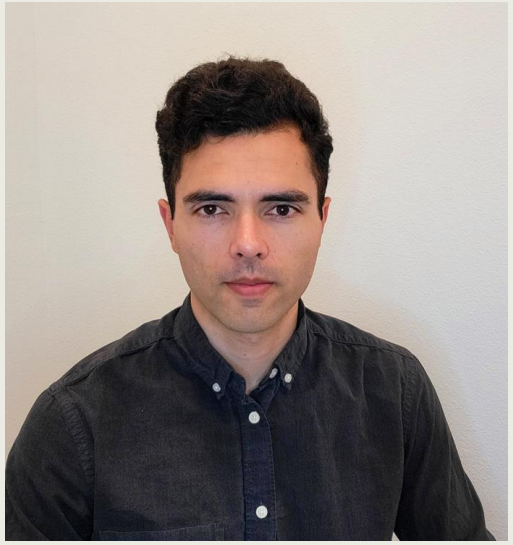
Presented by:
Abby Coleman
David Nino

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?


Veo

FUTURE READY ENGINEERS

WHY CHANGE?

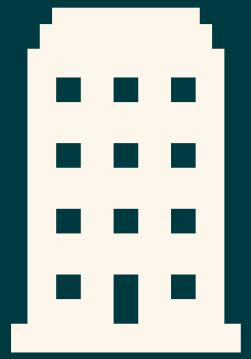
AEC INDUSTRY TREND

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]

[1] Autodesk University
[2] World Green Building Council

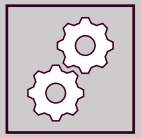
Billions are wasted from inefficient design review collaboration

2.6T ft

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

[1] Autodesk University

OUTLINE



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

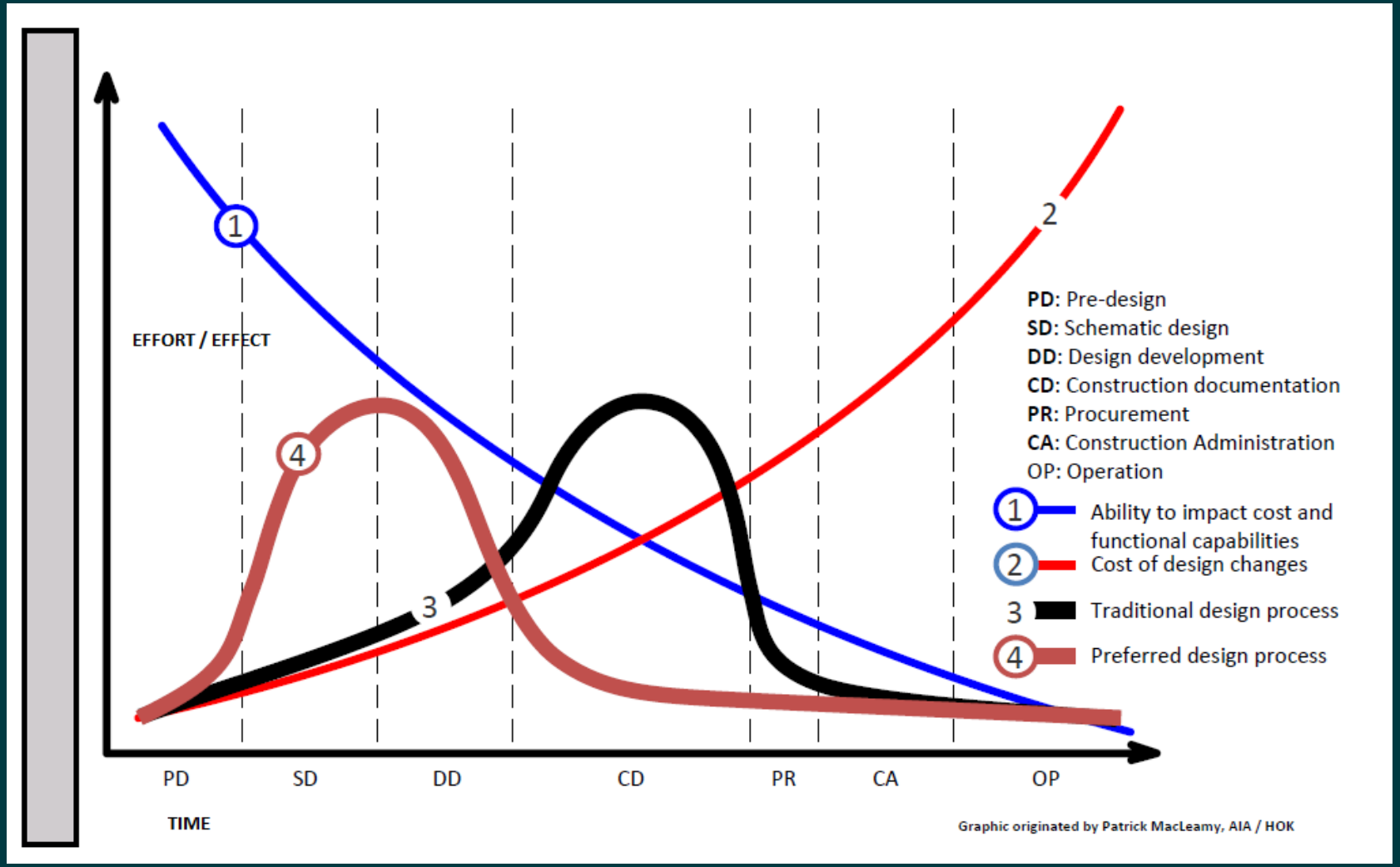
Explore the impact of immersive technologies (VR/AR/XR) on project collaboration

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

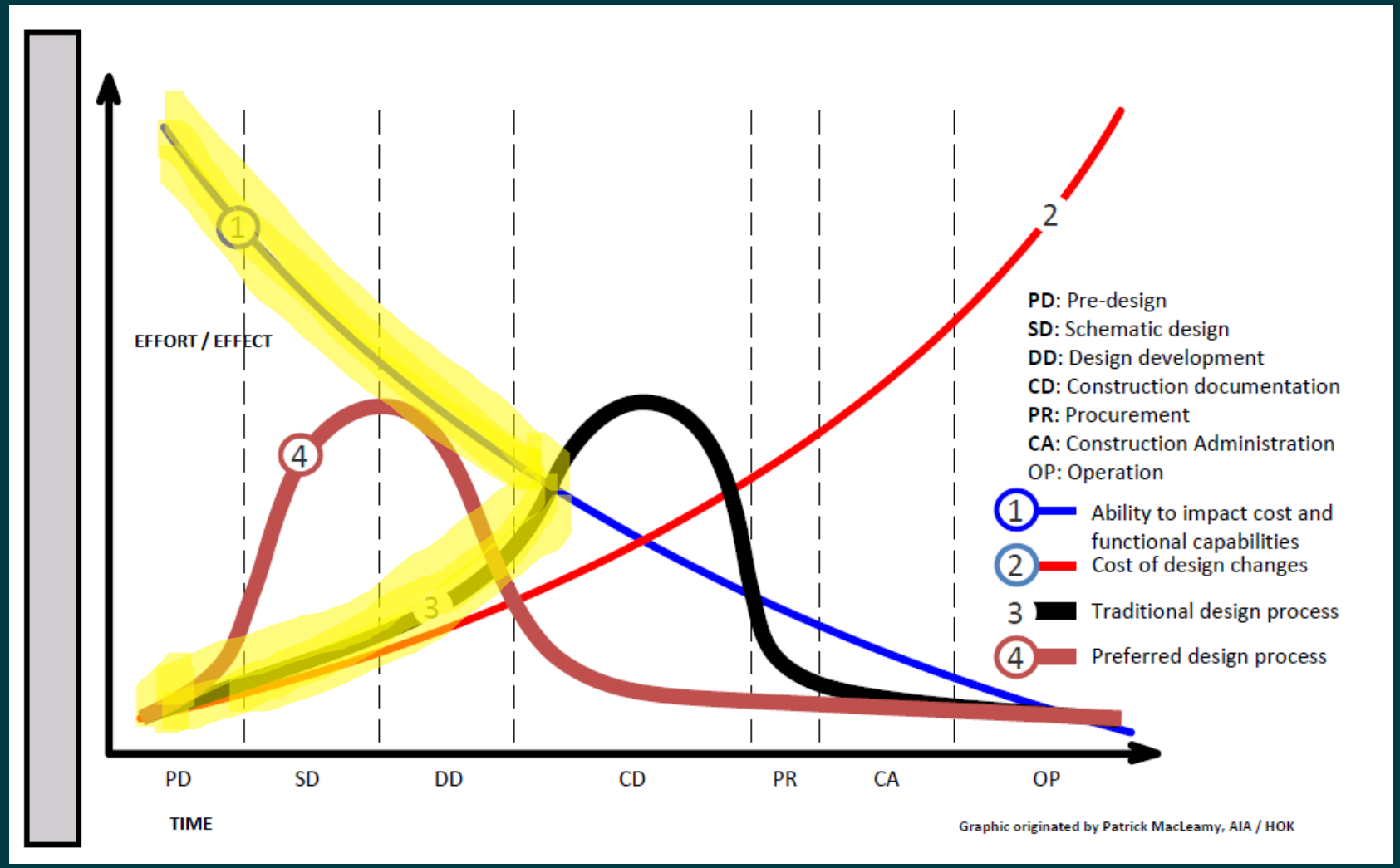
EARLY DESIGN STRUGGLE



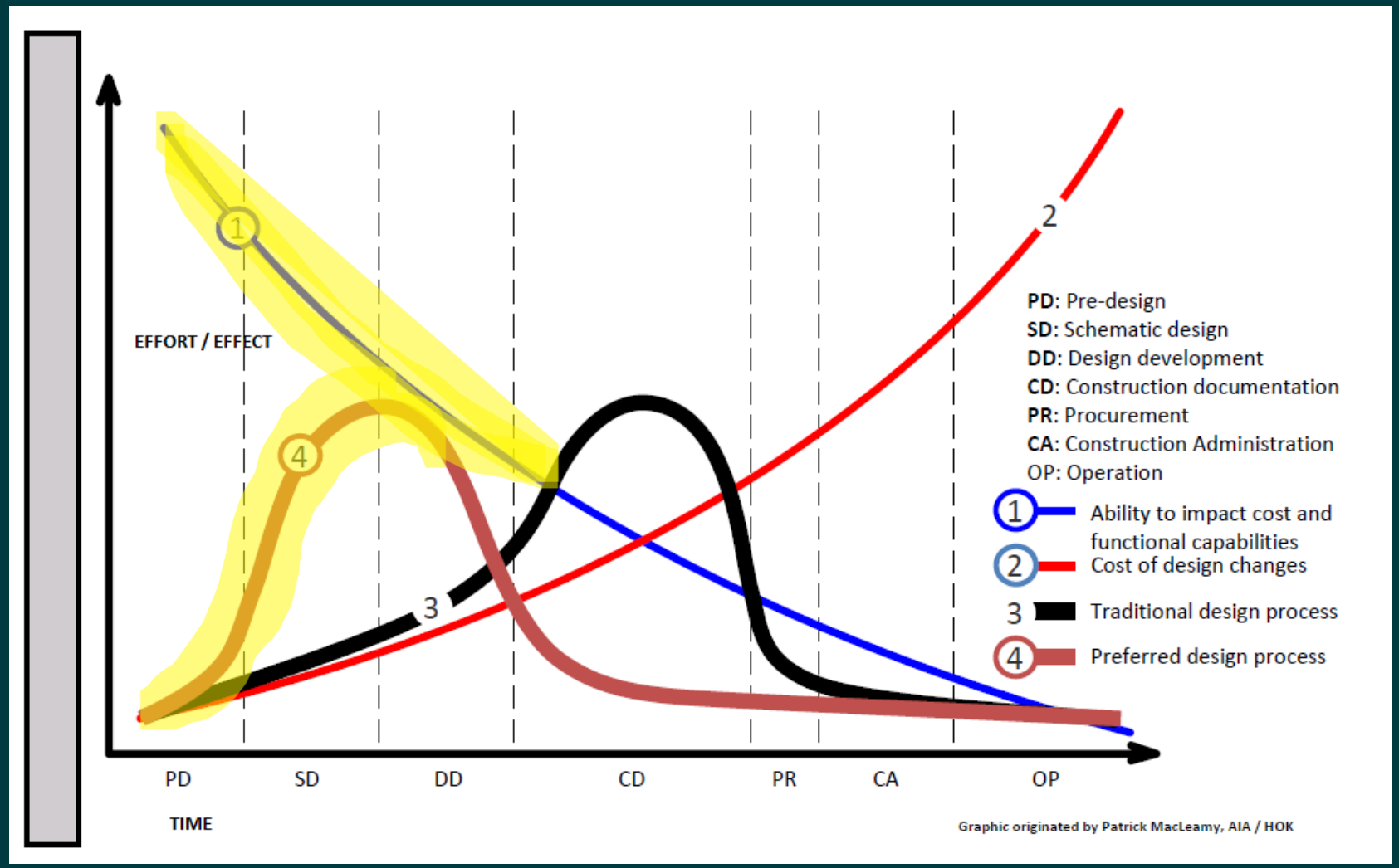
DECISIONS AT EARLY STAGES ARE CRITICAL

HOW DO WE MAKE INFORMED DECISIONS AT THE EARLY STAGES?

