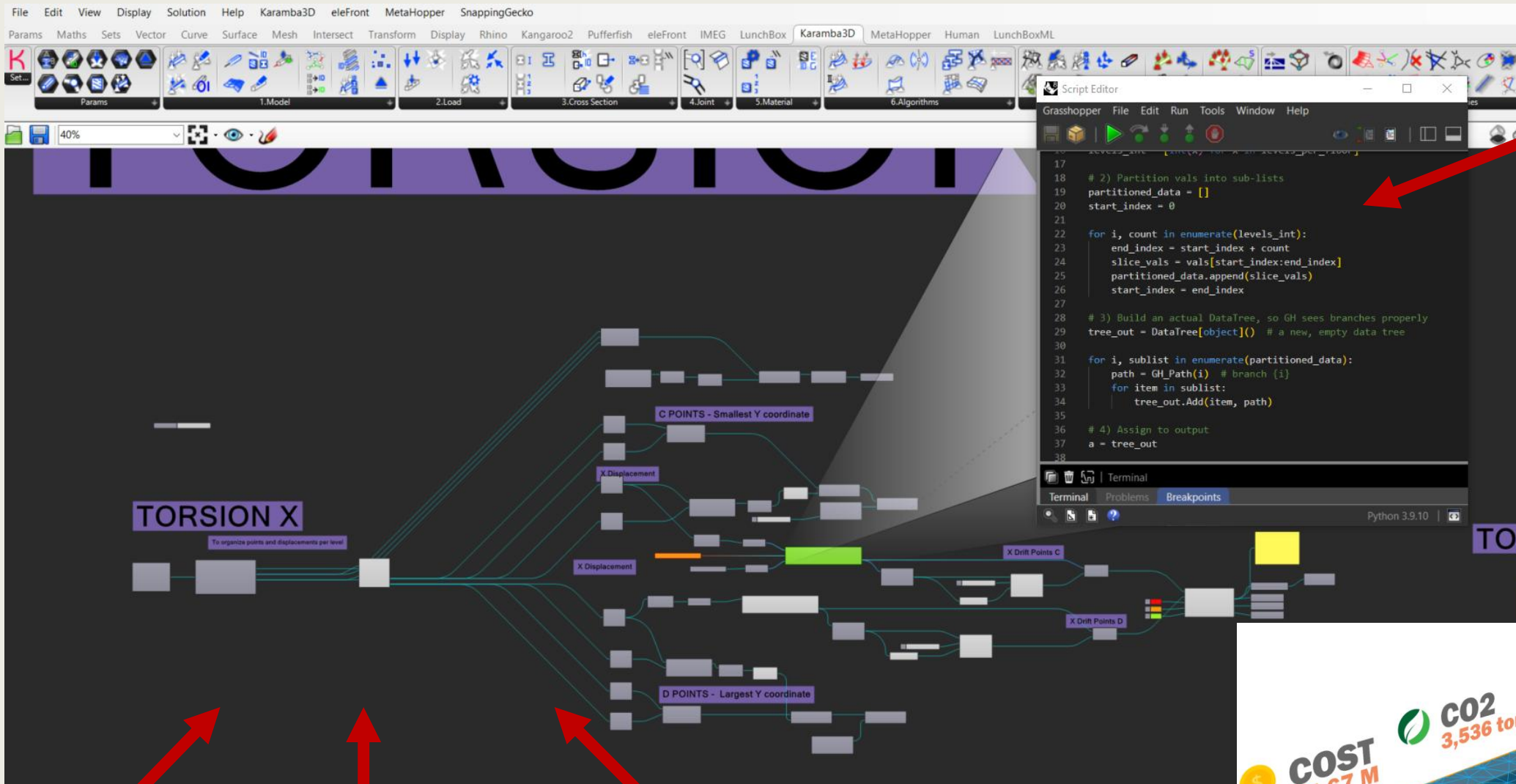




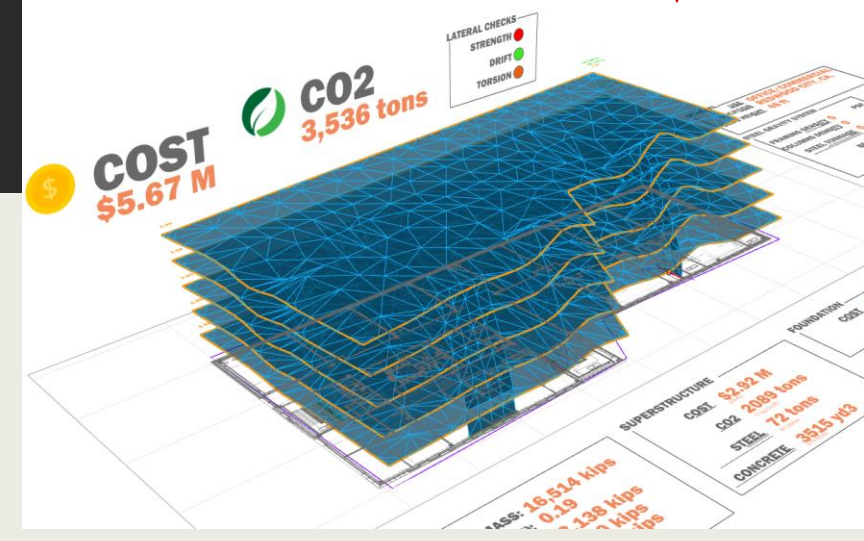
JOIST MAX SPACING 11 ft  
GIRTS MAX SPACING 11 ft

STEEL TONNAGE 514 tons  
FRAMING DENSITY 2.48 psf  
GIRTS DENSITY 0.48 psf  
COLUMNS DENSITY 3 psf  
STEEL DECK 3.0 psf

BEAMS 485 pieces  
GIRDERS 96 pieces  
COLUMNS 134 pieces



Rhino



Karamba 3D



python



# MULTIDISCIPLINARY CHECKS

## STRUCTURAL



### LATERAL CHECKS

**STRENGTH**

1.29 DCR



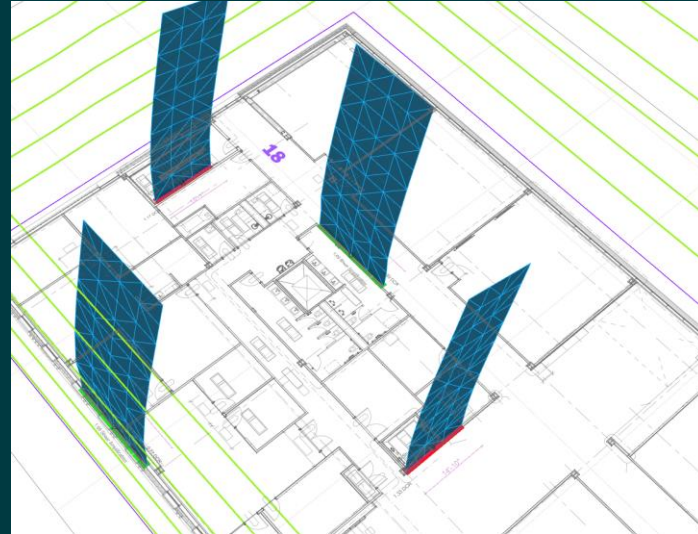
**DRIFT**

X: 0.67 % Y: 1.31 %



**TORSION**

X: 1.16 Y: 1.18



**COST**



**CO2**

# MULTIDISCIPLINARY CHECKS

STRUCTURAL



## LATERAL CHECKS

**STRENGTH**

1.29 DCR



**DRIFT**

X: 0.67 % Y: 1.31 %



**TORSION**

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**COST**

ARCHITECTURE



**CO2**



# MULTIDISCIPLINARY CHECKS

STRUCTURAL



## LATERAL CHECKS

**STRENGTH**

1.29 DCR



**DRIFT**

X: 0.67 % Y: 1.31 %



**TORSION**

X: 1.16 Y: 1.18



ARCHITECTURE



**COST**



BUDGET



**CO2**

# MULTIDISCIPLINARY CHECKS

STRUCTURAL



## LATERAL CHECKS

**STRENGTH**

1.29 DCR



**DRIFT**

X: 0.67 % Y: 1.31 %



**TORSION**

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ARCHITECTURE



**COST**



BUDGET



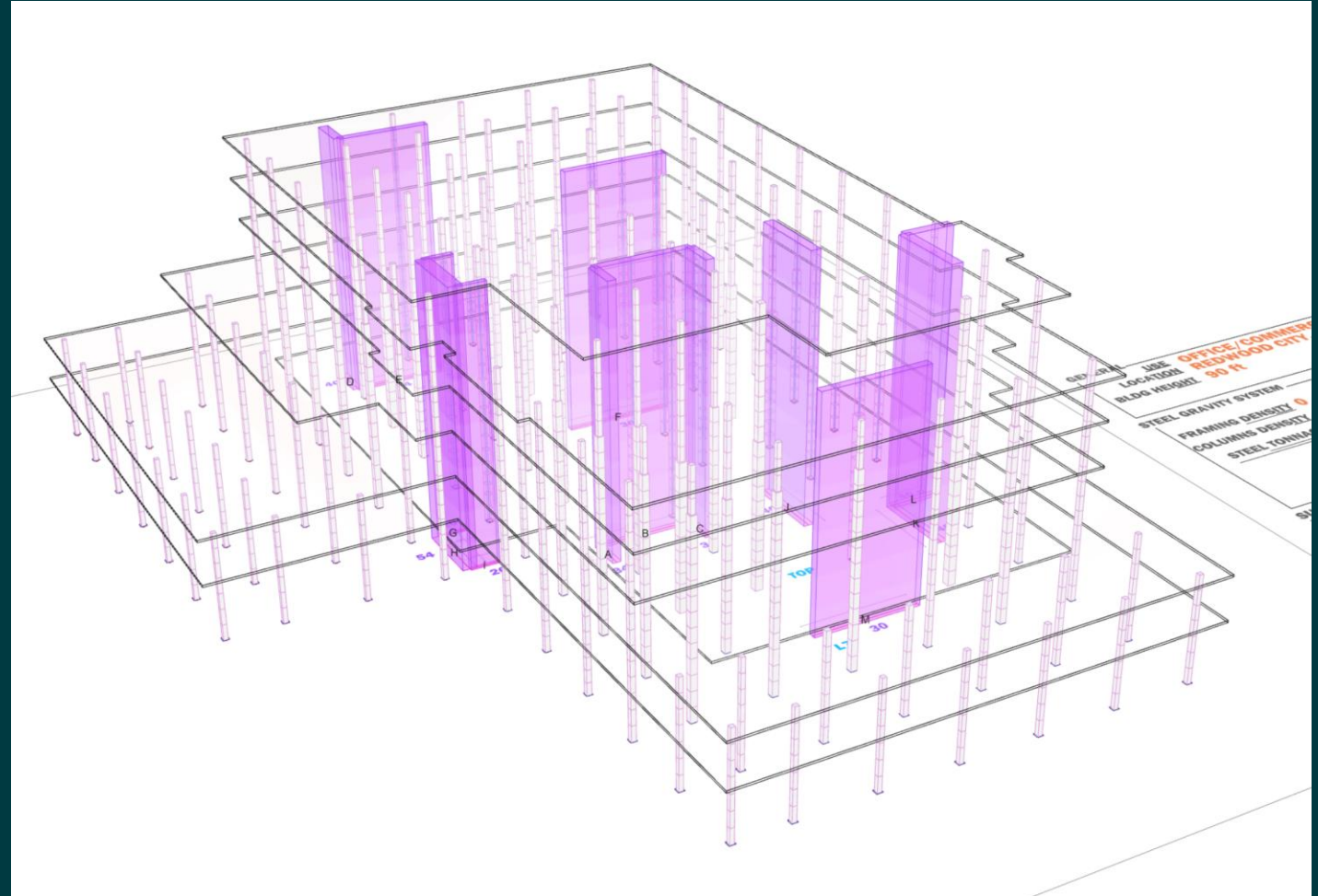
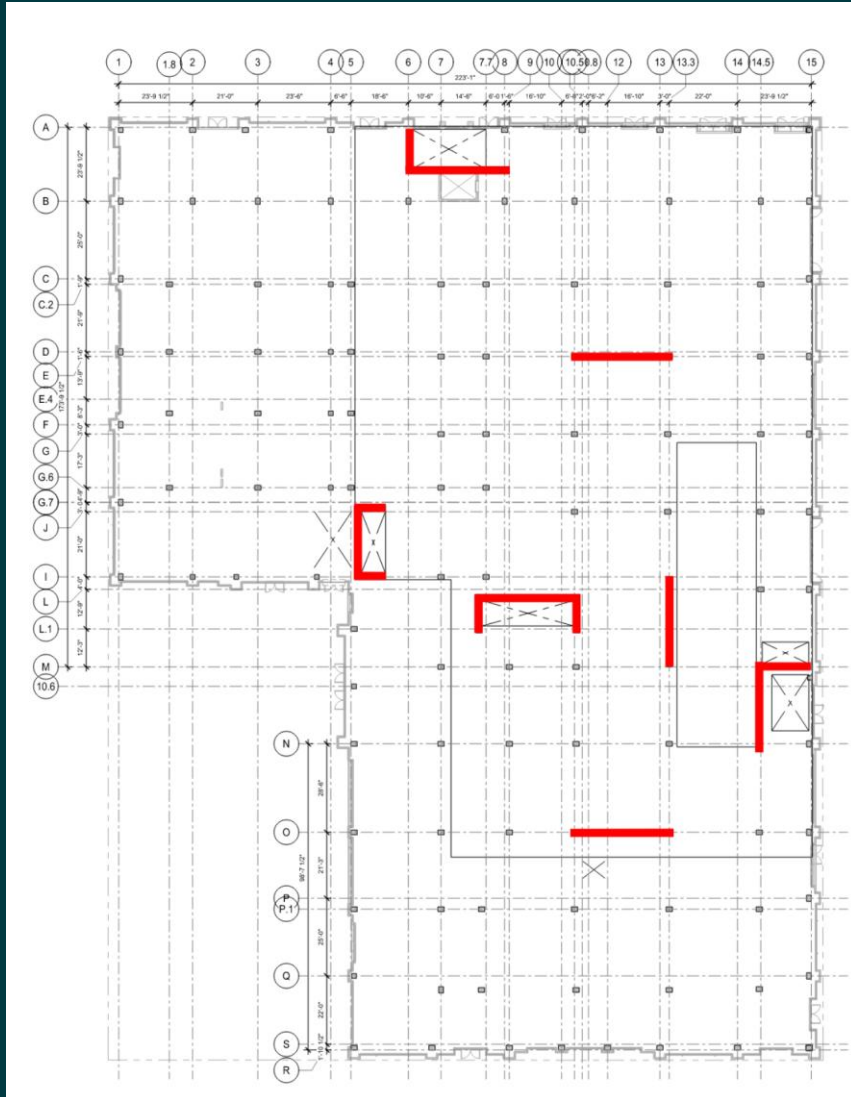
**CO2**