EARLY DESIGN STRUGGLE

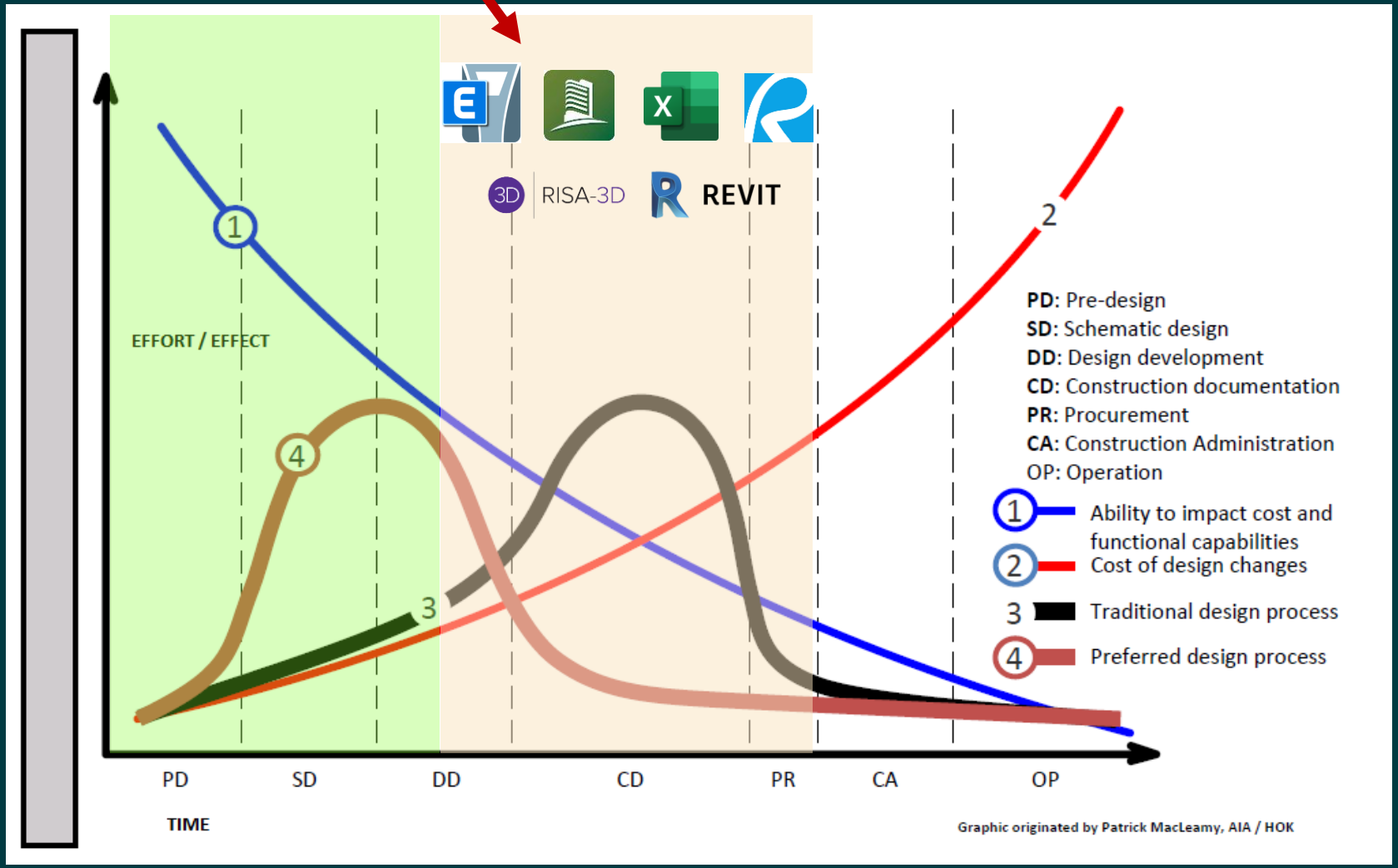


EARLY DESIGN STRUGGLE



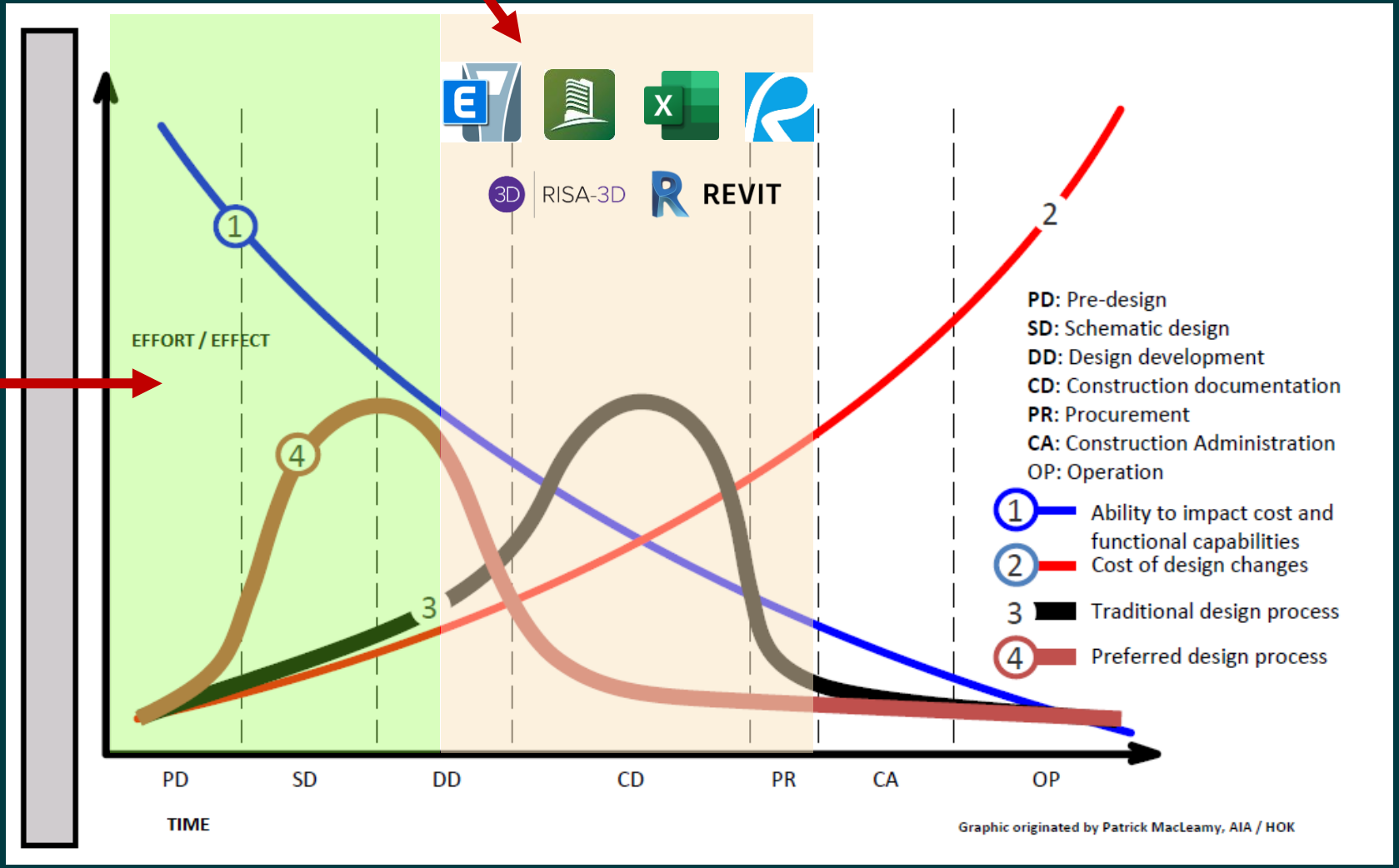
HOW?