ENVIRONMENTAL

# IMPLEMENTATION

# PRELIMINARY MARKUP



# STUDY A

## BASE SHEAR

SEISMIC MASS: **52,128 kips**  
SEISMIC COEFFICIENT (CS): **0.247**  
SEISMIC BASE SHEAR: **12,876 kips**  
WIND X BASE SHEAR: **1,124 kips**  
WIND Y BASE SHEAR: **779 kips**

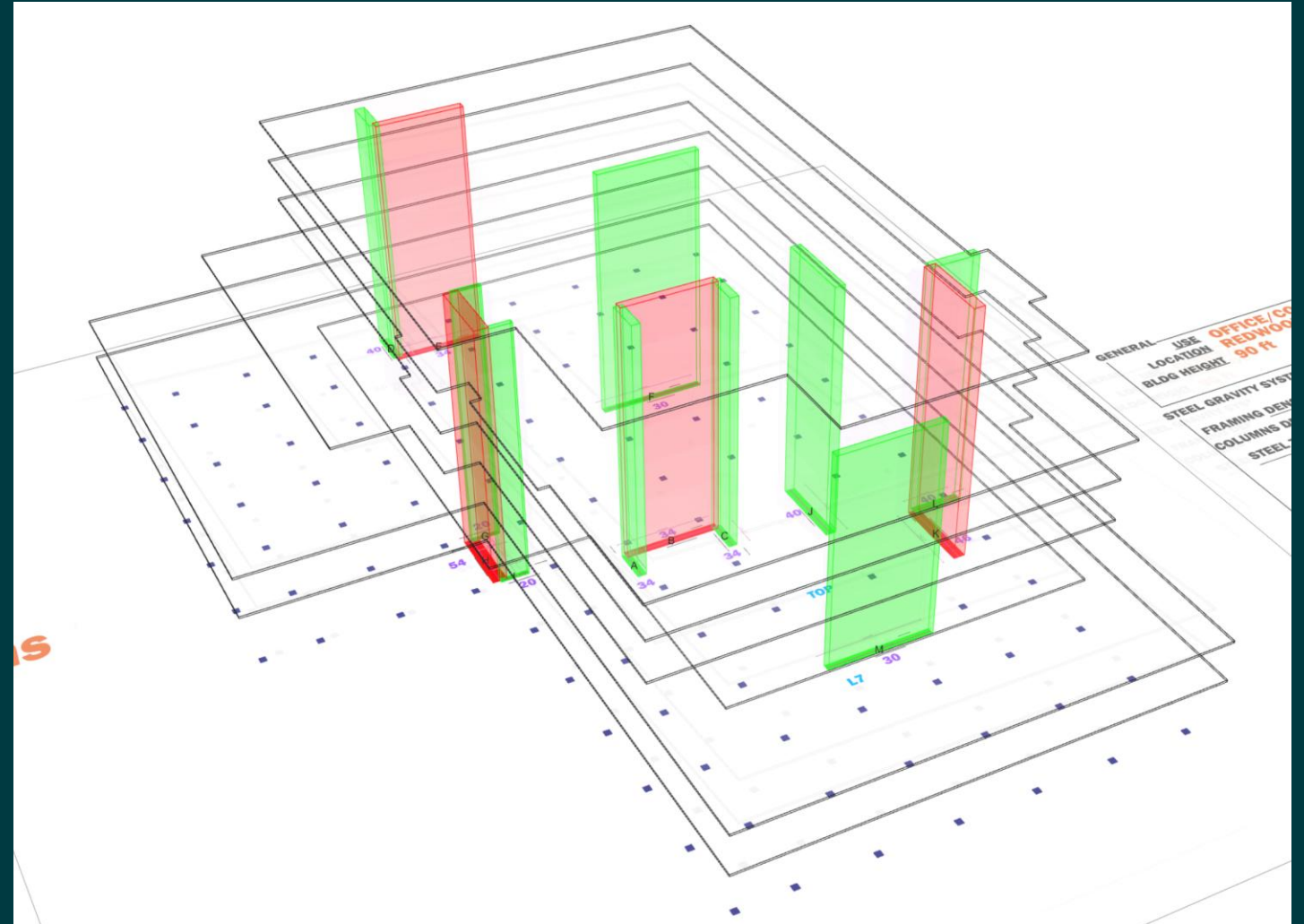
SUM OF X REACTIONS: 12875 kips  
SUM OF Y REACTIONS: 12875 kips

## LATERAL CHECKS

**STRENGTH** ●  
1.29 DCR

**DRIFT** ●  
X: 0.67 % Y: 1.31 %

**TORSION** ●  
X: 1.16 Y: 1.18





# STUDYA

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**TORSION** ●  
X: 1.16 Y: 1.18

## SUPERSTRUCTURE

**COST** **\$15.3 M**  
\$49/ft<sup>2</sup>

**CO<sub>2</sub>** **11413 tons**  
36 kgCO<sub>2</sub>/ft<sup>2</sup>

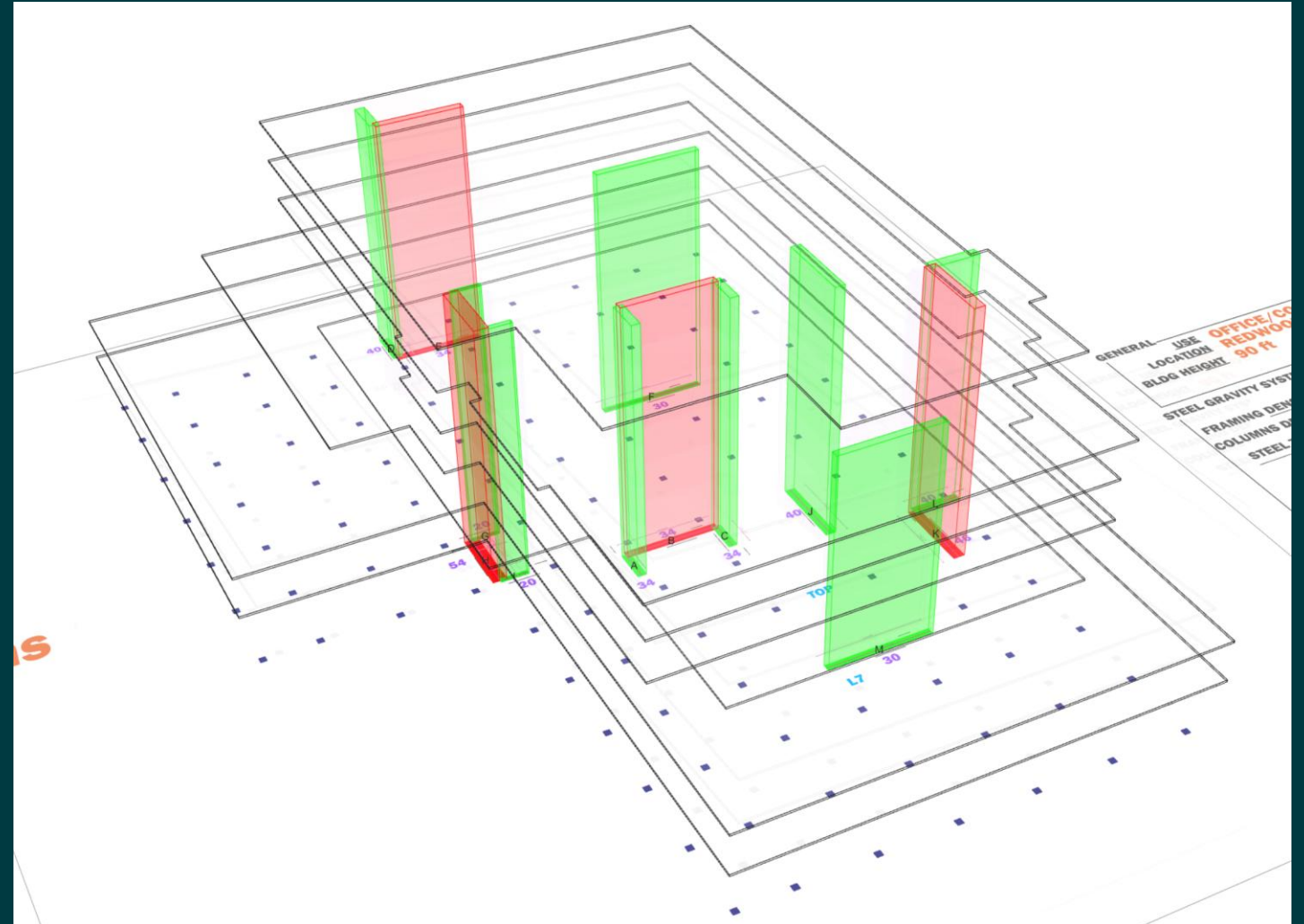
**STEEL** **1098 tons**  
25% CONNECTIONS FACTOR AND STEEL DECK  
\$1164/ton

**CONCRETE** **11228 yd<sup>3</sup>**  
0.98 ft<sup>3</sup>/ft<sup>2</sup>

## FOUNDATION

**COST** **\$14.43 M**  
\$46 /ft<sup>2</sup>

**CO<sub>2</sub>** **7909 tons**  
25 kgCO<sub>2</sub>/ft<sup>2</sup>



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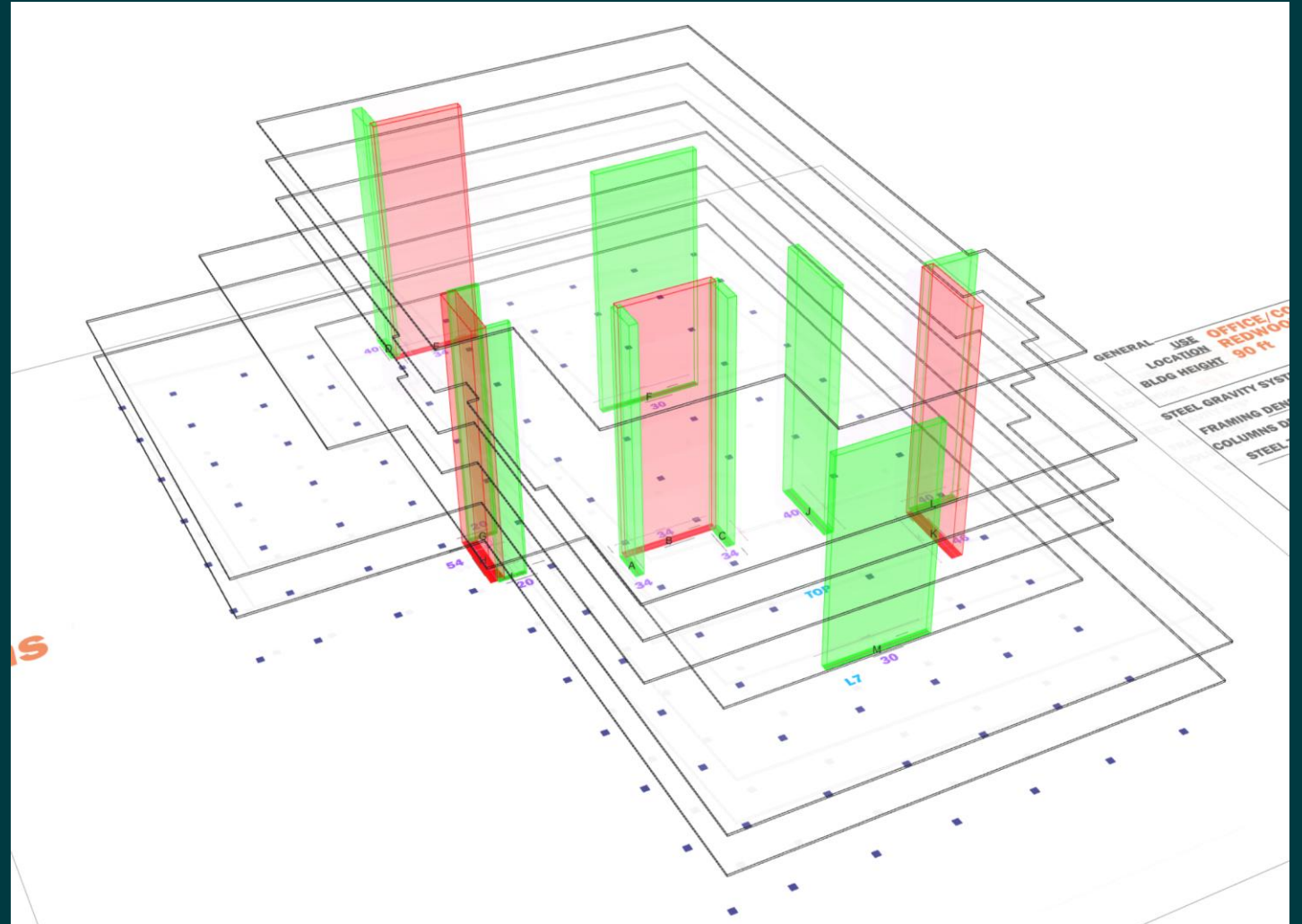
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SLABS, COMPOSITE FLOORS, WALLS AND COLUMNS  
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**BLDG AREA** **310,867 ft<sup>2</sup>** **COST** **\$29.73 M** **CO<sub>2</sub>** **19,322 tons**



# WHAT IFS?



- Remove small wall legs so  $\rho=1.0$ ?
- Add shorter blade walls towards the edges
- Enlarge SWF from 25ft to 35ft
- ACI 318 19 vs ACI 318 25 Shear Amplification
- Tune walls thicknesses
- Does it work for the parking layout?
- Does it work for the typical floor layout?
- Are Strength, Drift, Torsion, OK?
- COST and CO2 Impact?

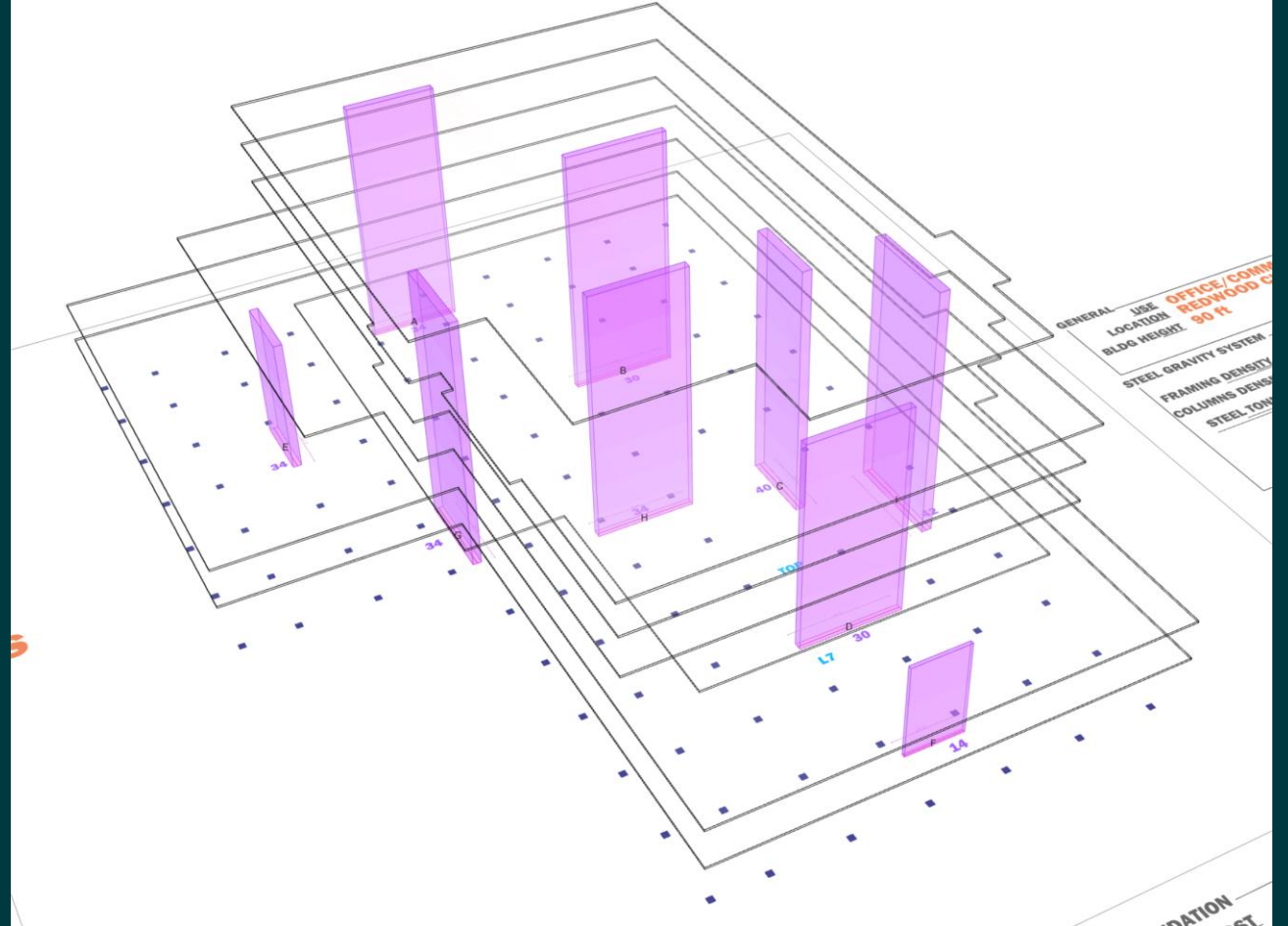
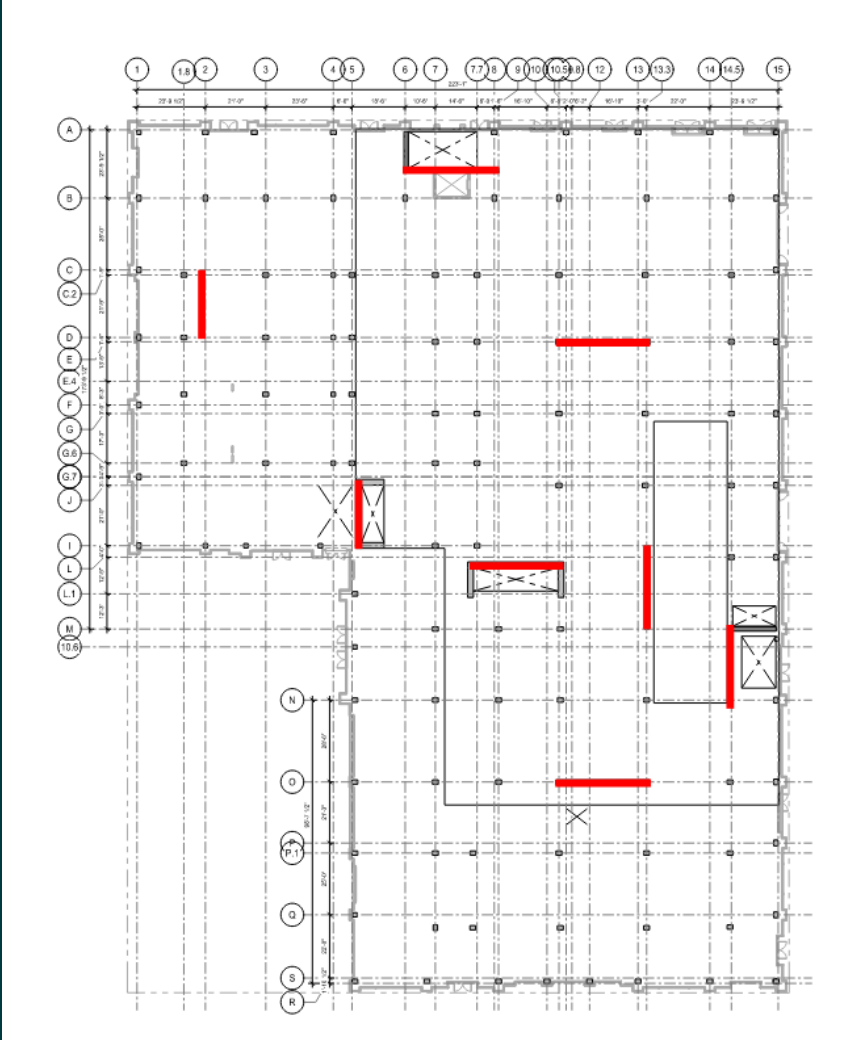
# POLL

# HOW LONG WOULD IT TAKE TO EXPLORE THOSE WHAT IF'S?

- A) 1 week
- B) 30 min
- C) 10 days
- D) 2 days



# STUDY B



# STUDY B

## BASE SHEAR

SEISMIC MASS: **50,157 kips**  
SEISMIC COEFFICIENT (CS): **0.19**  
SEISMIC BASE SHEAR: **9,530 kips**  
WIND X BASE SHEAR: **1,124 kips**  
WIND Y BASE SHEAR: **779 kips**

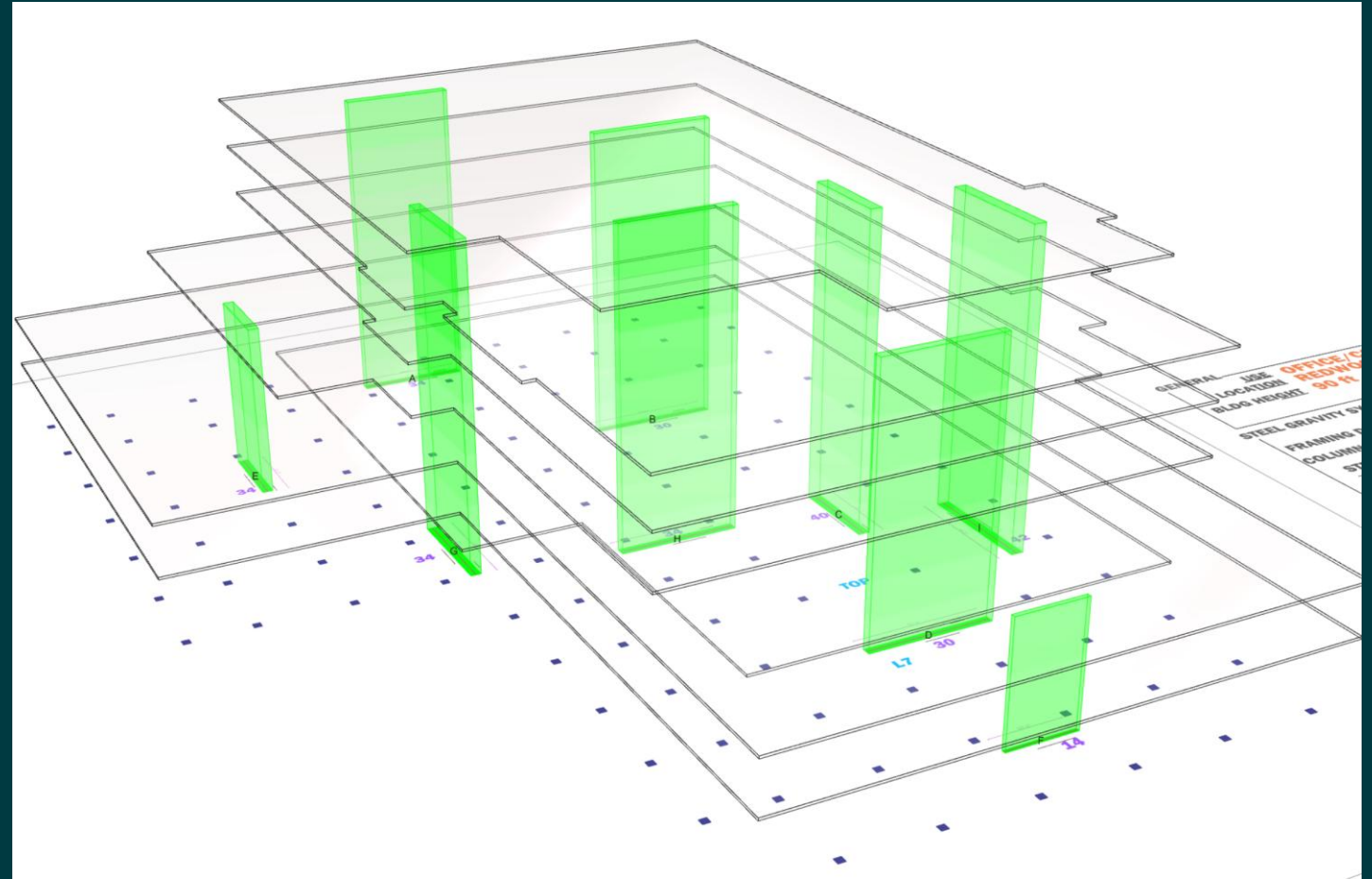
SUM OF X REACTIONS: 9529 kips  
SUM OF Y REACTIONS: 9529 kips

## LATERAL CHECKS

**STRENGTH** ●  
0.7 DCR

**DRIFT** ●  
X: 0.7 % Y: 0.96 %

**TORSION** ●  
X: 1.17 Y: 1.06



# STUDY B

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**C02** 11067 tons  
35 kgCO<sub>2</sub>/ft<sup>2</sup>

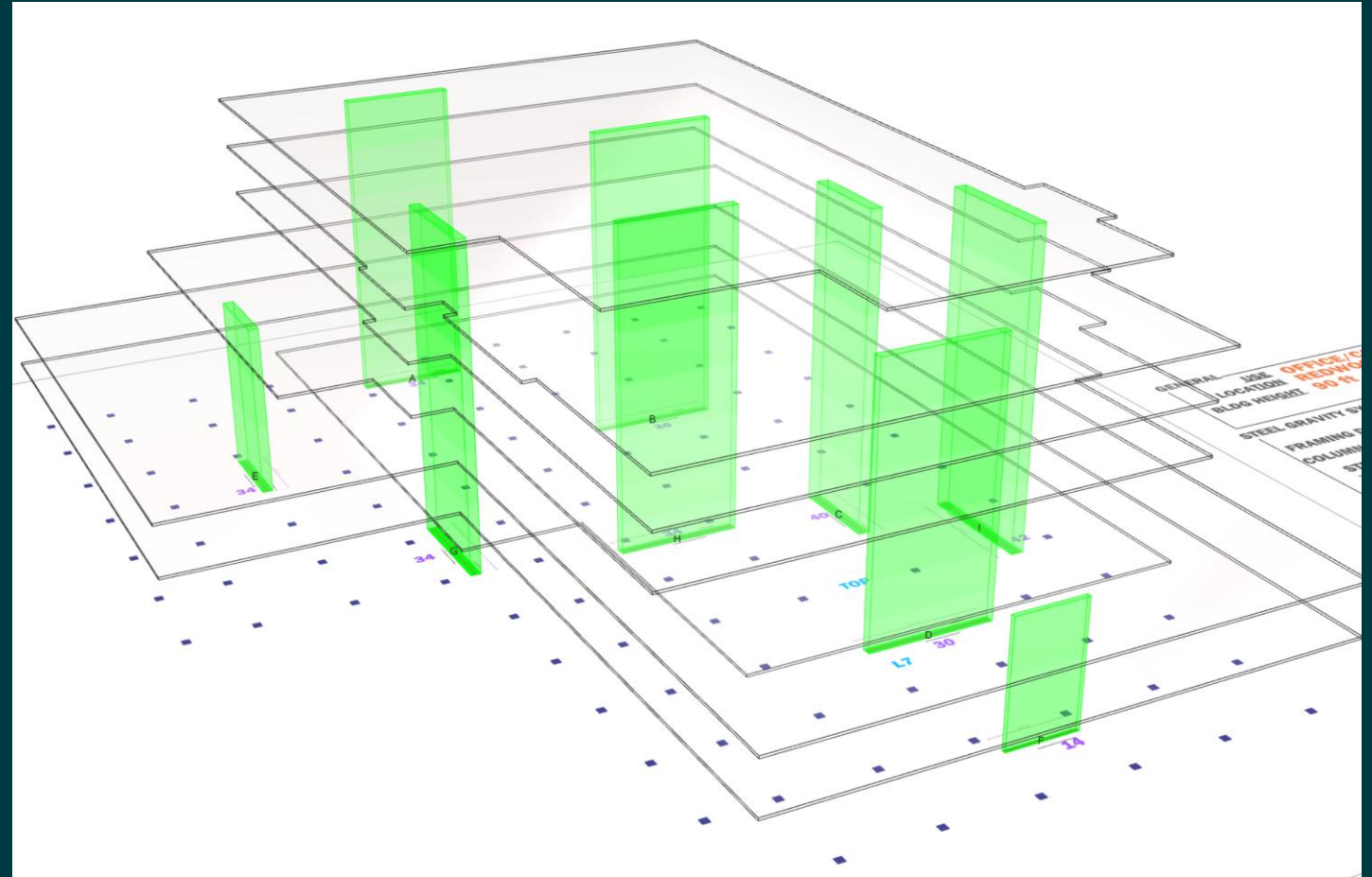
**STEEL** 1098 tons  
GRAVITY, LATERAL,  
25% CONNECTIONS FACTOR AND STEEL DECK  
\$1164/ton