CONVENTIONAL TOOLS



CONVENTIONAL TOOLS

WE NEED TOOLS THAT CAN HANDLE THE EARLY STAGES



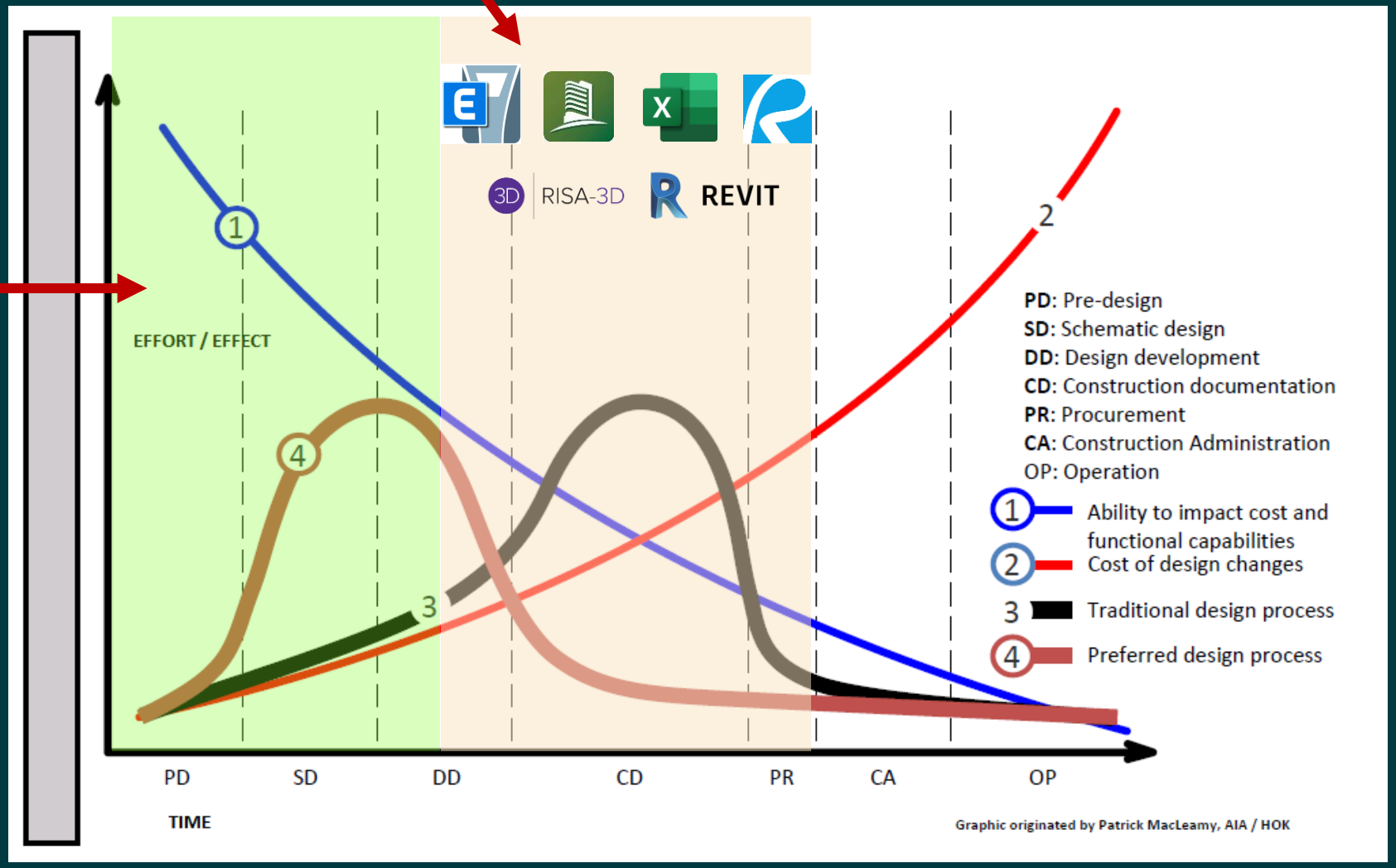
CONVENTIONAL TOOLS

PARAMETRIC ENGINEERING

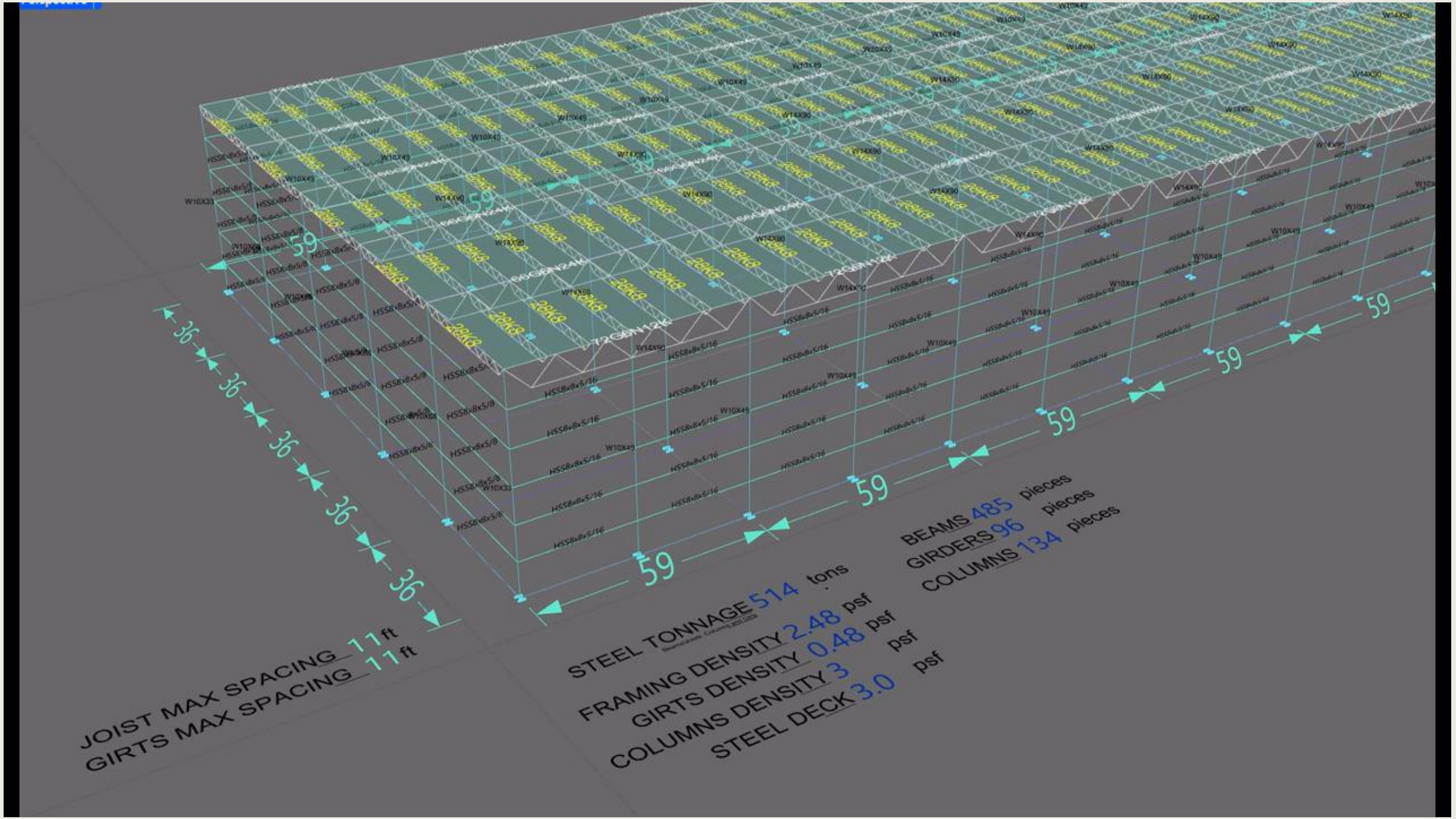
Rhinoceros

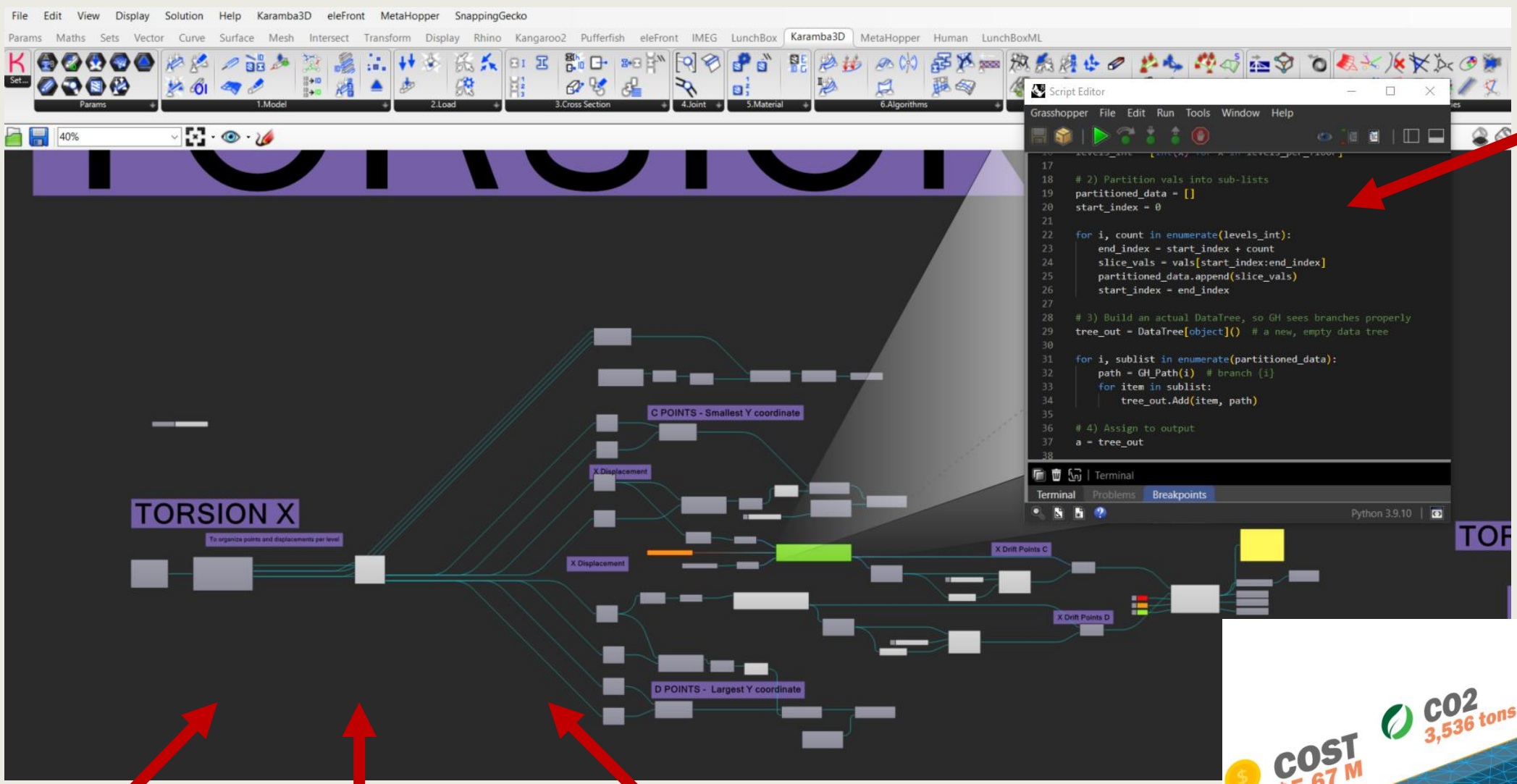
python

Karamba3D

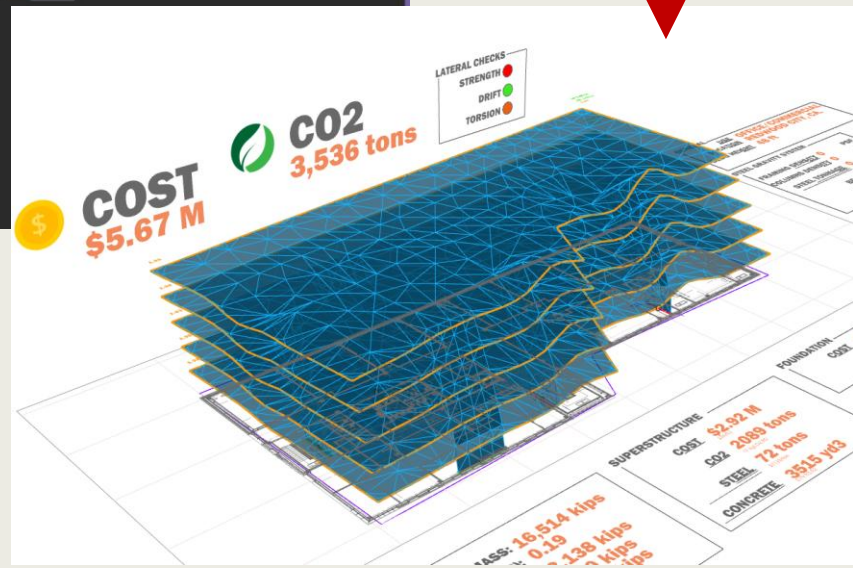



Perspective
GRAVITY COLUMNS SYSTEM
CONCRETE SQ COLUMNS
STEEL WF COLUMNS
STEEL HSS COLUMNS
LATERAL SYSTEM
CONCRETE SHEAR WALLS
STEEL BRACED FRAMES BRBS
STEEL BRACED FRAMES HSS
ANALYSIS AND EXPORT
BEAMS GIRDERS
GRAVITY COLUMNS
LATERAL SYSTEM
FOUNDATION
EXPORT_TO_ETABS
DISPLAY
3D MODEL
ONLY LATERAL
SECTION TAGS
3D SECTIONS
MESH MODEL
BAKE GRIDS
3D BAKE
GRAVITY RESUTLS
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
CTOR FOR BA...
BLDG AREA
COST
CO2
LATERAL CHECKS
STRENGTH
DRIFT
TORSION
BEAMS ORIENTATION
VERTICAL
HORIZONTAL
FOUNDATION
COST
CO2
SUPERSTRUCTURE
COST
CO2
STEEL
CONCRETE
0 kips
1


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
36
36
36
36
36
59
59
59
59
59
59



Rhinoceros



Karamba3D

python™

MULTIDISCIPLINARY CHECKS

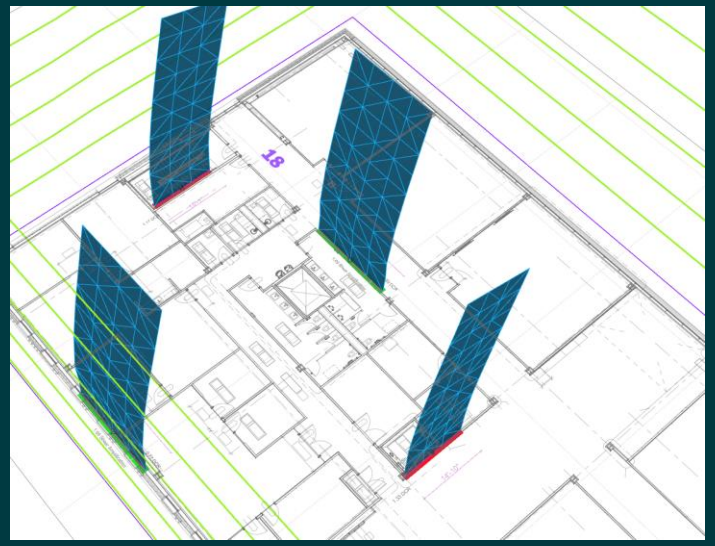
STRUCTURAL

LATERAL CHECKS

STRENGTH
1.29 DCR

DRIFT
X: 0.67 % Y: 1.31 %

TORSION
X: 1.16 Y: 1.18



COST

CO2

MULTIDISCIPLINARY CHECKS

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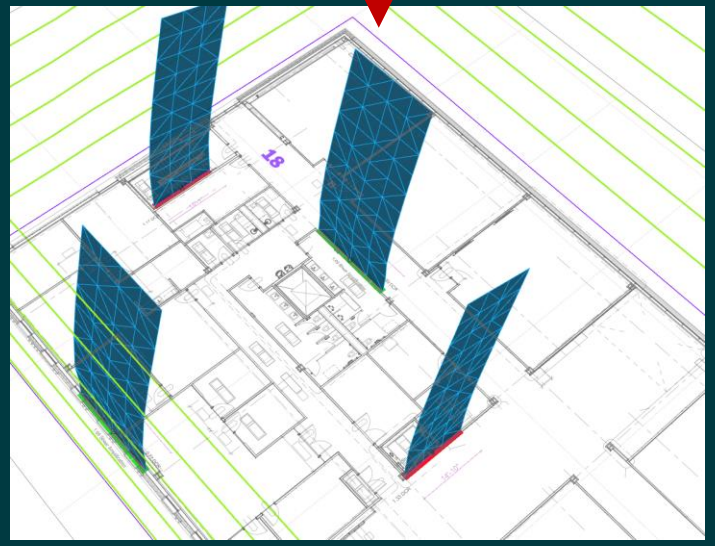
ARCHITECTURE



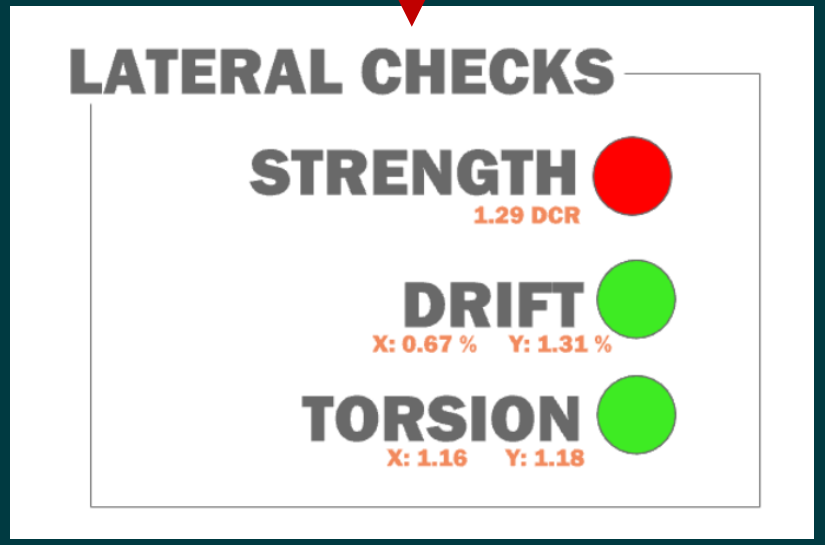
COST

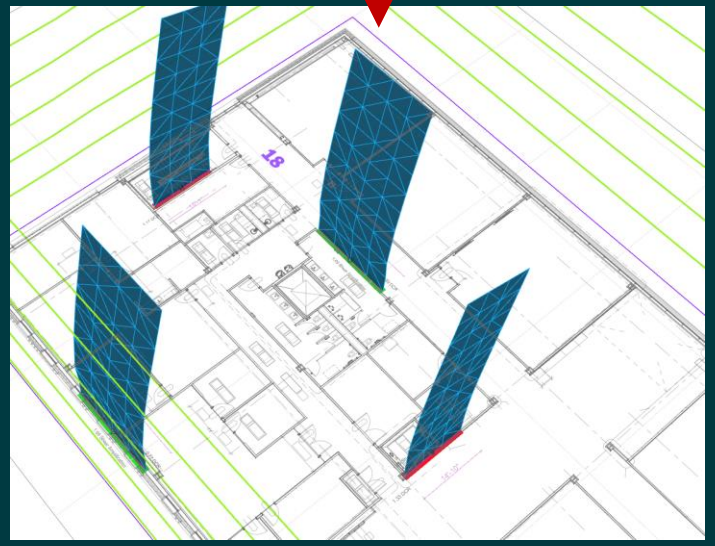
CO2

MULTIDISCIPLINARY CHECKS

STRUCTURAL

ARCHITECTURE

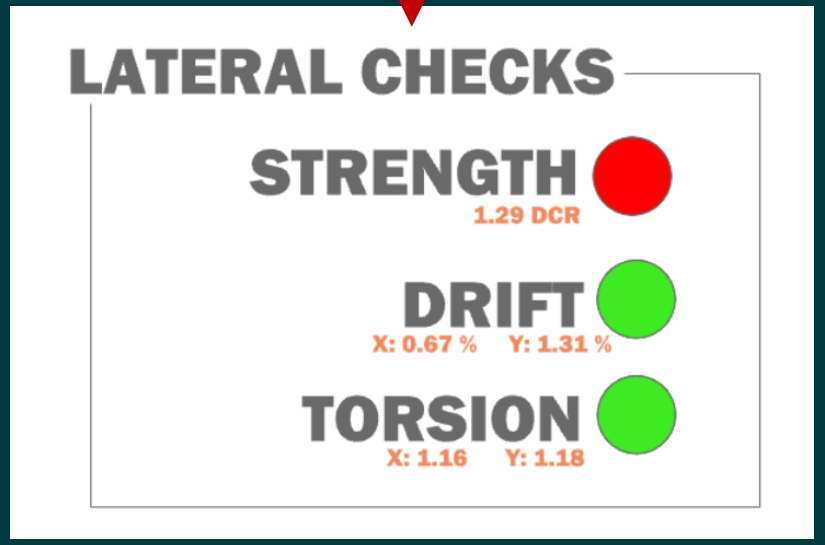




BUDGET

MULTIDISCIPLINARY CHECKS

STRUCTURAL



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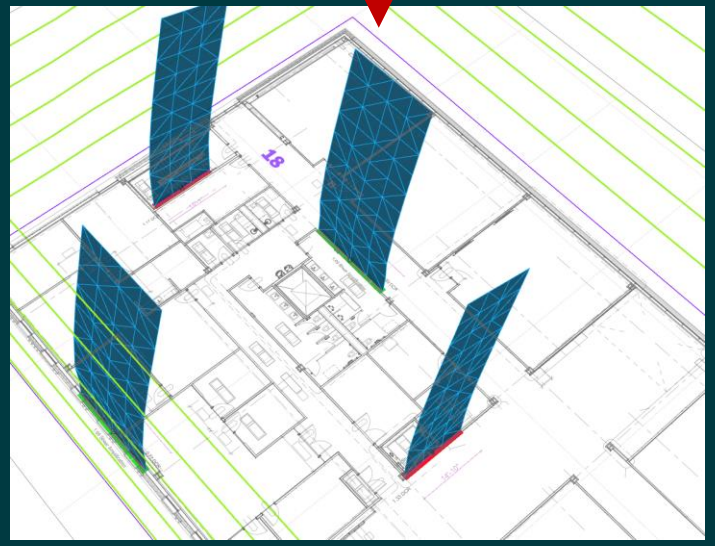
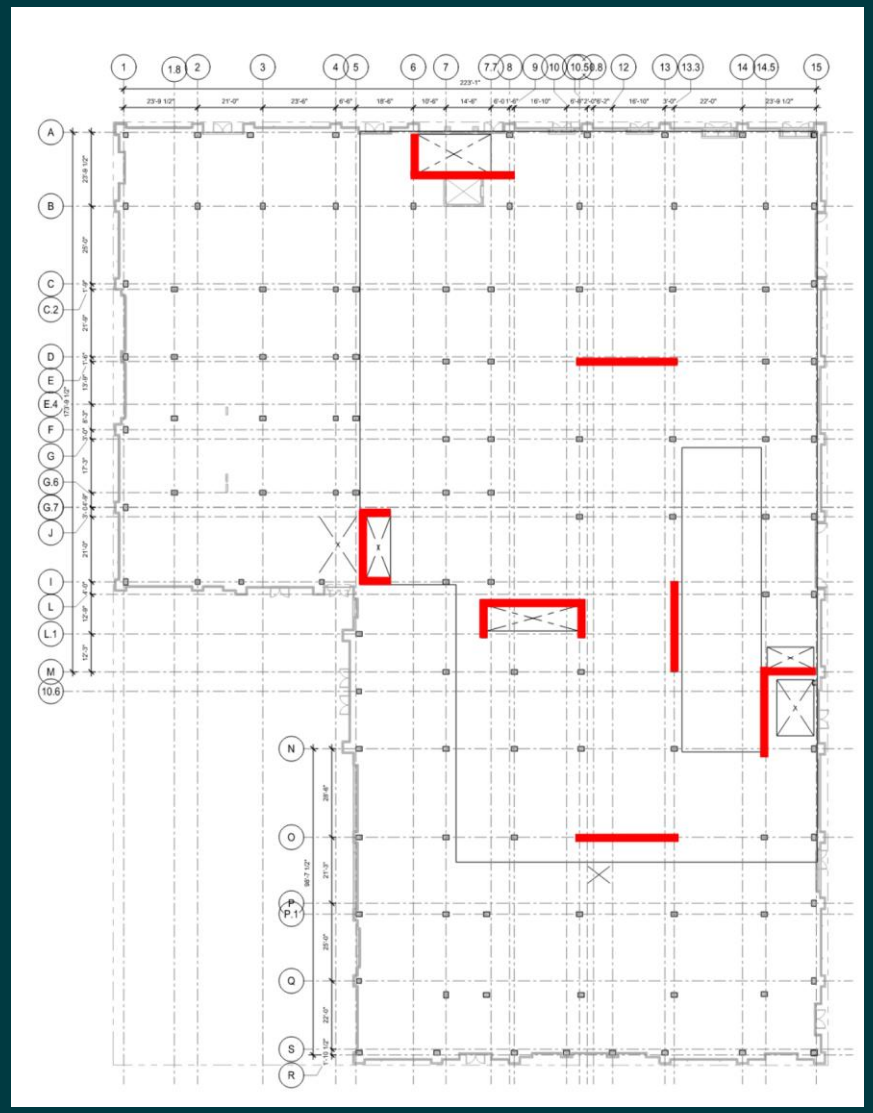


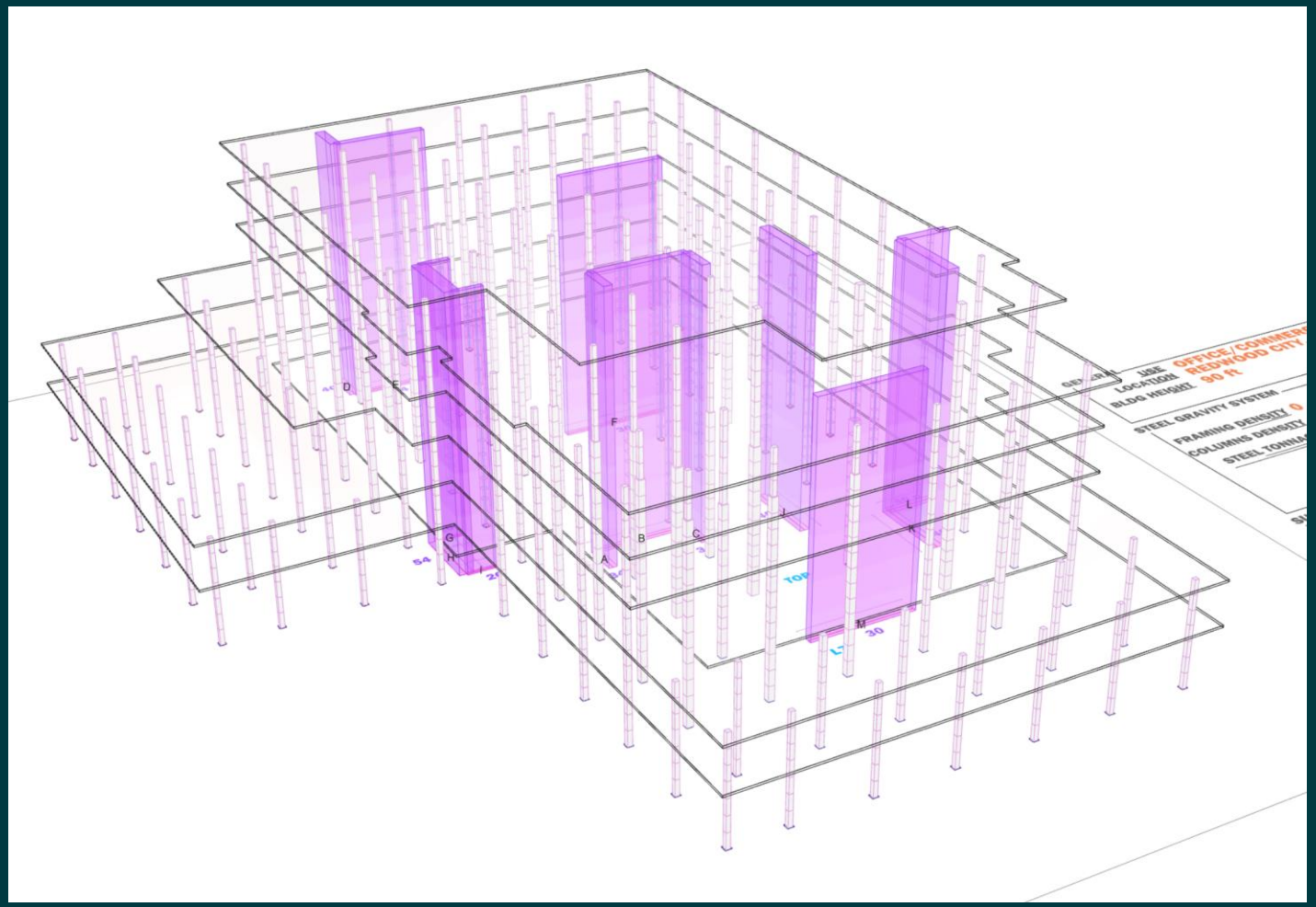
BUDGET

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

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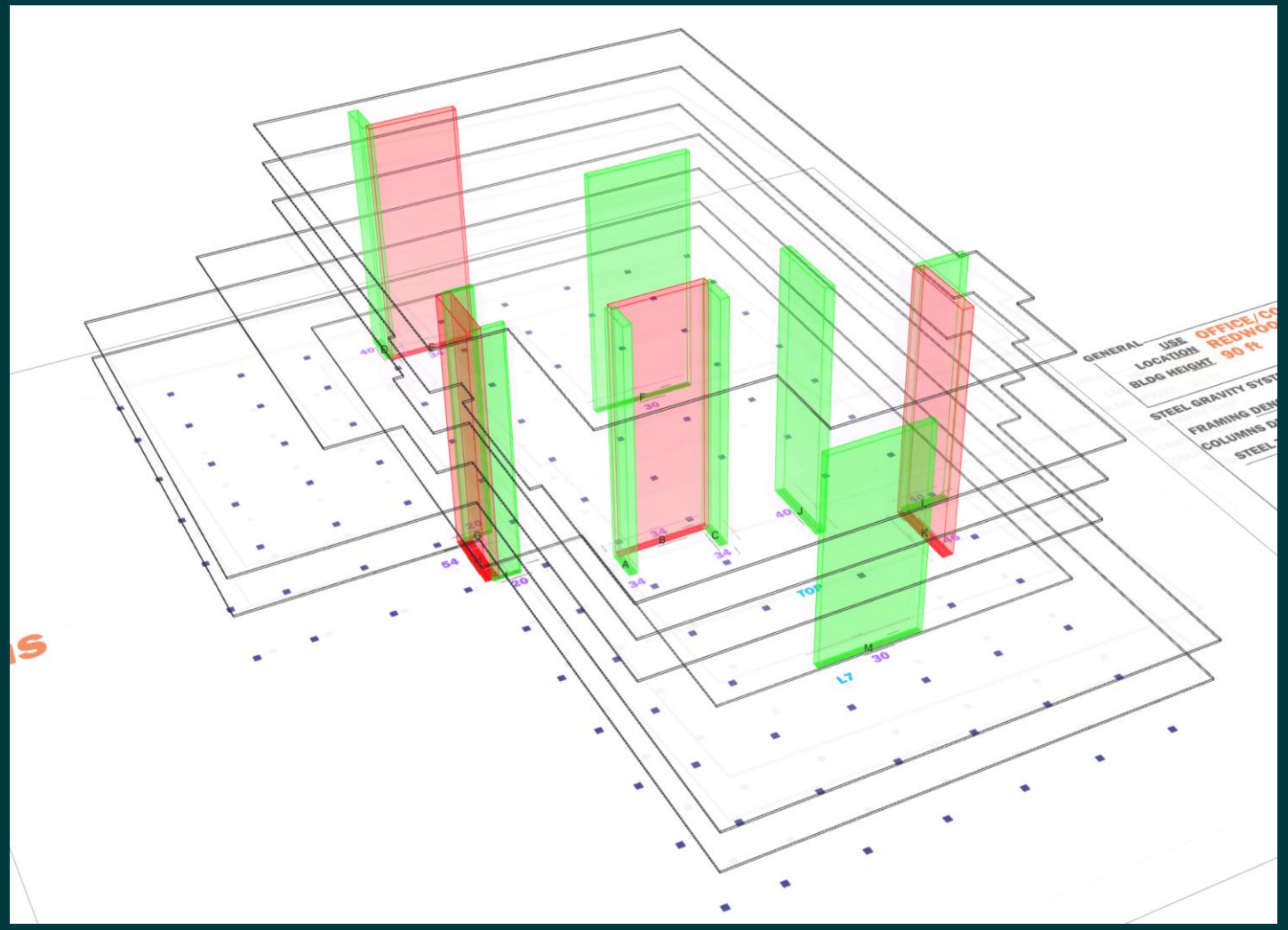