**CONCRETE** 10742 yd<sup>3</sup>  
SLABS, COMPOSITE FLOORS, WALLS AND COLUMNS  
0.93 ft<sup>3</sup>/ft<sup>2</sup>

## FOUNDATION

**COST** \$13.77 M  
\$44 /ft<sup>2</sup>

**C02** 7669 tons  
24 kgCO<sub>2</sub>/ft<sup>2</sup>





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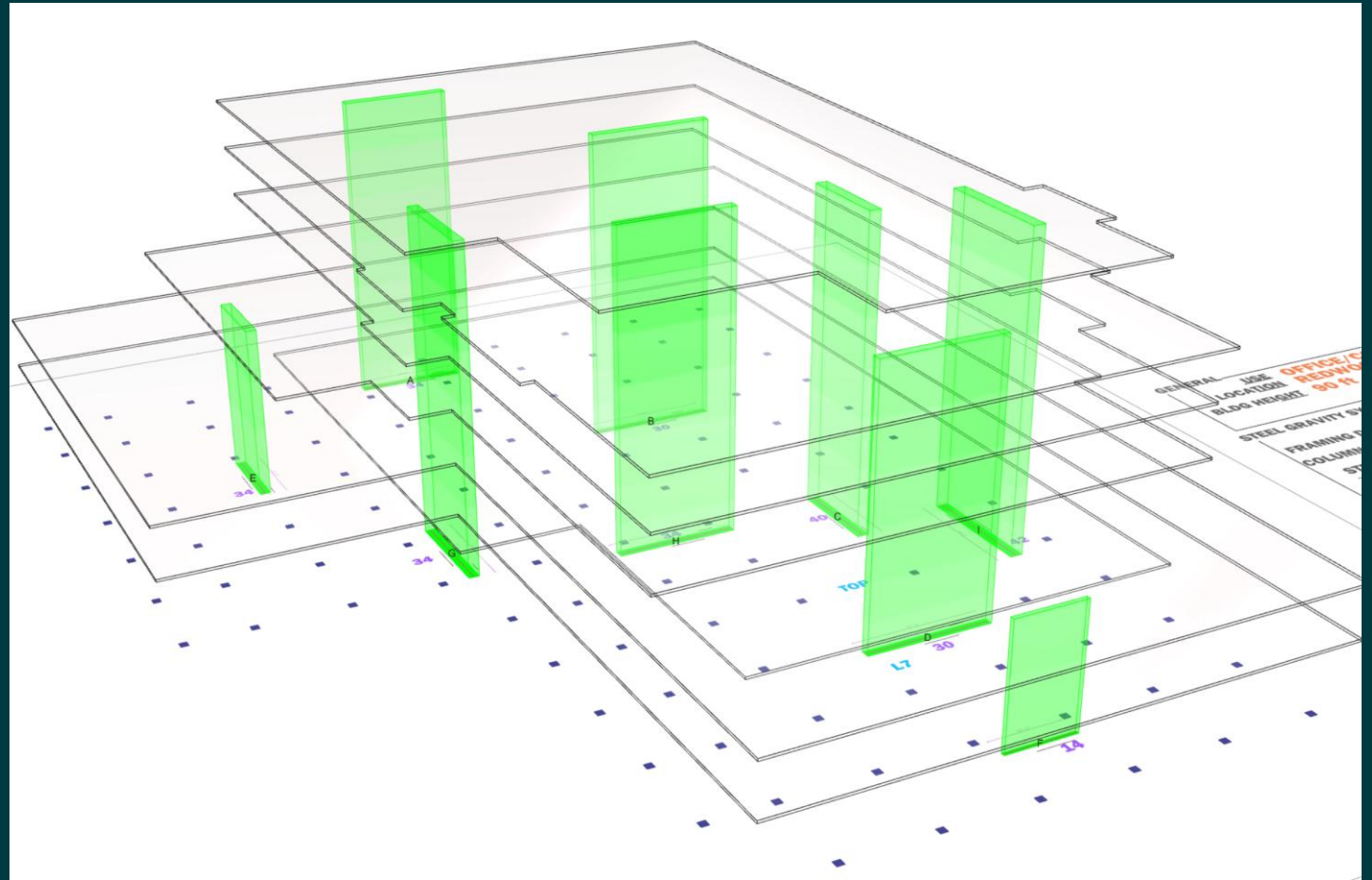
**BLDG AREA**  
**310,867 ft<sup>2</sup>**



**COST**  
**\$28.38 M**



**C02**  
**18,736 tons**



# RELATIVE COMPARISONS



# STUDY A

**BLDG AREA**

**310,867 ft<sup>2</sup>**



**COST**

**\$29.73 M**



**CO<sub>2</sub>**

**19,322 tons**

## LATERAL CHECKS

**STRENGTH**   
1.29 DCR

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X: 1.16 Y: 1.18

# STUDY A

**BLDG AREA**

**310,867 ft<sup>2</sup>**



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**19,322 tons**

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# STUDY A

**BLDG AREA**  **COST**  **CO2**  
**310,867 ft2** **\$29.73 M** **19,322 tons**

## LATERAL CHECKS

**STRENGTH**   
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# STUDY B

**BLDG AREA**  **COST**  **CO2**  
**310,867 ft2** **\$28.38 M** **18,736 tons**

## LATERAL CHECKS

**STRENGTH**   
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X: 1.17 Y: 1.06

# SAVINGS

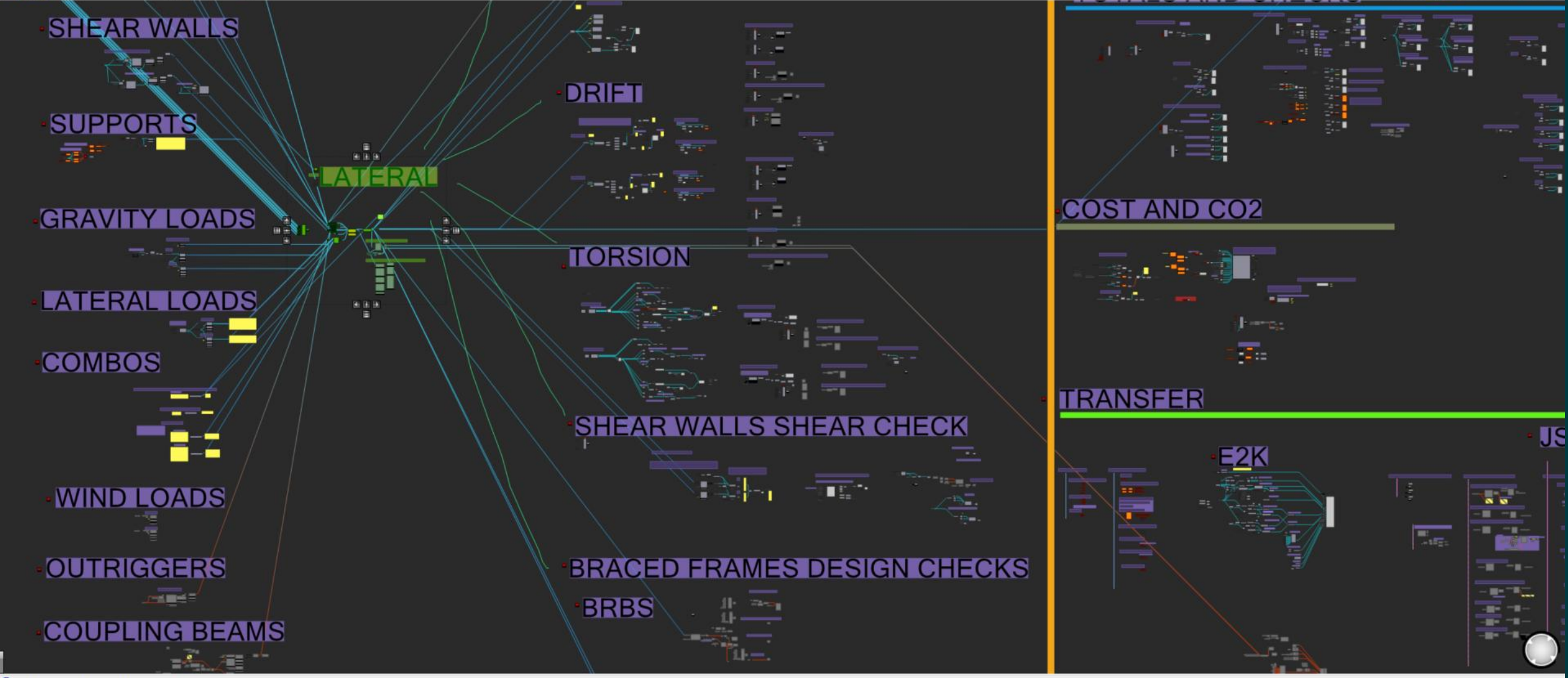
 **COST**

**\$1.35 M**

 **CO2**

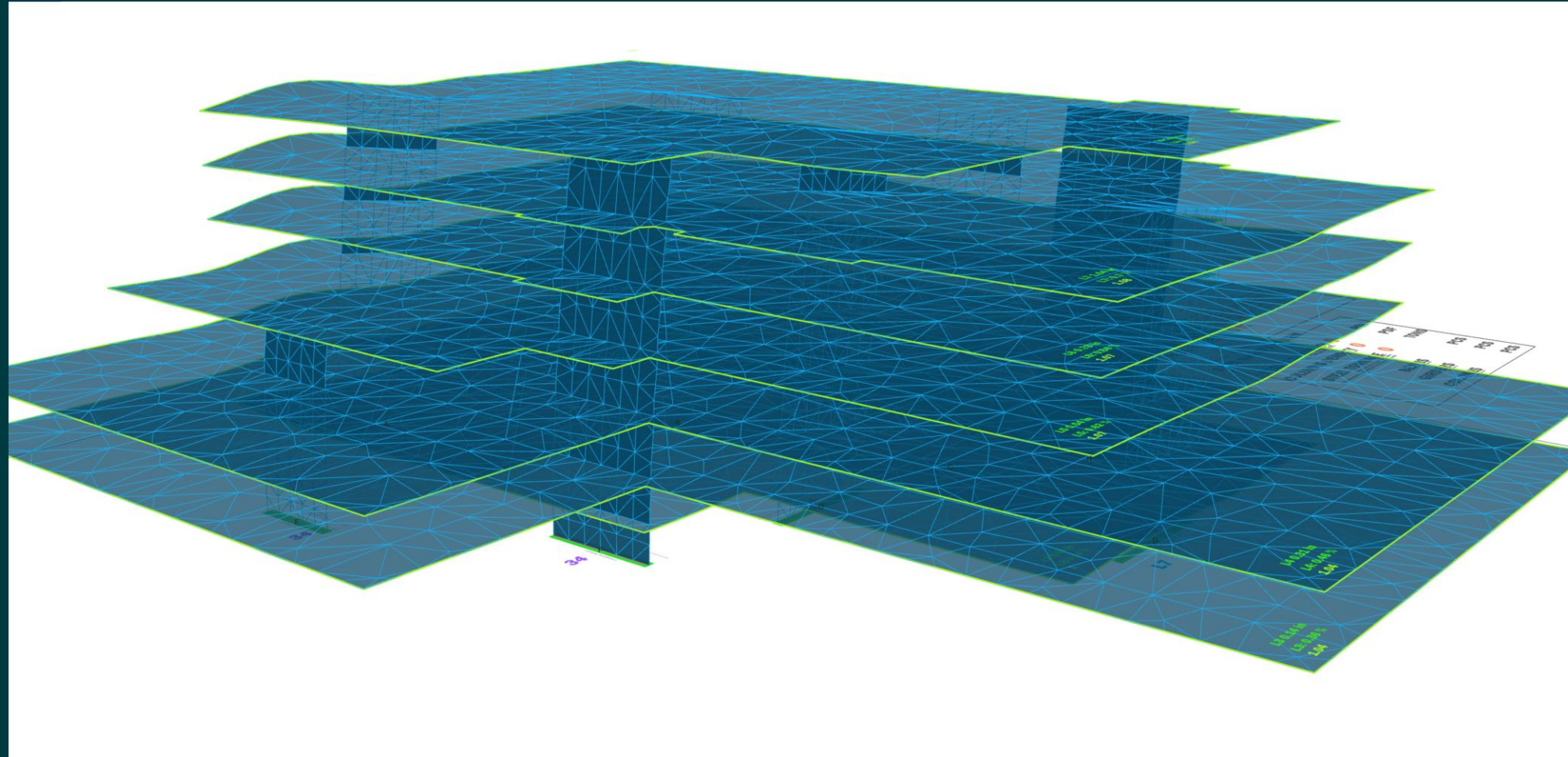
**586 tons**

# LOGIC CONSTRAINTS AND DEVELOPMENT





# COMPUTATIONAL POWER STRUGGLE



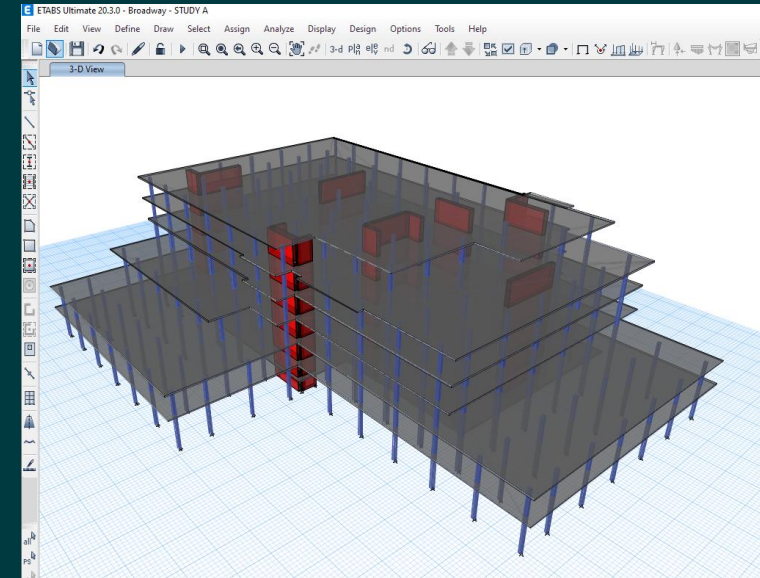
# INTEROPERABILITY



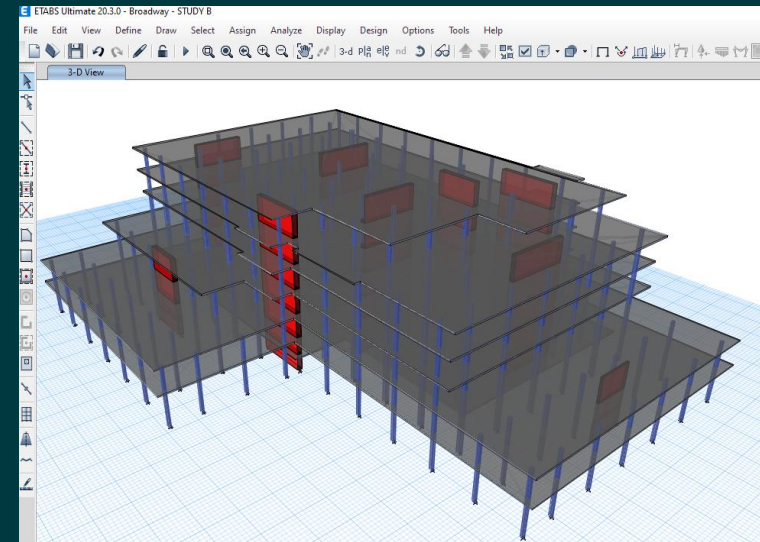
# INTEROPERABILITY



## STUDY A

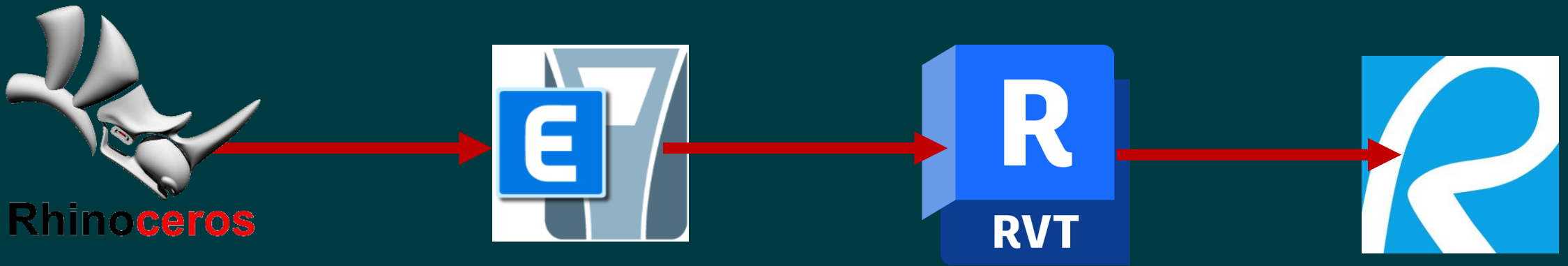


## STUDY B





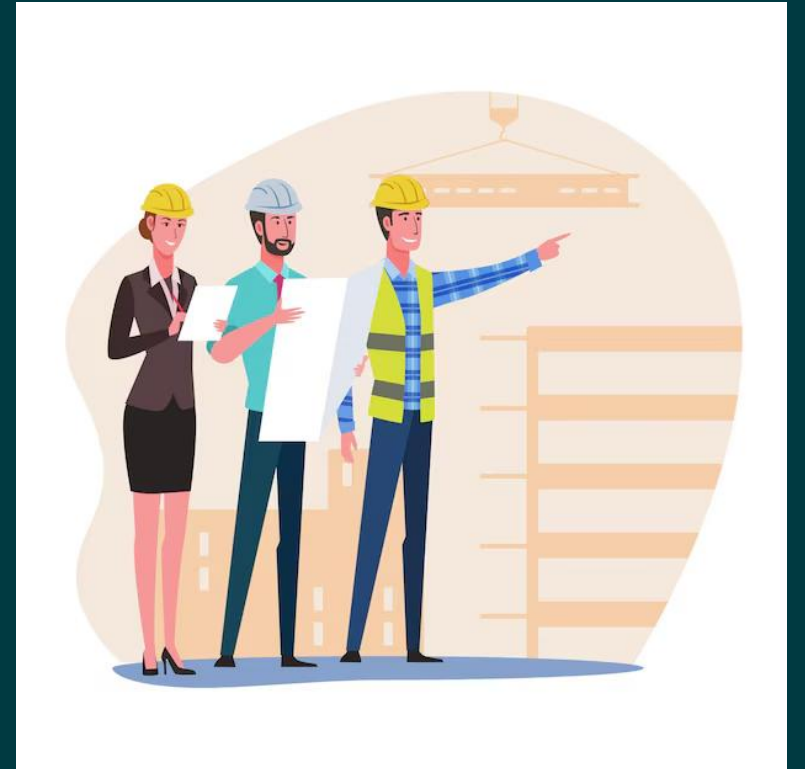
# INTEROPERABILITY



# POLL

**Who do you think benefits the most from quickly exploring and assessing possibilities in the early design stages?**

- A) ARCHITECTS**
- B) STRUCTURAL ENGINEERS**
- C) CLIENTS**
- D) GENERAL CONTRACTORS**

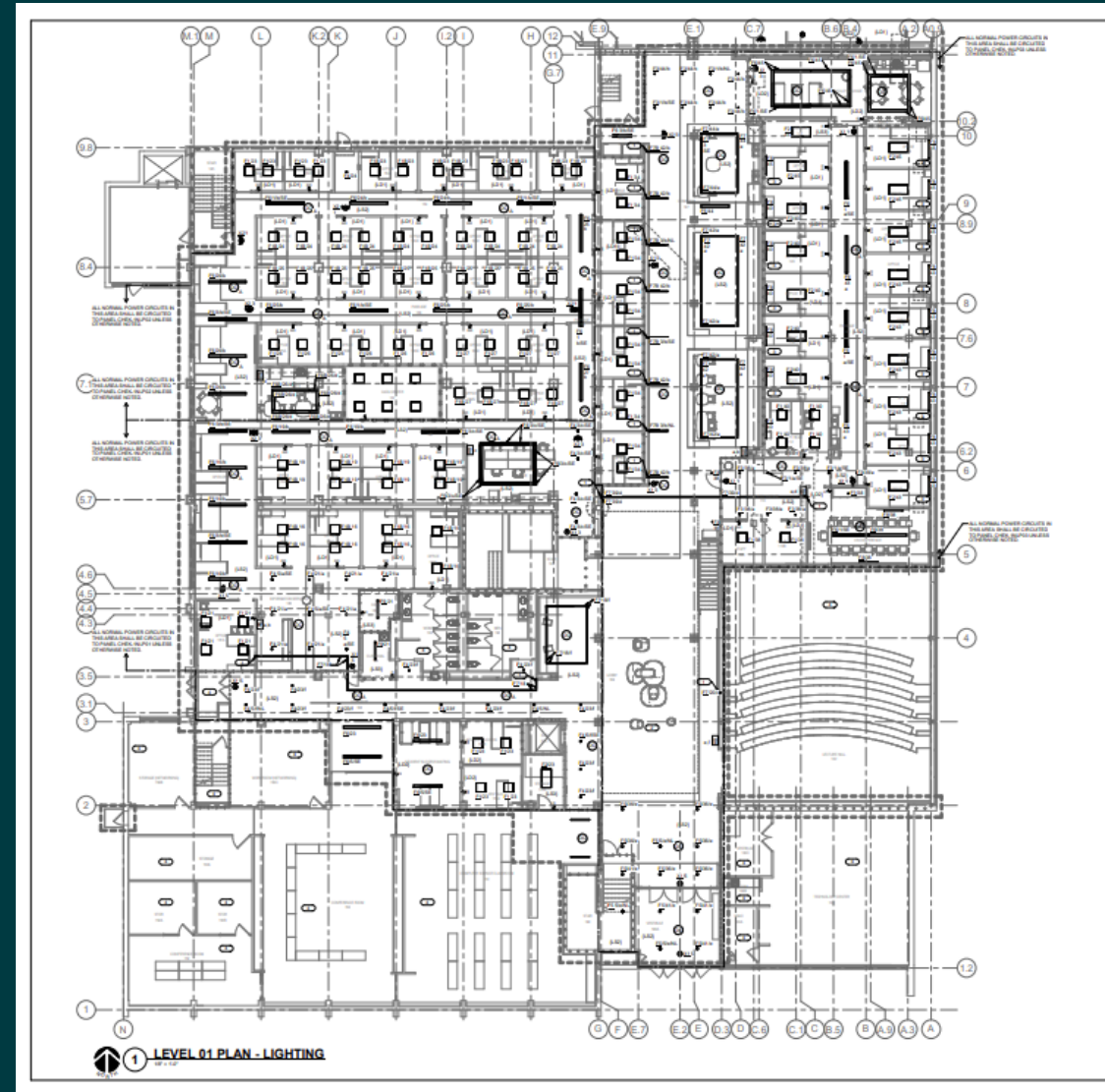
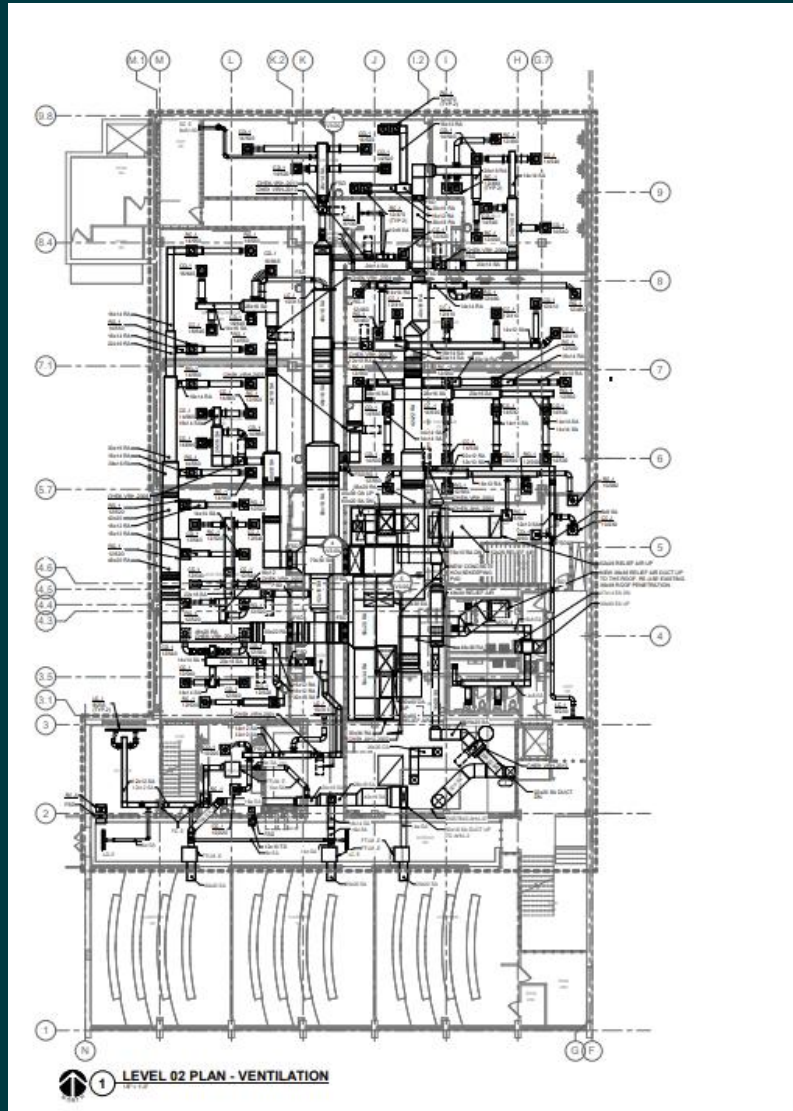


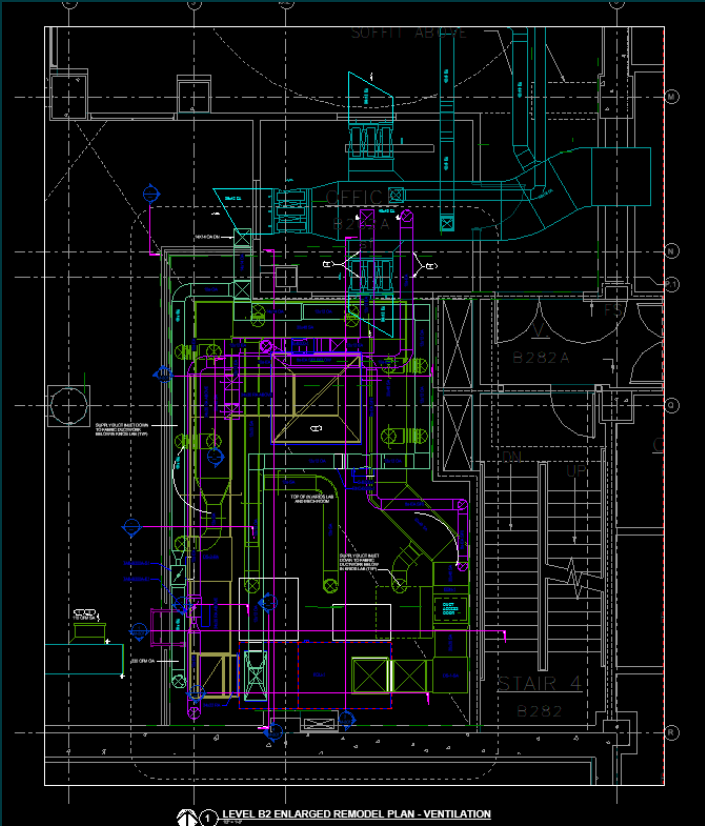
# IMMERSIVE TECHNOLOGY





# FLOORPLANS

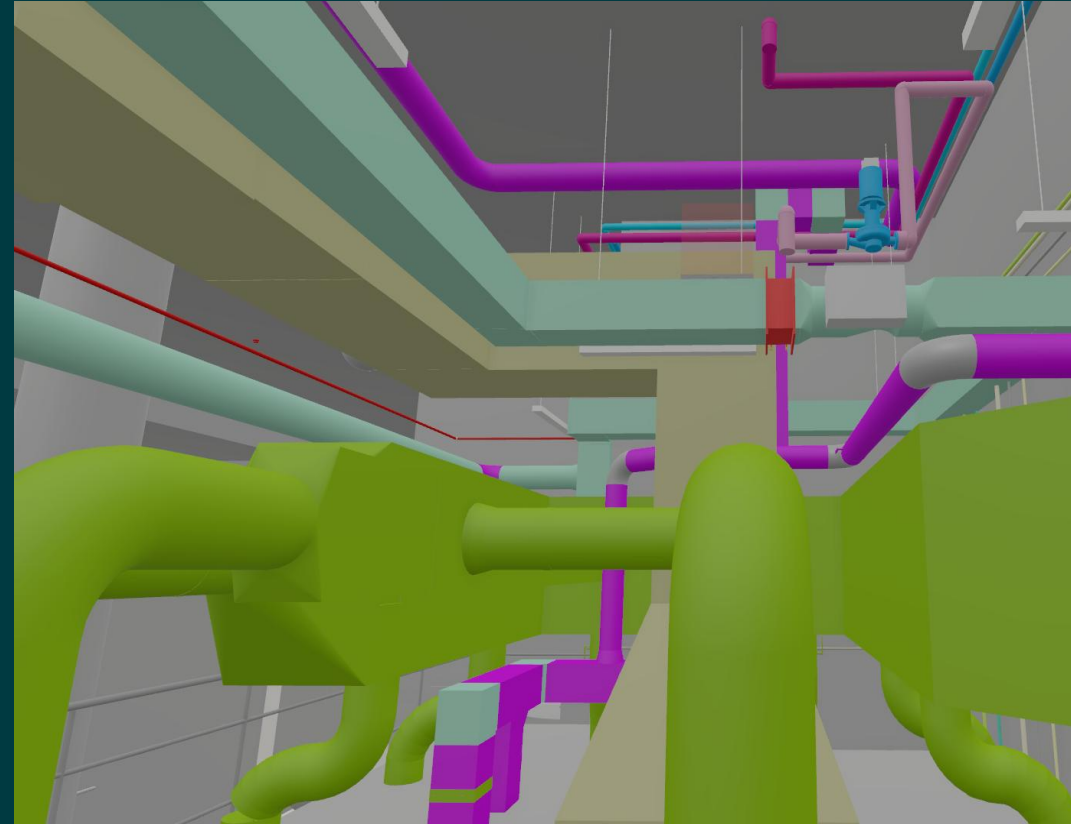




2D



3D scaled down



3D 1:1





CONSTRUCTION  
DEVELOPMENT

WWW.RUSSELLCO.COM

QCR  
Future headquarters of QCR Holdings, Inc. and Quad City Bank & Trust

QCR  
Future headquarters of QCR Holdings, Inc. and Quad City Bank & Trust

# XR (Extended Reality)

Collective term applied to immersive experiences incorporating varying degrees of digital and real information