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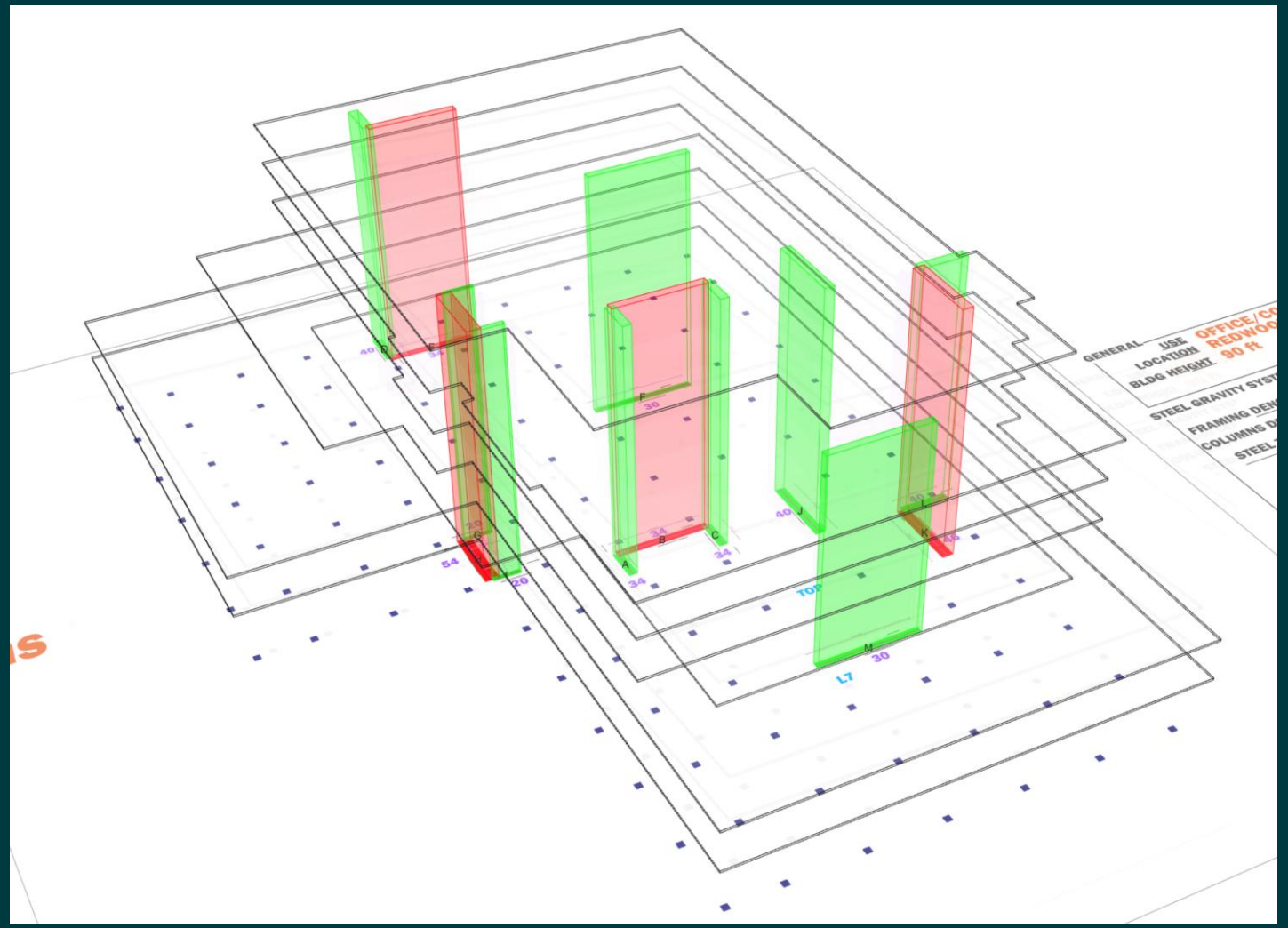
SUPERSTRUCTURE

COST	$15.3 M	$49/ft2
CO2	11413 tons	36 kgCO2/ft2
STEEL	1098 tons	$1164/ton
CONCRETE	11228 yd3	0.98 ft3/ft2

STEEL: GRAVITY, LATERAL, 25% CONNECTIONS FACTOR AND STEEL DECK
CONCRETE: SLABS, COMPOSITE FLOORS, WALLS AND COLUMNS

FOUNDATION

COST	$14.43 M	$ 46 /ft2
CO2	7909 tons	25 kgCO2/ft2



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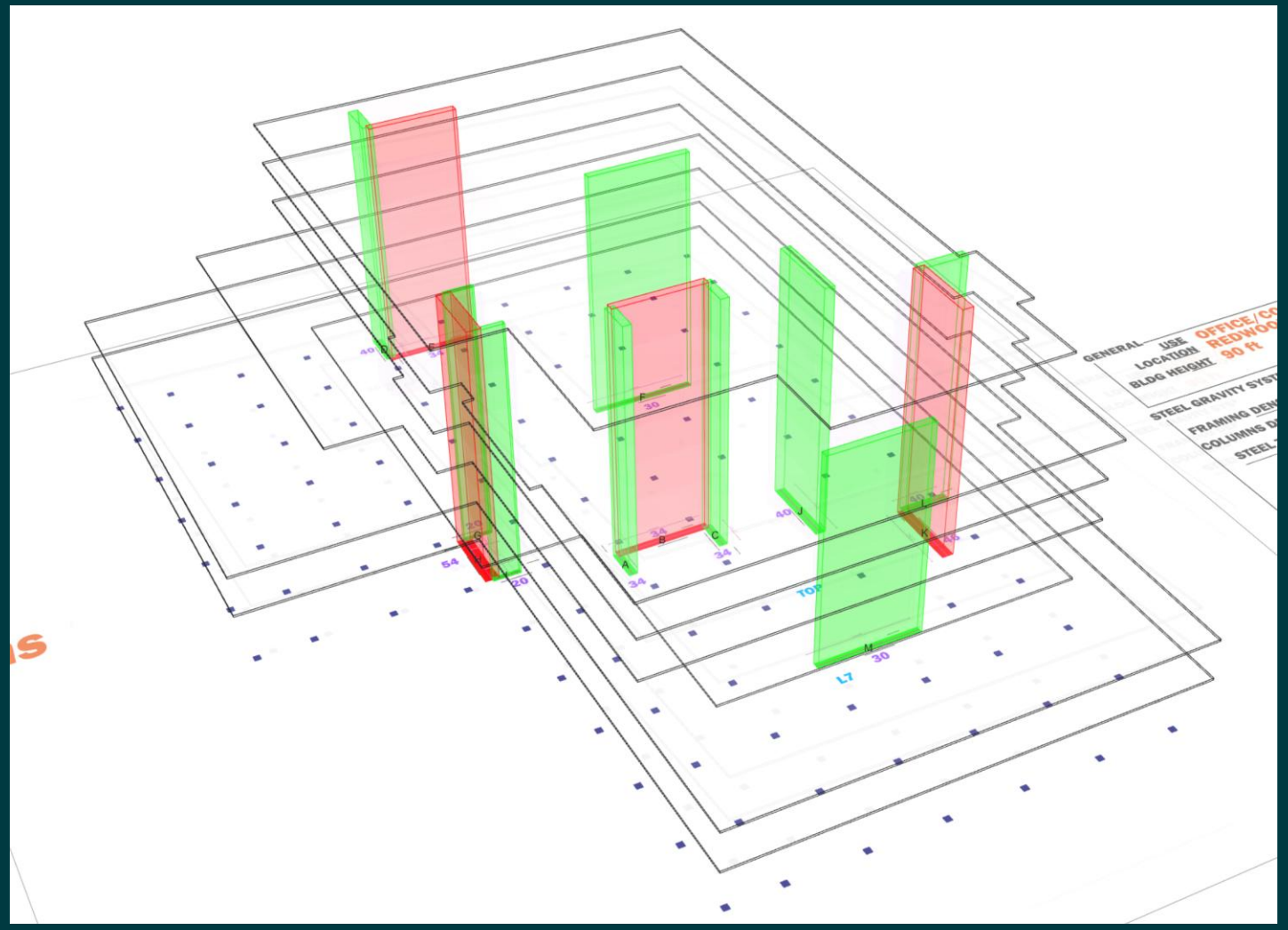
BLDG AREA
310,867 ft2

COST
$29.73 M

CO2
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?

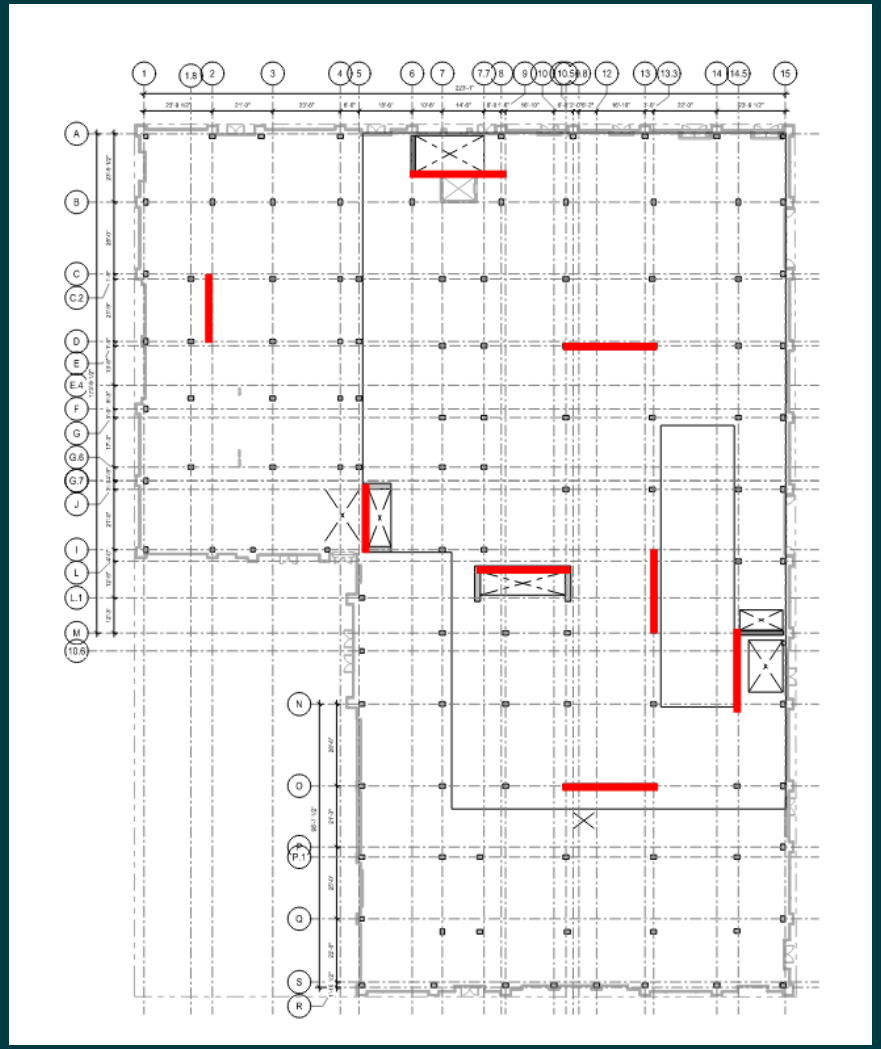
-COST and CO_2 Impact?