**AR**

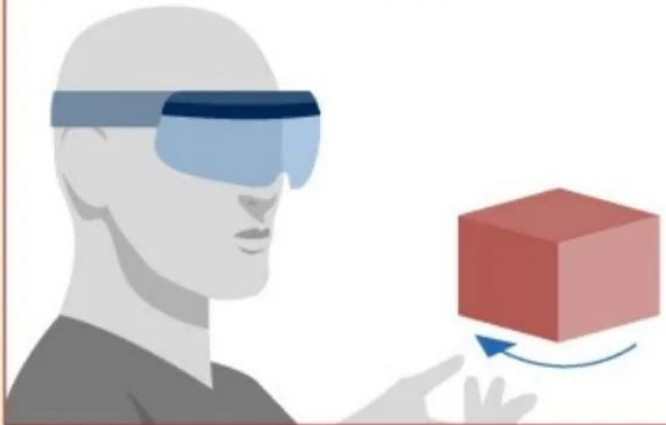
(Augmented Reality)



User views static digital information or visual elements integrated into the real environment

**MR**

(Mixed Reality)



User interacts with responsive virtual elements integrated into the real environment

**VR**

(Virtual Reality)

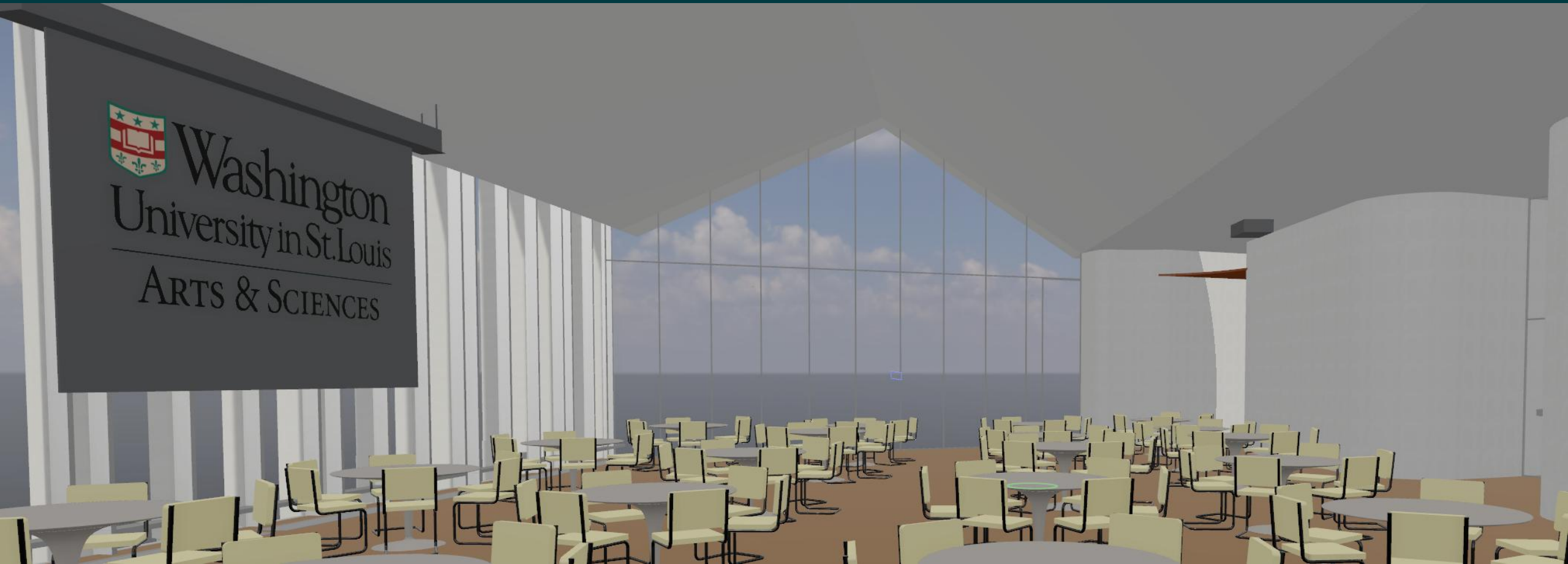


User is immersed in an interactive, digitally-generated environment



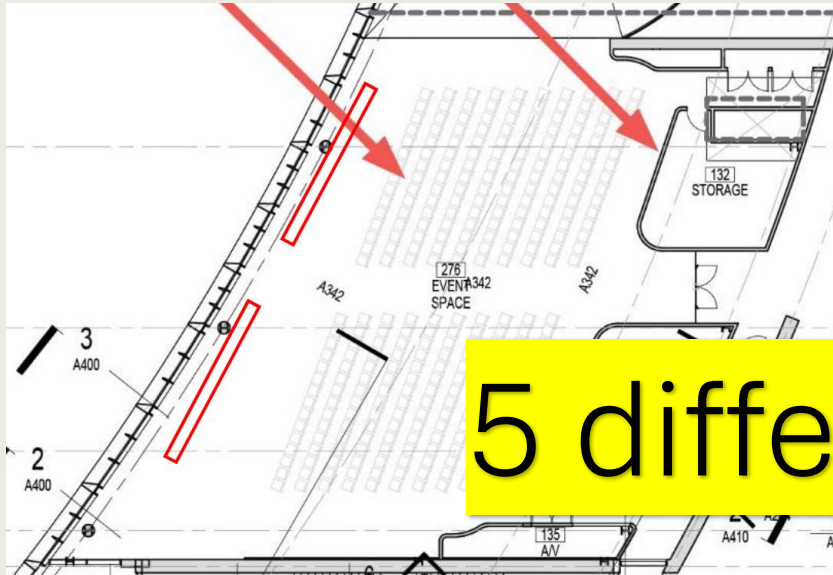


# XR IN ACTION: DESIGNING

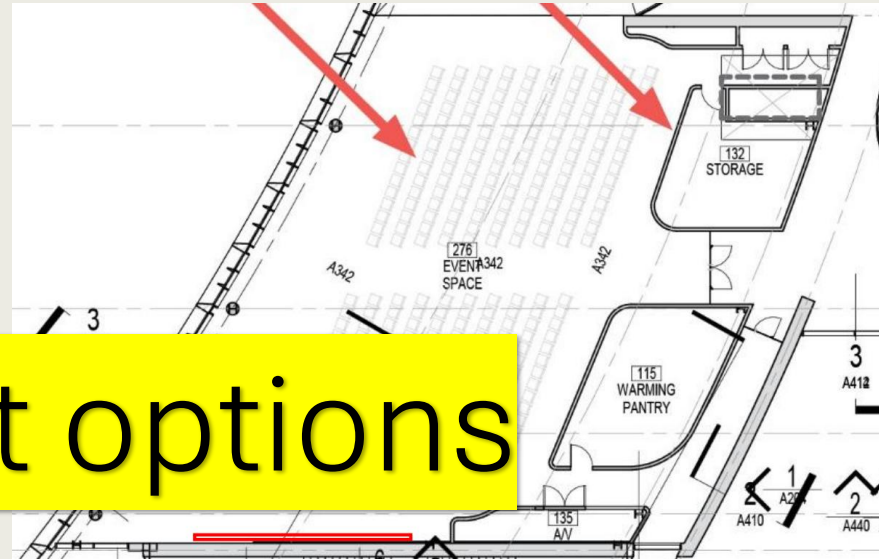


# DESIGN OPTIONS PURPOSED

## Option 1&2:



## Option 3:



5 different options

### Screen Size

- 142" diagonal first column line
- 265" diagonal second column line
- 326" diagonal full depth
- Recommend 277"





# DESIGN OPTIONS PURPOSED

## Option 1&2:



\$200K+

## Option 3:



### Screen Size

- 142" diagonal first column line
- 265" diagonal second column line
- 326" diagonal full depth
- Recommend 277"





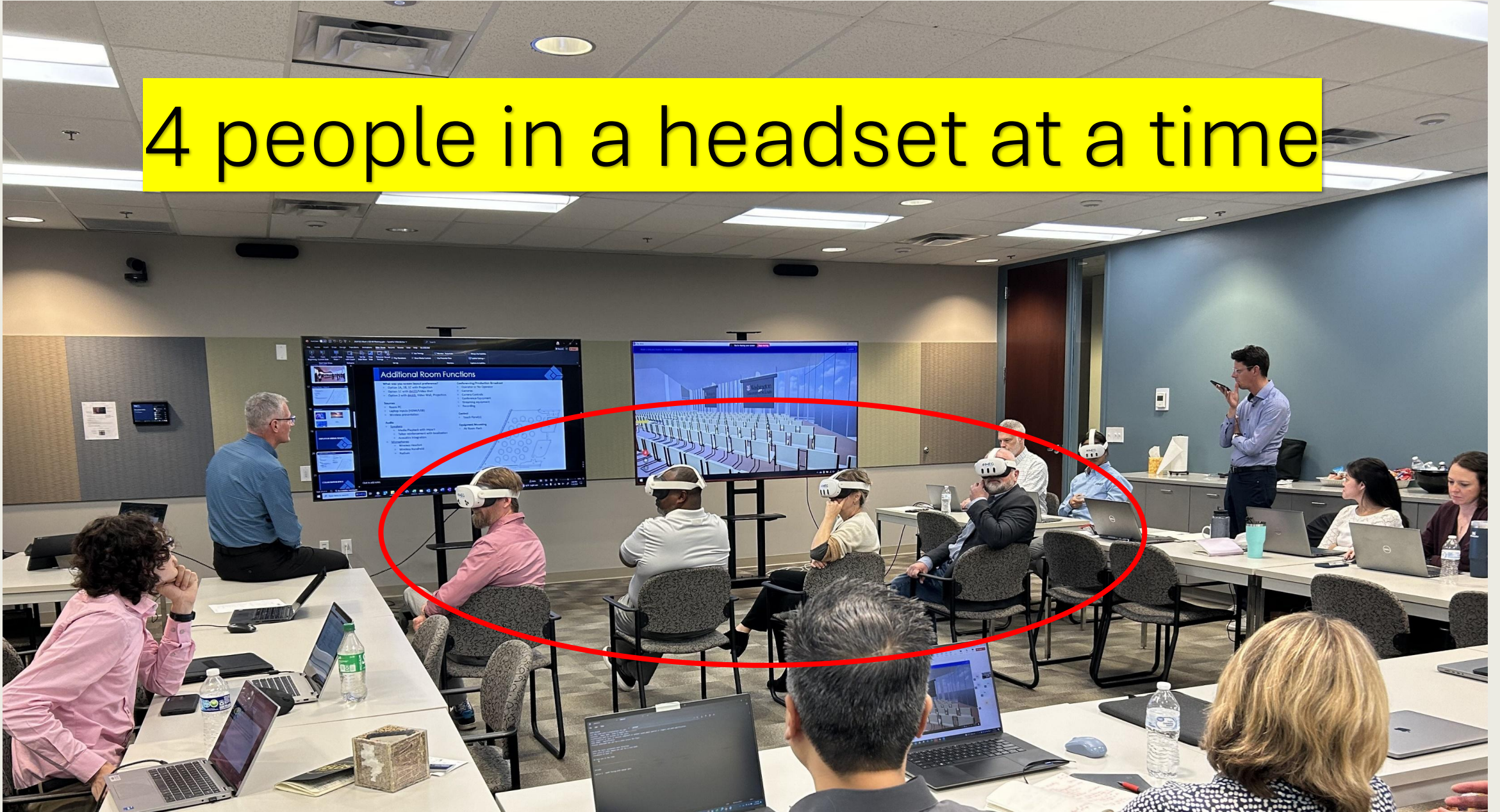
# VR MEETING





# VR MEETING

4 people in a headset at a time





# VR MEETING

Cast VR environment to TV



# Event Space

# Event Space

# RESULTS



Client chose an option that was not purposed; **Option 6**

**Faster** decision making

**More confident** decision making



# Feedback

**Scored  
9.5/10**

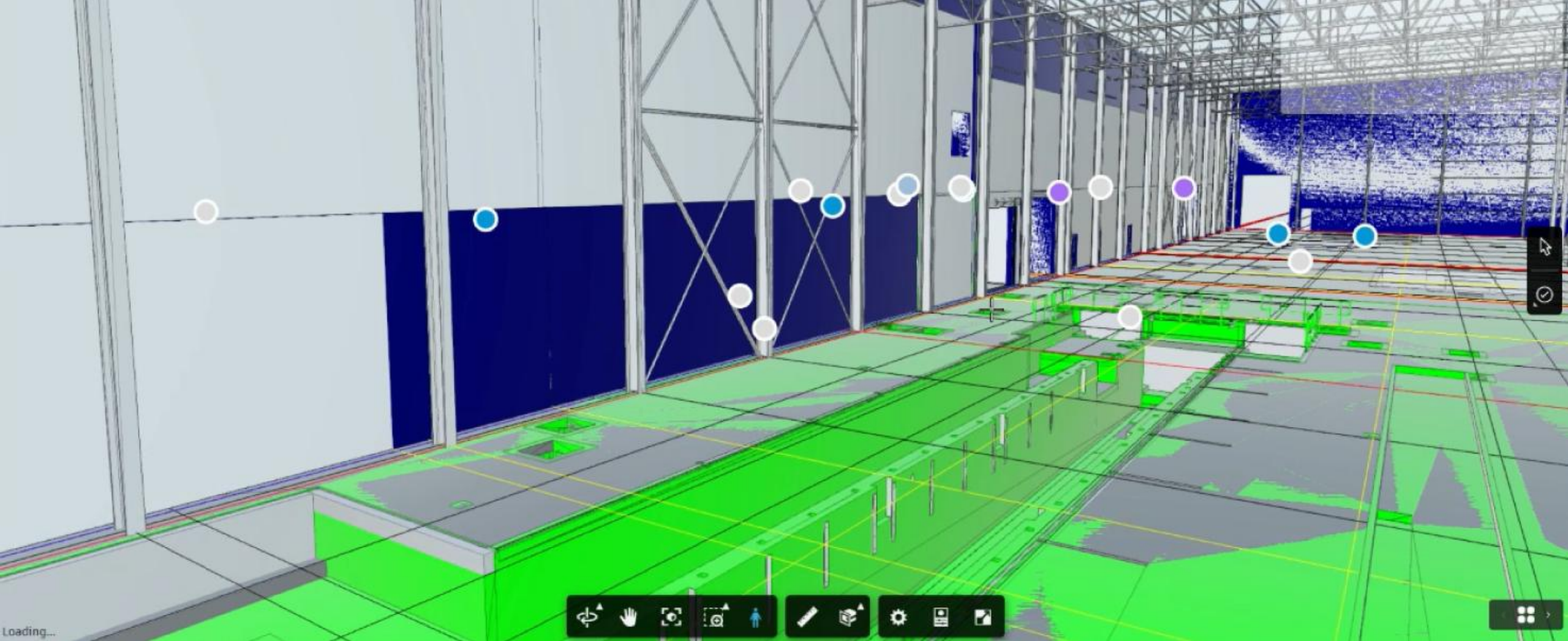
10 = Very Helpful



**Would you like to utilize VR on future projects?**

**100% said “Yes”**

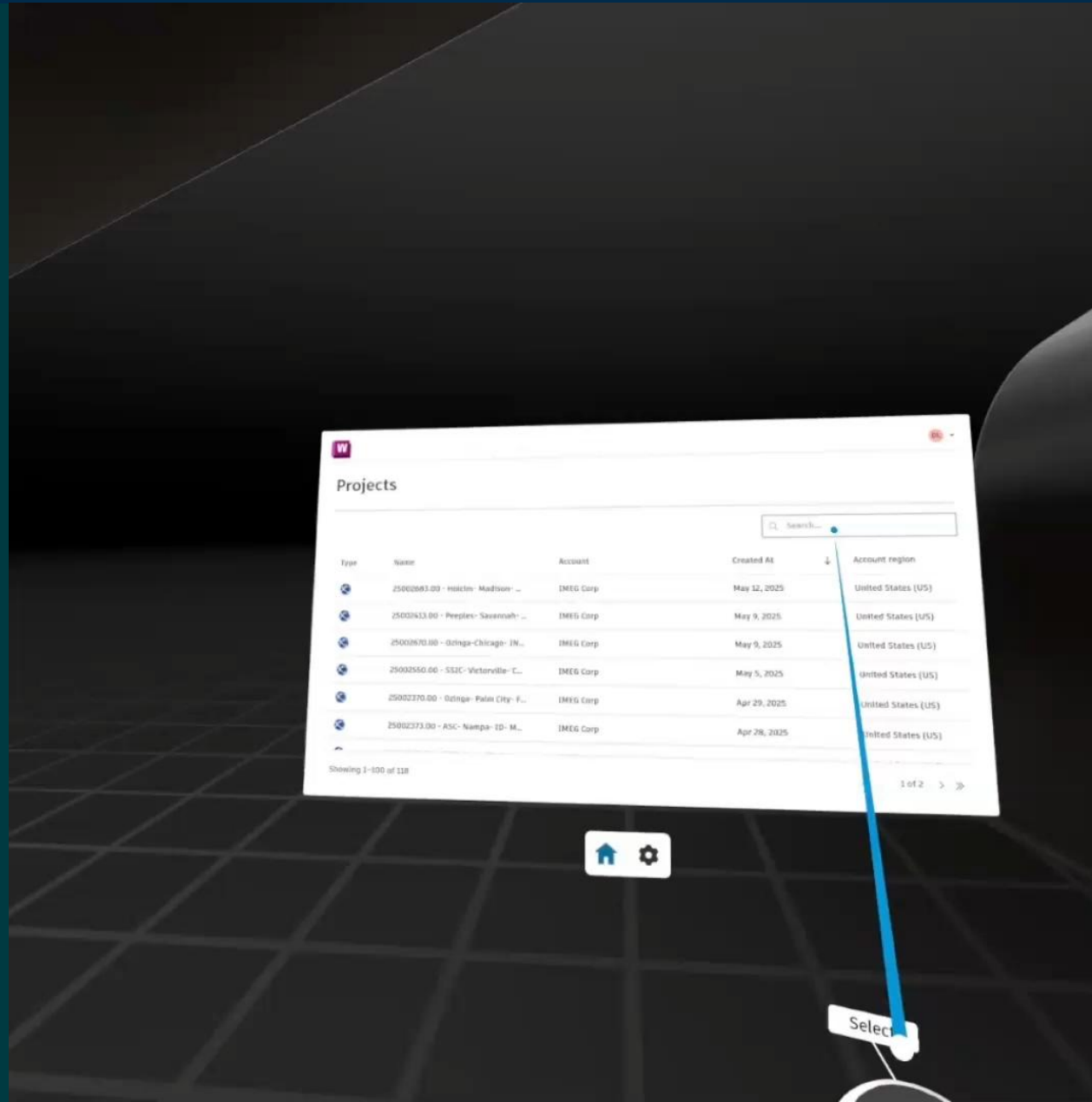
- *“VR seemed very helpful for end users who may not be able to read 2D plans...”*
- *“I can actually picture what the rooms will look like and function as”*
- *“I found it significantly more helpful in terms of more instant changes to the layout versus a typical notes to re-issue scenario...”*
- *“I cant imagine not using this tool more that I’ve been able to use it”*



# XR IN ACTION: REVIEWING



# XR Design Review



# Collaboration

The screenshot displays the Autodesk Construction Cloud interface, specifically the 'Files' section for a project named '25000813.00 - Kronospan Eastaboga OSB P...'. The interface is organized into a sidebar on the left and a main content area on the right.

**Sidebar Navigation:**

- Docs
- Files
- Specifications
- Reviews
- Transmittals
- Issues
- Reports
- Members
- Bridge
- Settings

**Main Content Area:**

The main area is titled 'Files' and shows a list of files under the 'Folders' tab. The list includes columns for Name, Description, Version, Indicators, Markups, Size, Last updated, Updated by, Version added by, and Review status.

Name	Description	Version	Indicators	Markups	Size	Last updated	Updated by	Version added by	Review status
3D ARCH W-II02 MO...		V28			86.2 MB	May 16, 2025 6:48 ...	David Landa IMEG Corp	David Landa IMEG Corp	
25000813.00-Kronos...		V3			22.3 MB	Apr 8, 2025 12:58 P...	David Landa IMEG Corp	David Landa IMEG Corp	
A1034_Foundation_...		V1			709.8 KB	May 6, 2025 12:56 ...	David Landa IMEG Corp	David Landa IMEG Corp	

At the bottom of the screen, a status bar indicates 'Showing 3 items'. A sharing notification from teams.microsoft.com is visible, stating 'teams.microsoft.com is sharing your screen.' with buttons for 'Stop sharing' and 'Hide'.

# ACC Issues List

Autodesk Construction Cloud

25000813.00 - Kronospan Eastaboga OSB P...

Files

Folders Packages

Project Files

IMEG 2024

Upload files

Export Search and filter

Name	Description	Version	Indicators	Markups	Size	Last updated	Updated by	Version added by	Review status
IMEG 2024		--		--	--	May 9, 2025 7:49 AM	David Landa IMEG Corp	--	--

Showing 1 item

teams.microsoft.com is sharing your screen. Stop sharing Hide

# RESULTS



VR walkthrough at least **once a week**

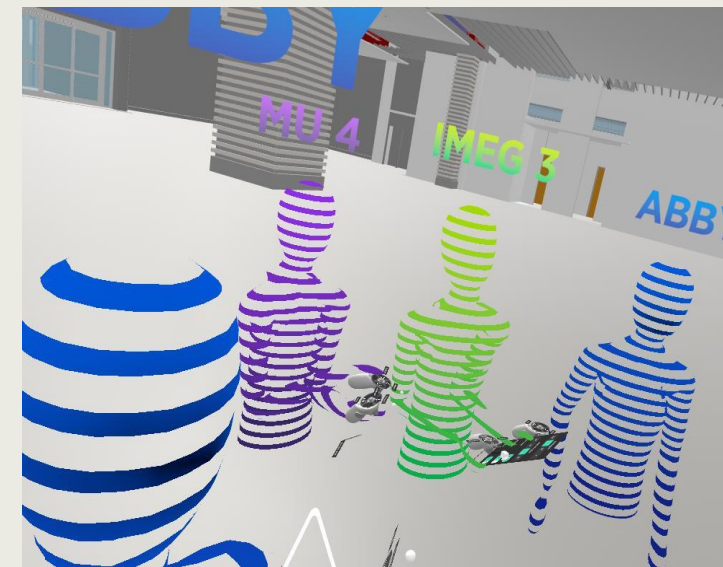
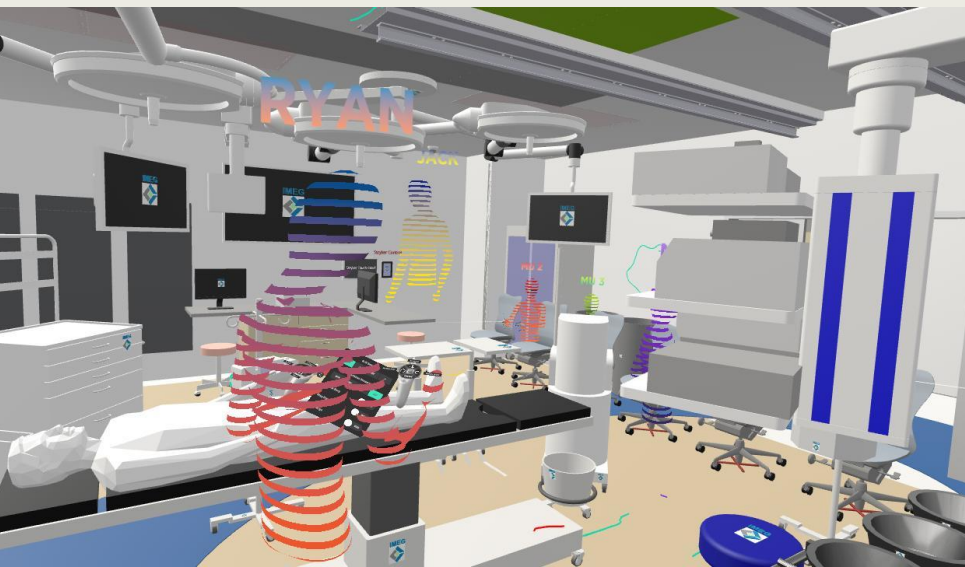
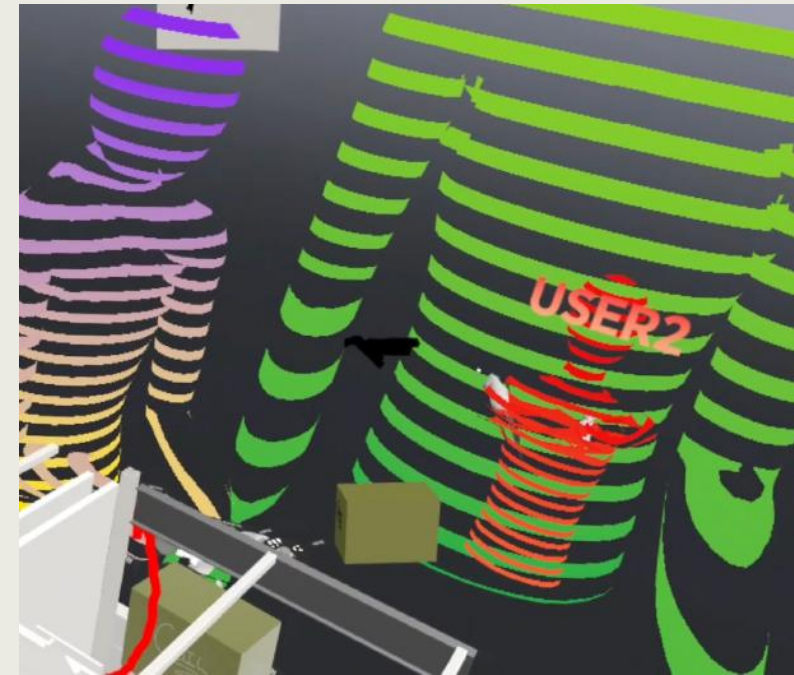
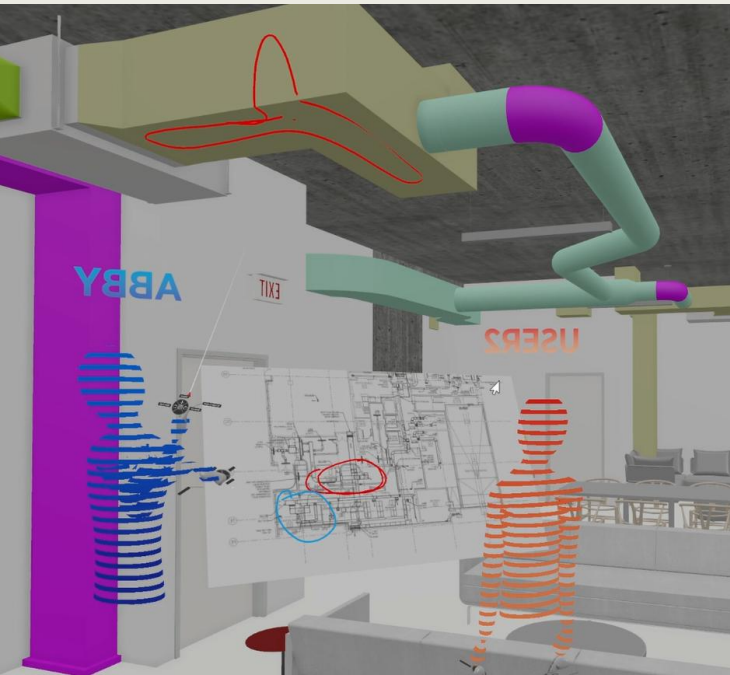
**2-3 errors** per VR walkthrough

**100+ issues** per project

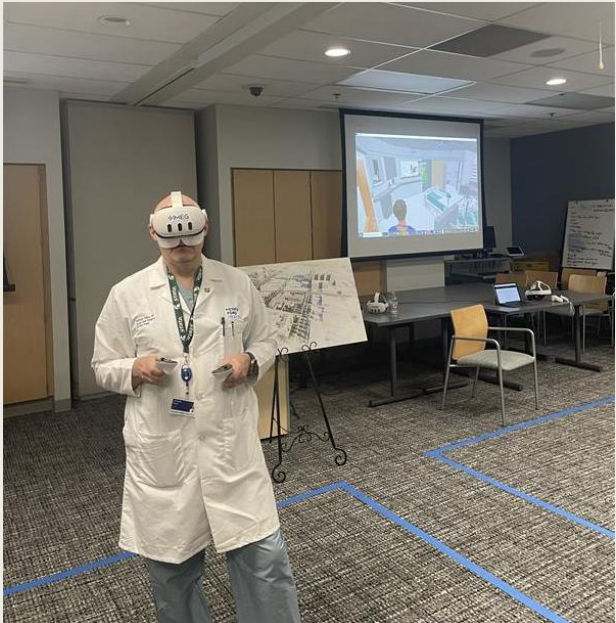
**\$150,000+ saved** per project

*Based on 30% actionable issues, at \$5,000 per issue*











# IMMERSIVE TECH IMPACT

Confident & faster decisions



Reduced rework



Reduced operational carbon



Cost efficiency

AI









**AI =**

Computer systems designed to perform tasks that typically require human intelligence, such as understanding language, recognizing patterns, solving problems, and making decisions.