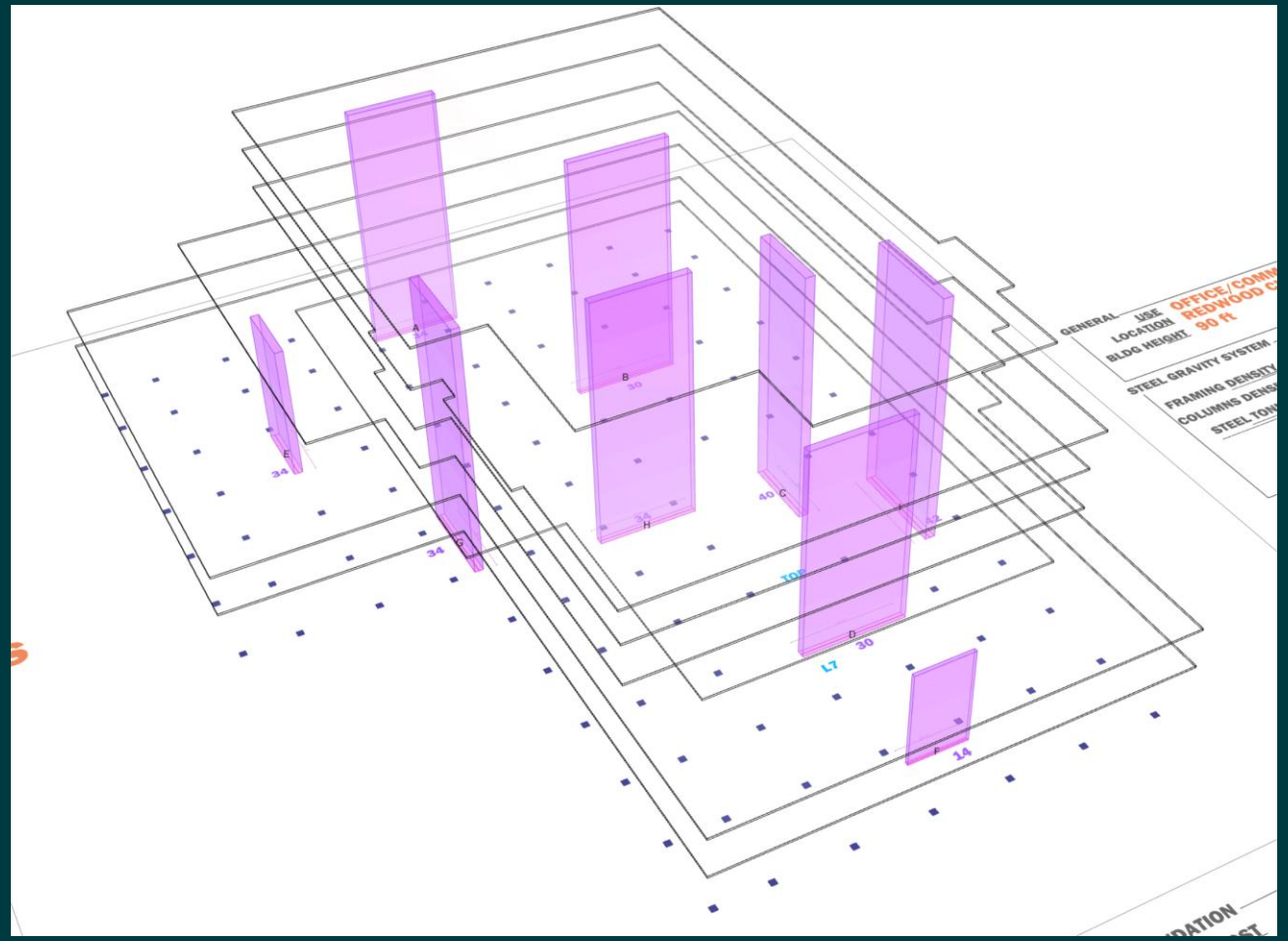
POLL

HOW LONG WOULD IT TAKE TO EXPLORE THOSE WHAT IFS?

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

STUDY B




GENERAL
USE
LOCATION
BLDG HEIGHT
90 ft
STEEL GRAVITY SYSTEM
FRAMING DENSITY
COLUMNS DENS
STEEL TON

STUDY B

BASE SHEAR

SEISMIC MASS:	50,157 kips
SEISMIC COEFFICIENT (CS):	0.19
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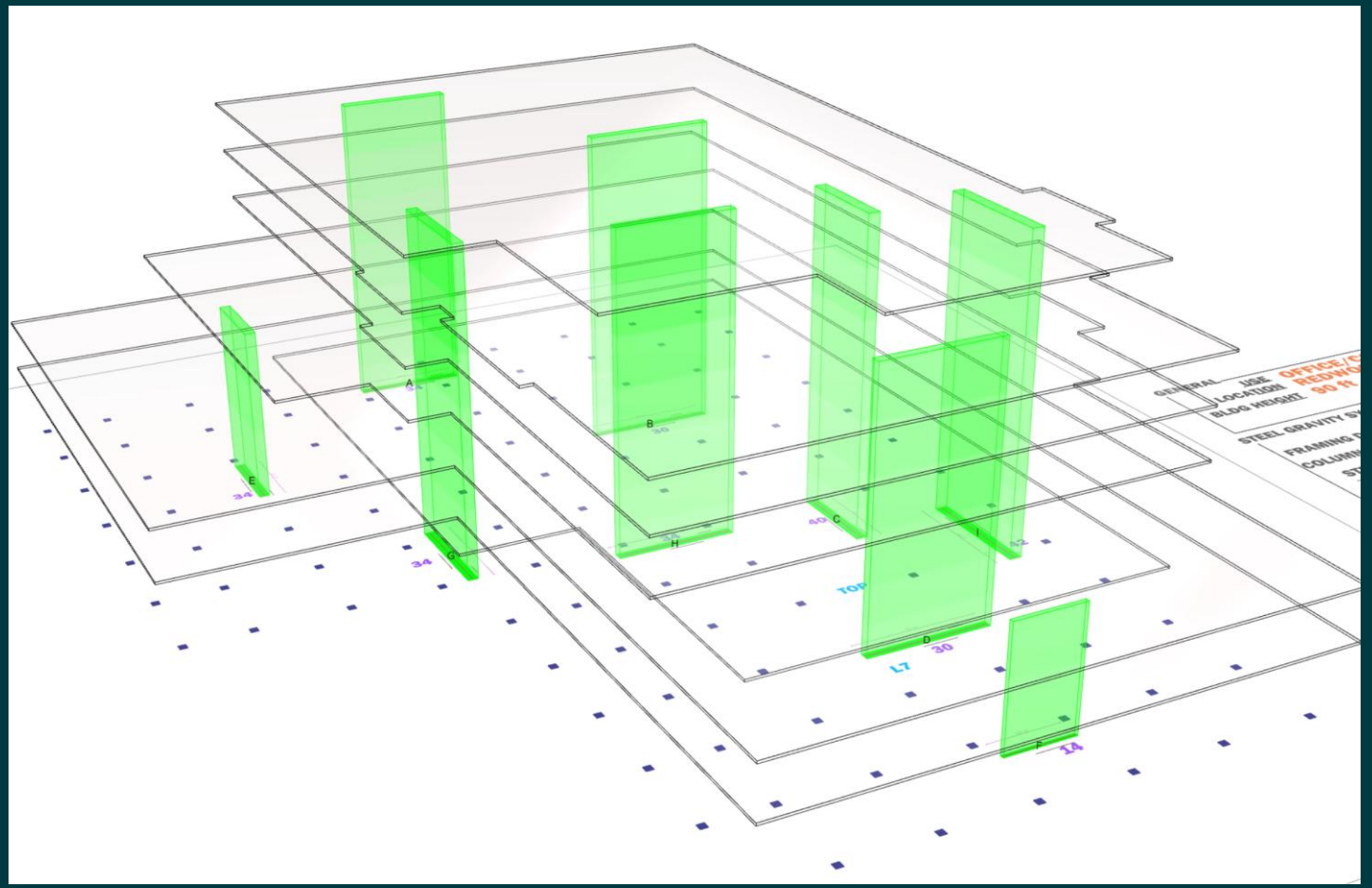
SUM OF X REACTIONS: 9529 kips
SUM OF Y REACTIONS: 9529 kips

LATERAL CHECKS

STRENGTH 0.7 DCR

DRIFT X: 0.7 % Y: 0.96 %

TORSION X: 1.17 Y: 1.06



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COST $14.61 M
$46/ft2

CO2 11067 tons
35 kgCO2/ft2

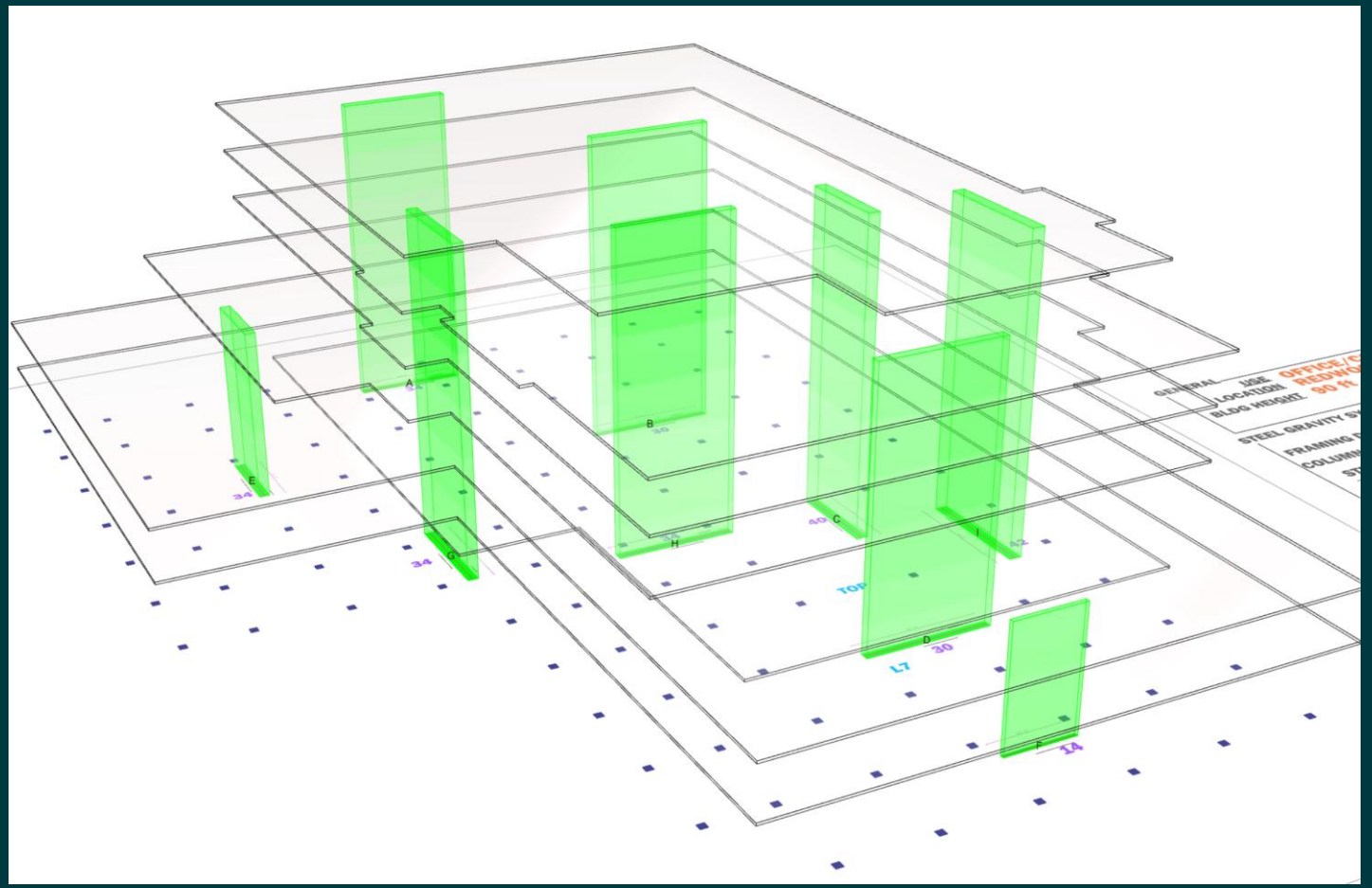
STEEL 1098 tons
GRAVITY, LATERAL, 25% CONNECTIONS FACTOR AND STEEL DECK
$1164/ton