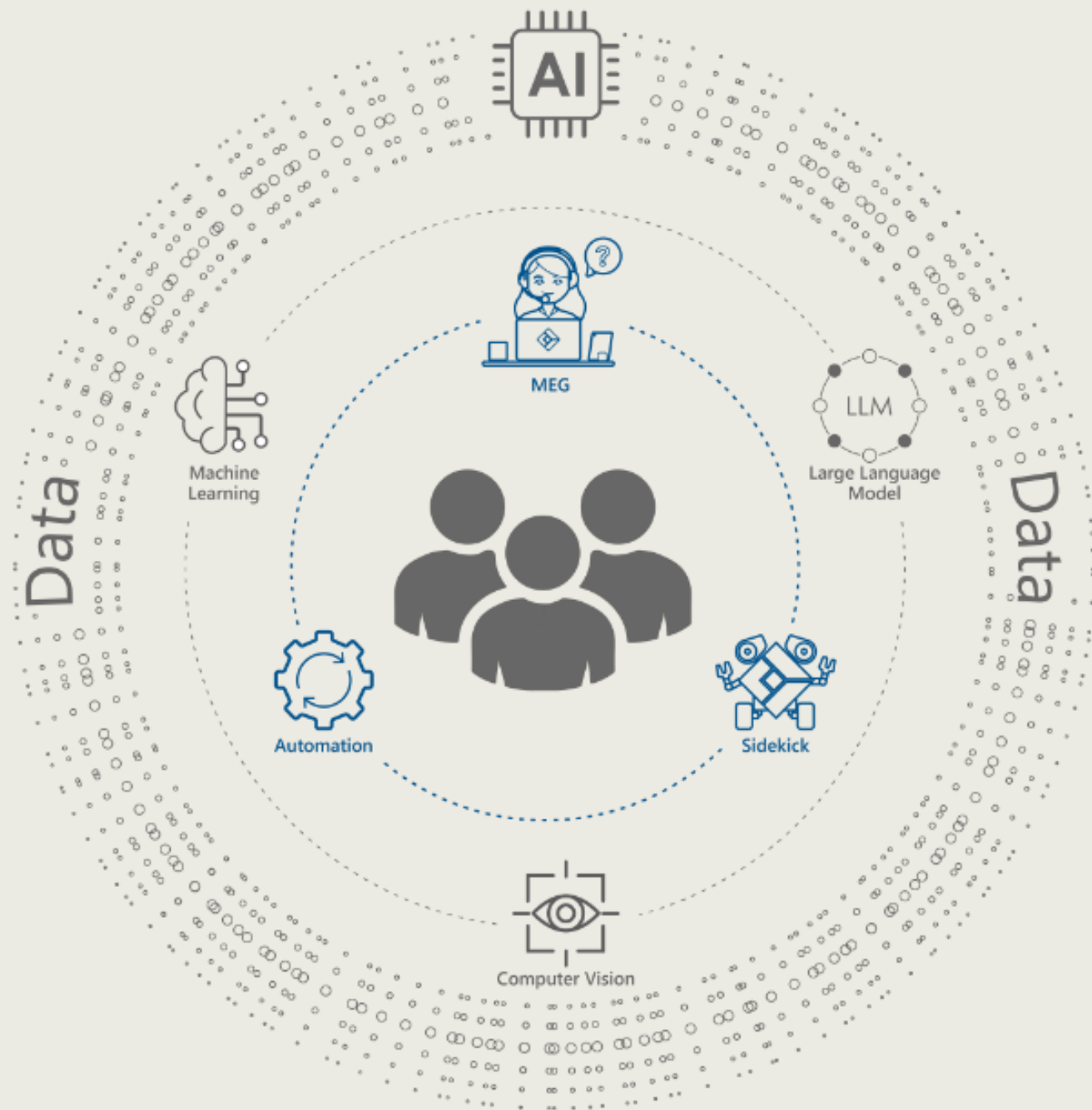
# AI CAPABILITIES

## Good

- Repetitive tasks & first-pass reviews
- Spotting errors, patterns, and trends quickly
- Turning complex data into simple outputs

## Bad

- A substitute for human judgment
- Perfection & accuracy
- Big picture creativity







MegAgents

4:49 PM

Let's Run a QUICK REVIEW, where we quickly run a review all standard Schedules and Equipment Schedules





Thinking...

Stop Responding

Mechanical Schedule QC

Type here...

Project #: 24006063.00



Prompt Library





**FIND THE DIFFERENCE**



Products

Daikin ...Pages 4-9

9 2 14 15

Checked Against:  
Drawing Schedule  
- SPLIT SY...

No Exceptions

Make Correction

Revise And Re

Rejected

Add  
general

Air Adju... Page 10

BRC...Pages 11-13

558-238126 Split system AC units SD\_2024.12.02\_M053

Daikin City Submitted Submittal Data  
(Daikin's products are subject to continuous improvements. Daikin reserves the right to modify product design, specifications and information in this data sheet without notice and without incurring any obligations)  
Submitted Date: 9/3/2024 9:41:53 AM  
Page 2 of 5

DAIKIN

Submittal Data Sheet

R-32 — 2-Ton Wall Mounted Daikin OTERRA Heat Pump System - FTXF24AXVJU-RXF24AXVJU

Project: Edwardsville Lincoln Middle School BD4

Submitted by: Joe Amisier of THERMAL MECHANICS INC. STL on 9/3/2024

Submitted to: n/a

INDOOR UNIT DETAILS

Power Supply (V/Hz/Ph):	208-230 / 60 / 1	Airflow Rate (H4H4ML/SL) (CFM):	754/716/605/467/395
Power Supply Connections:	L1, L2, L3, Ground	Moisture Removal (Gal/hr):	0.9
Min. Circuit Amps MCA (A):		Gas Pipe Connection (inch):	5/8
Max Overcurrent Protection (MOP) (A):		Liquid Pipe Connection (inch):	1/4
Dimensions (HxWxD) (in):	11-11/16 x 39-9/16 x 10-3/4	Condensate Connection (inch):	5/8
Net Weight (lb):	30.5	Sound Pressure (HML/SL) (dBA):	53/45/39/34
Ext. Static Pressure (Rated/Max) (inWG):	/	Sound Power Level (dBA):	

DIMENSIONAL DRAWING - INDOOR UNIT

Model : FTKF18/24A, FTXF18/24A

FOR ILLUSTRATIVE PURPOSES ONLY

REAR

LEFT

RIGHT

FRONT

BOTTOM

14 Spect AI | Drawing

Dimensions exceed equipment schedule requirements.

15 Spect AI | Drawing

The CU-B315 has CFM 754/716/605/467/395 which has HH greater than 705, per SPLIT SYSTEM UNIT SCHEDULE.

16 Spect AI | Drawing

Voltage and Phase comply with equipment schedule requirements.

17 Spect AI | Spec

Air filters are provided, per Section 2.1-B.5

18 Spect AI | Spec

Service access provided for wall mounted units, per 2.1-B.2.

19 Spect AI | Spec

Exposed units come with concealed refrigerant piping, condensate drain piping, wiring connections, per Section 2.1-C.1.B.

Spect AI | Spec

There is no information about Piping specifications, per Section 2.2.

Spect AI | Spec

There is no information about AHRI Standard 210/240 compliance.

Spect AI | Spec

There is no information about ETL compliance, per Section 2.1-B.6.

Spect AI | Spec

There is no information about NEC compliance, per Section 2.1-B.7.

Open Files

84

**Summary**  
This job site observation report details numerous deficiencies. [View more](#) comments related to the installation, labeling, insulation, and com...

### JOB SITE OBSERVATION REPORT #008

Roswell cGMP

IMEG #22003040.00  
November 22, 2024

**OBSERVER(S):** Douglas Smith      **OBSERVATION DATE:** 11/12/2024

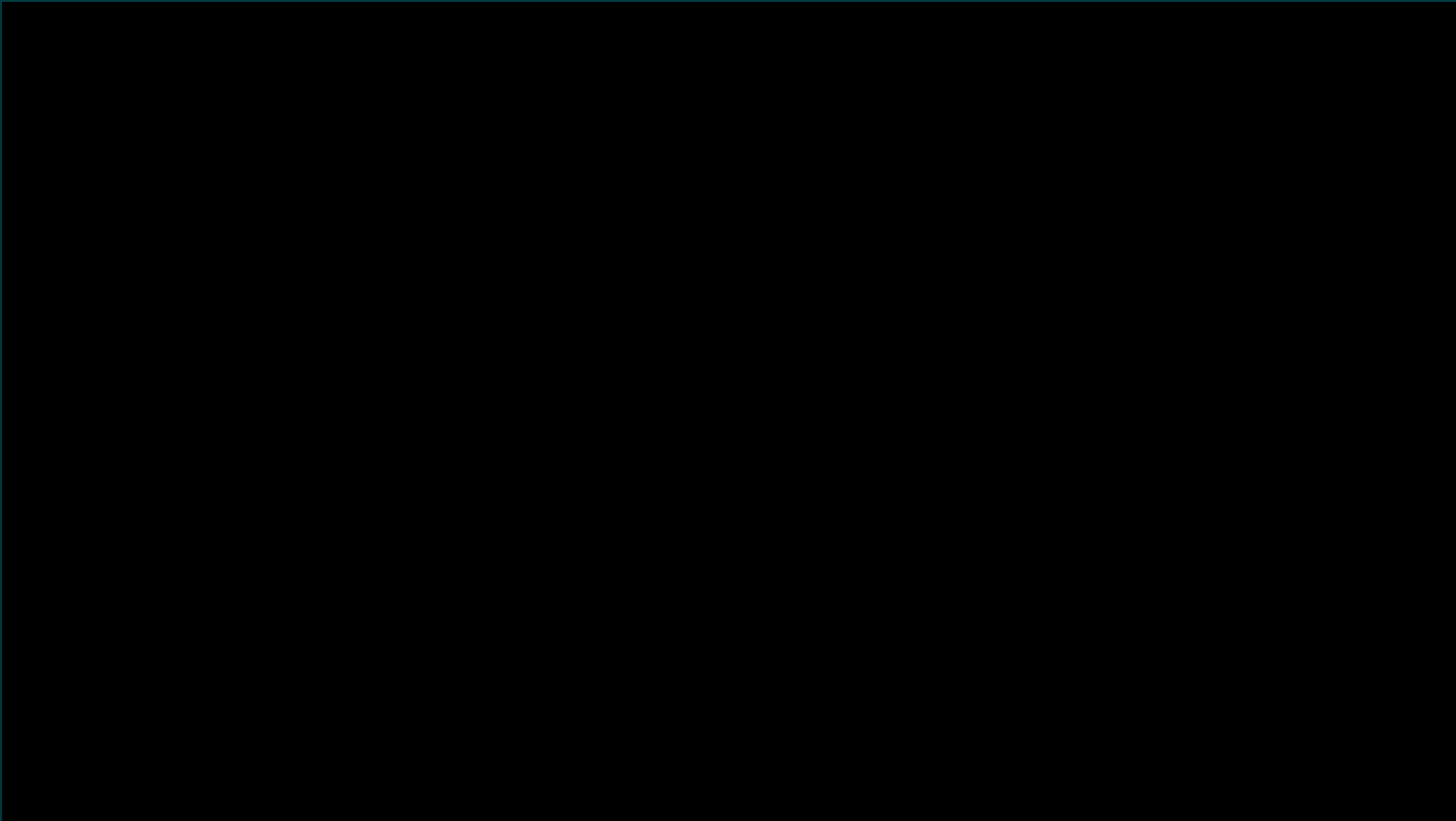
This report itemizes observed portions of the installation of workmanship and/or material items that fail to meet the intent of the contract documents. This report shall not be construed as having any other purpose but to notify the contractor of visible deviations from the contract documents that were observed on the date noted. Omissions or unnoted items do not relieve the contractor of his or her responsibility to complete all work in accordance with the contract documents.

**General Comments:**

Finish controls programming and commissioning on all air handlers.  
Complete and submit testing and balancing report.

**Deficiencies:**

No	Location	Date	Description	Date Closed
001	ROOF-W	11/12/24	Trash not removed from exhaust unit. (JSO-008 Photo RD 01.1)	
002	ROOF-W	11/12/24	Equipment tags are not installed on all equipment as typically required. (JSO-008 Photo RD 02.1 through JSO-008 Photo RD 02.2)	
003	ROOF-W	11/12/24	Condensate drains are to be extended to roof drains. This applies typically to all equipment. (JSO-008 Photo RD 03.1)	
004	ROOF-E/W	11/12/24	Piping less than 4 inches requires strapping to supports, typical of the installation. (JSO-008 Photo RD 04.1)	
005	ROOF-E	11/12/24	Condenser water piping is not labeled. (JSO-008	





# AI INTEGRATION



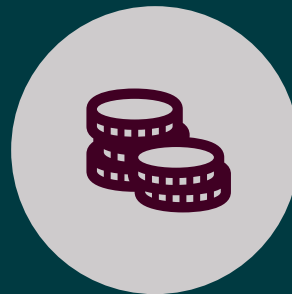
**Catching errors  
early**



**Reducing rework**



**Saving time**



**Cost efficiency**



**Parametric  
Engineering**

**Immersive  
Tech**

**Cost savings, carbon  
reduction, client confidence**

**AI**



# QUESTIONS