CONCRETE 10742 yd3
SLABS, COMPOSITE FLOORS, WALLS AND COLUMNS
0.93 ft3/ft2

FOUNDATION

COST $13.77 M
$ 44 /ft2

CO2 7669 tons
24 kgCO2/ft2



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FOUNDATION

COST	$13.77 M	$ 44 /ft2
CO2	7669 tons	24 kgCO2/ft2

BLDG AREA

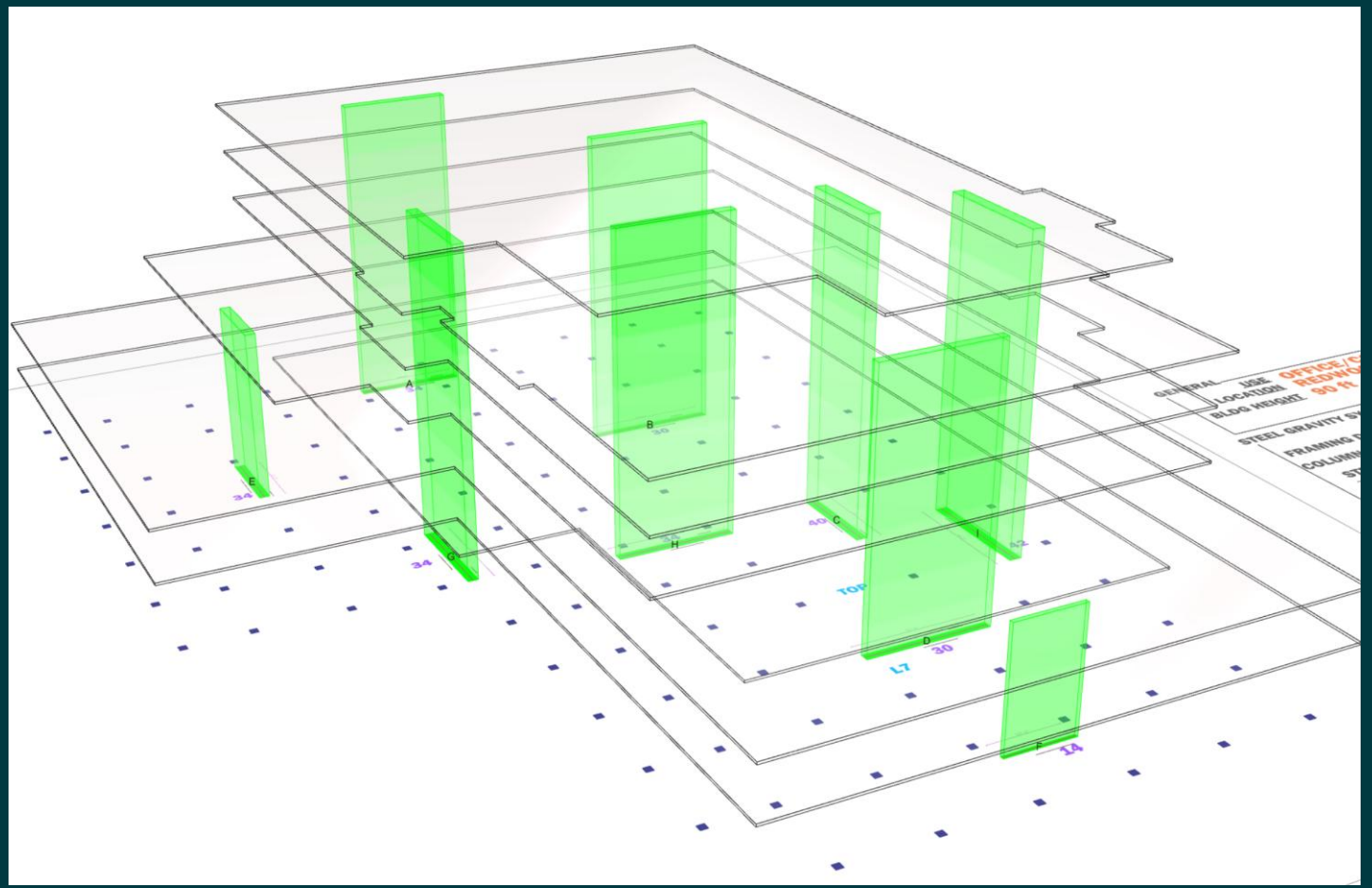
310,867 ft2

COST

$28.38 M

CO2

18,736 tons



RELATIVE COMPARISONS

STUDY A

BLDG AREA
310,867 ft2

COST
$29.73 M

CO2
19,322 tons

LATERAL CHECKS

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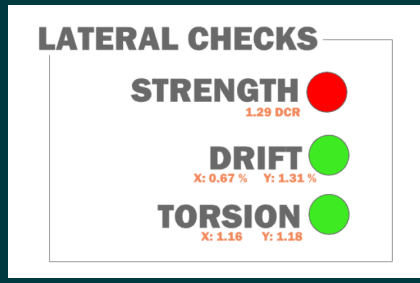

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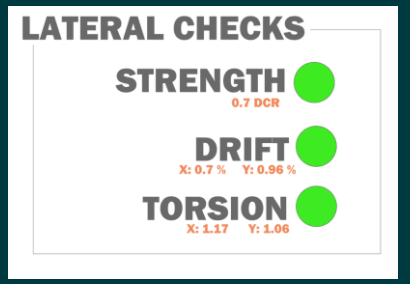


SAVINGS

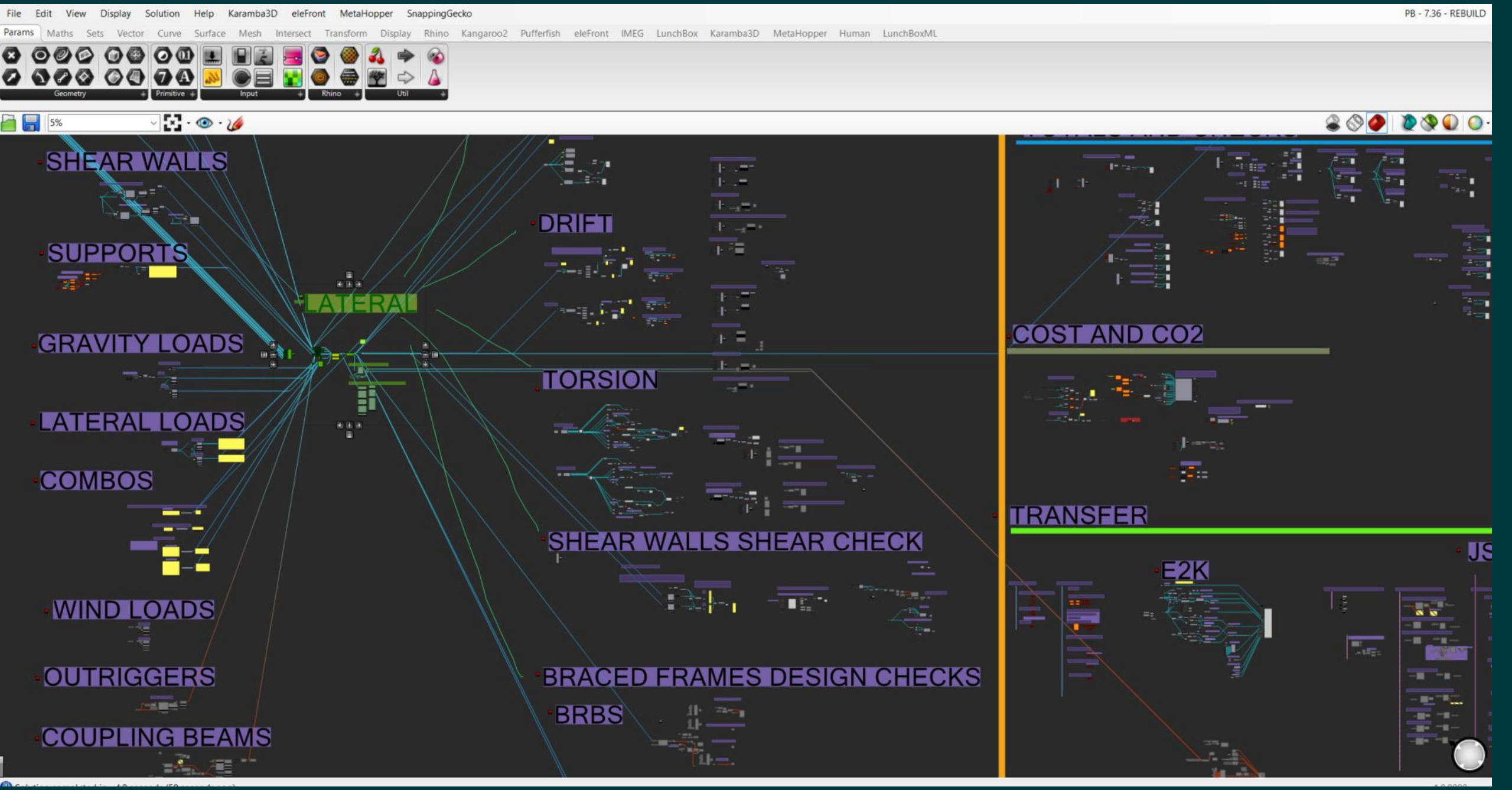
COST

$1.35 M

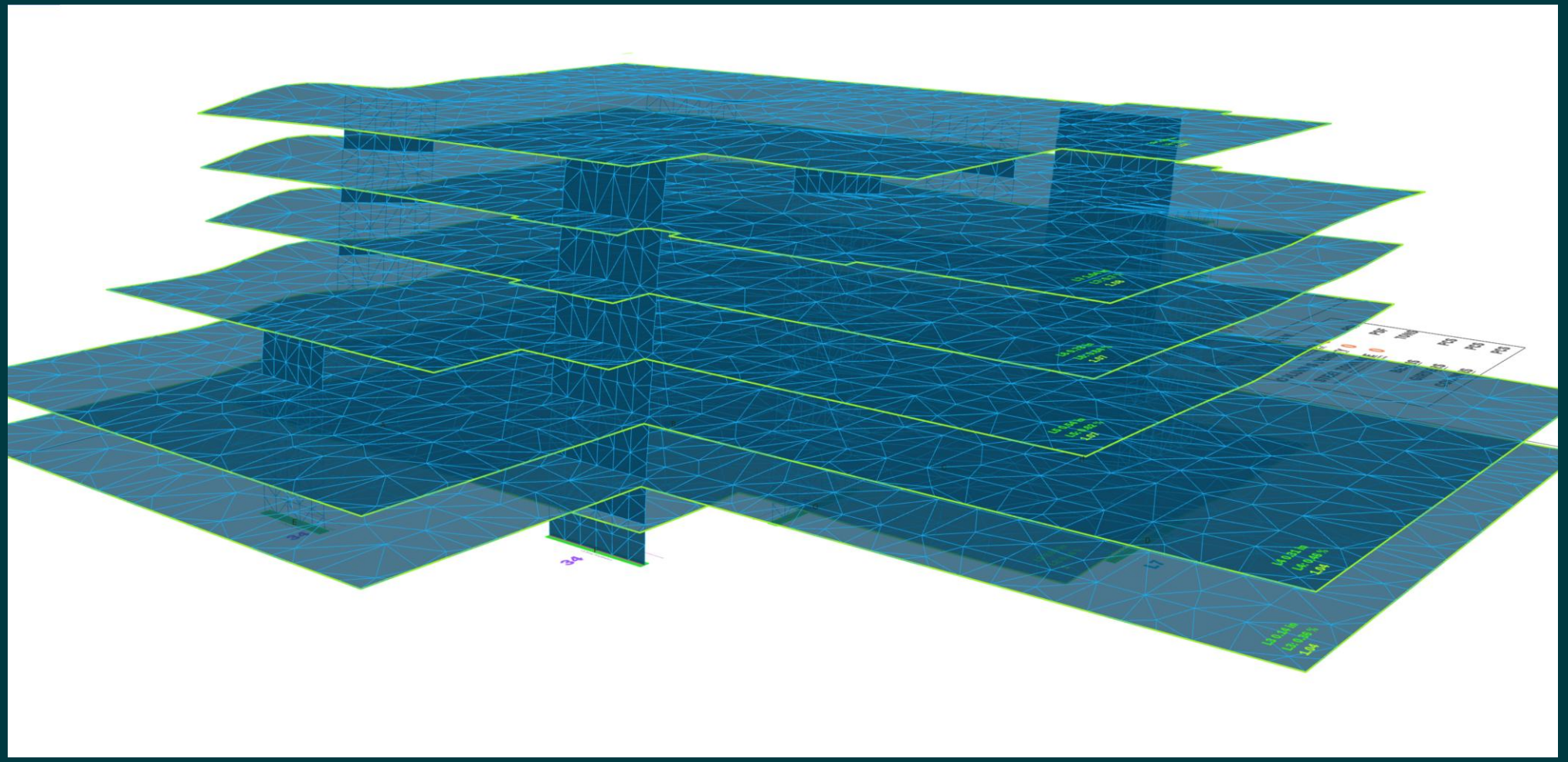
CO2

586 tons

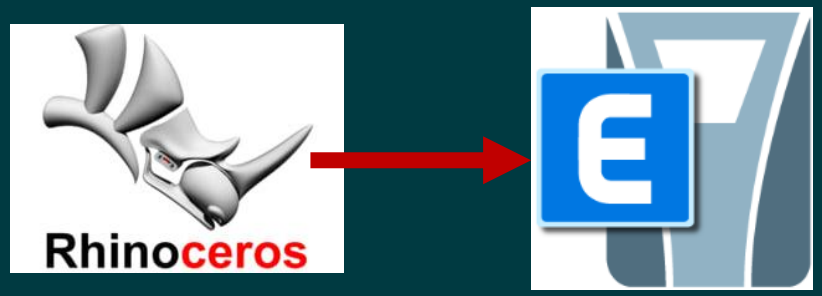
LOGIC CONSTRAINTS AND DEVELOPMENT


File Edit View Display Solution Help Karamba3D eleFront MetaHopper SnappingGecko
PB - 7.36 - REBUILD
Params Maths Sets Vector Curve Surface Mesh Intersect Transform Display Rhino Kangaroo2 Pufferfish eleFront IMEG LunchBox Karamba3D MetaHopper Human LunchBoxML
Geometry Primitive Input Rhino Util
5%
SHEAR WALLS
SUPPORTS
LATERAL
GRAVITY LOADS
LATERAL LOADS
COMBOS
WIND LOADS
OUTRIGGERS
COUPLING BEAMS
DRIFT
TORSION
SHEAR WALLS SHEAR CHECK
BRACED FRAMES DESIGN CHECKS
BRBS
COST AND CO2
TRANSFER
E2K

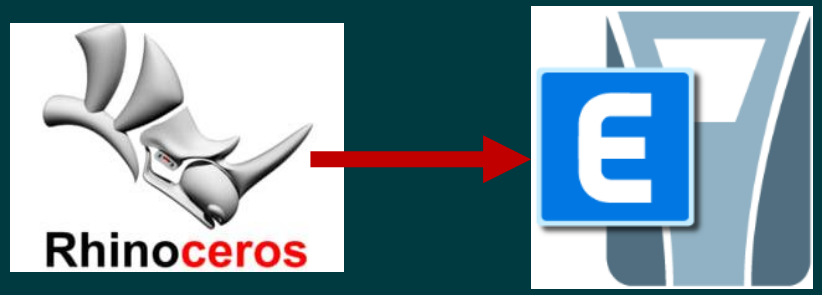
COMPUTATIONAL POWER STRUGGLE



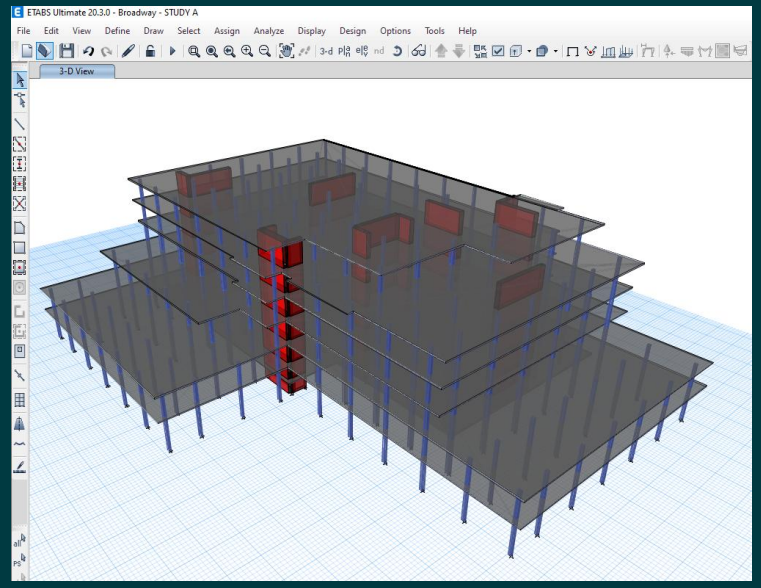
INTEROPERABILITY



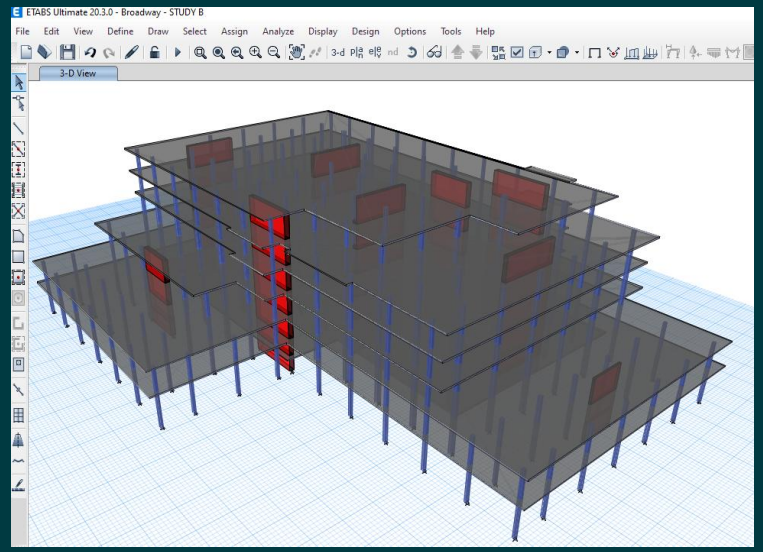
INTEROPERABILITY



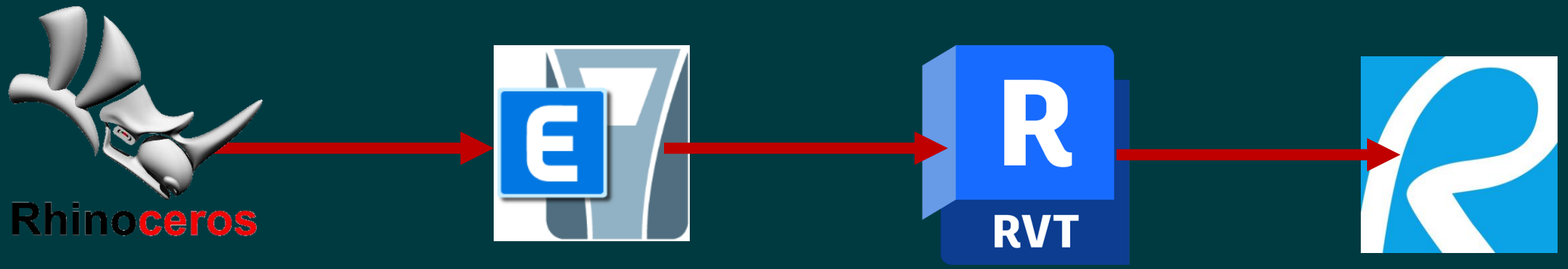
STUDY A



STUDY B



INTEROPERABILITY



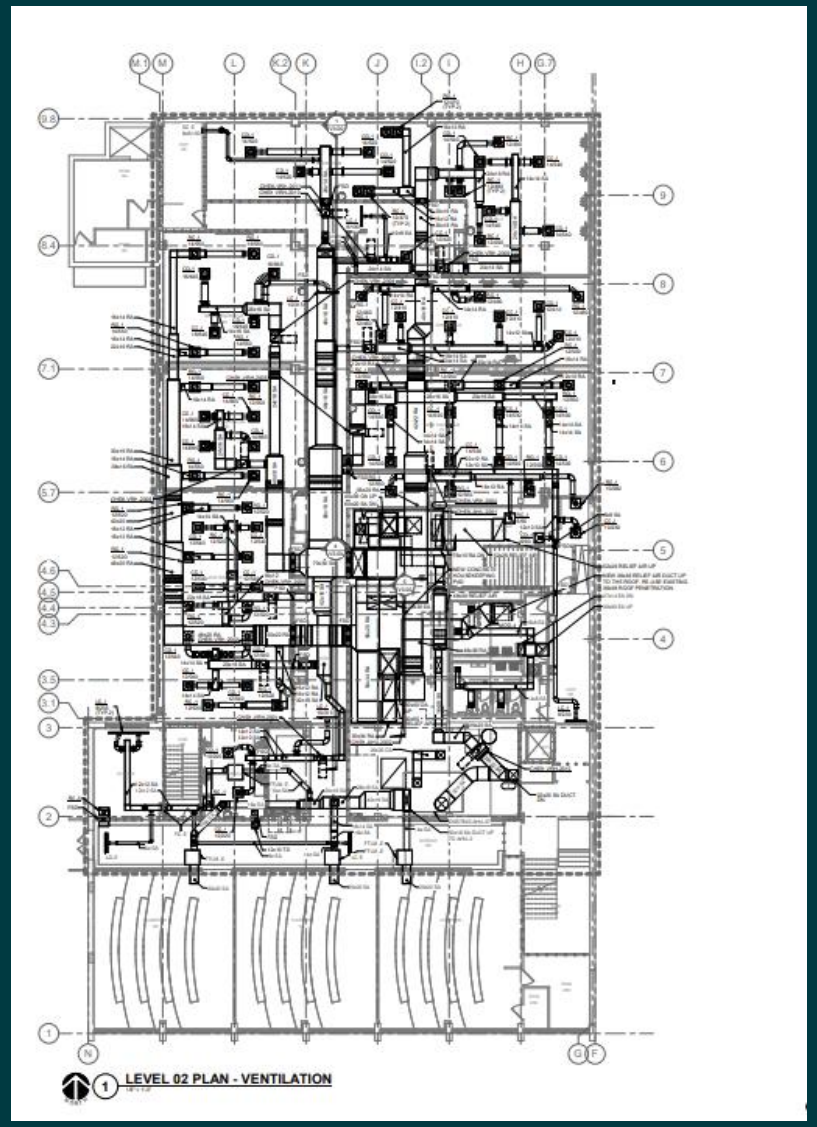
POLL

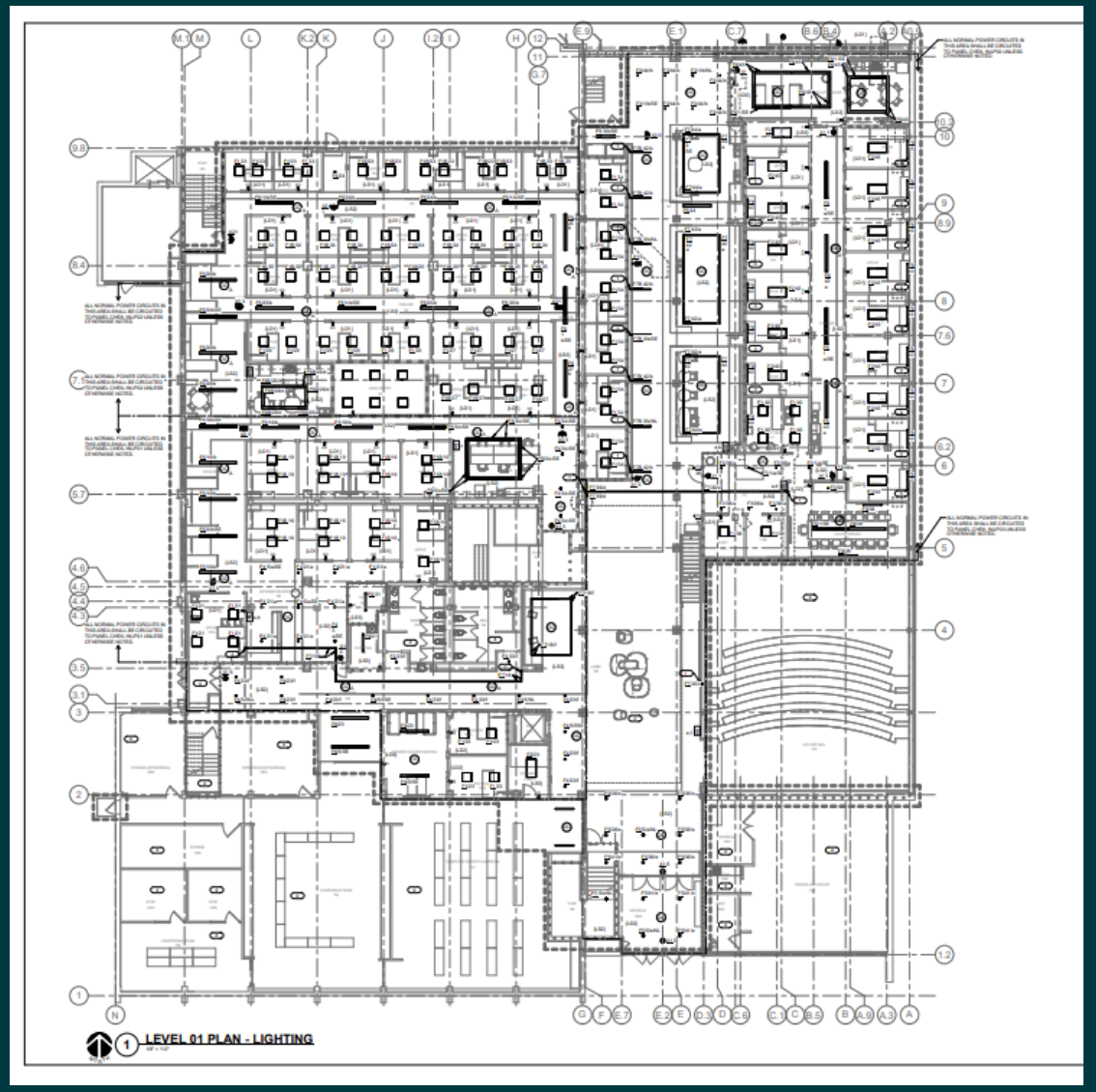
Who do you think benefits the most from quickly exploring and assessing possibilities in the early design stages?

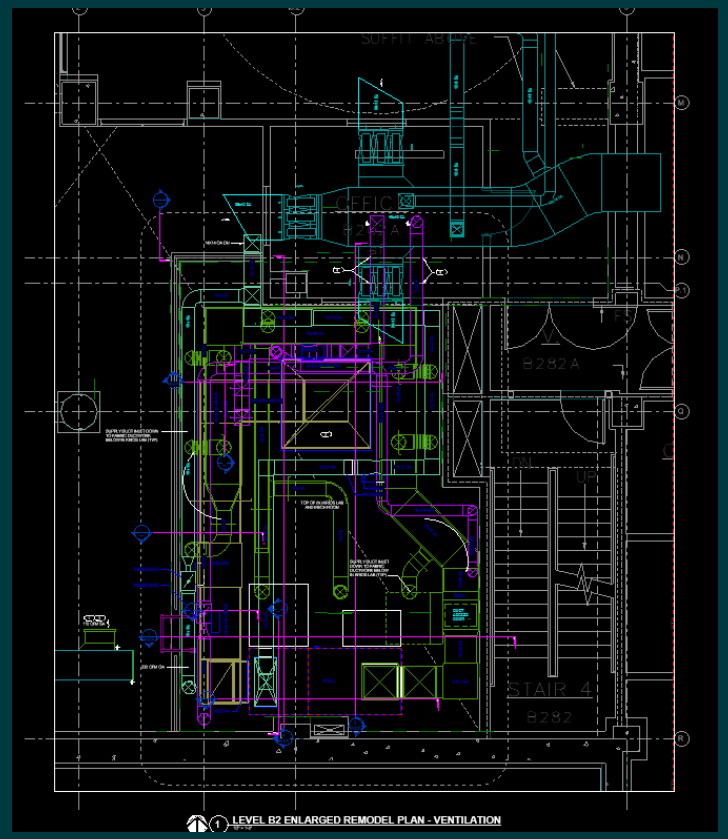
A) ARCHITECTS
B) STRUCTURAL ENGINEERS
C) CLIENTS
D) GENERAL CONTRACTORS

IMMERSIVE TECHNOLOGY

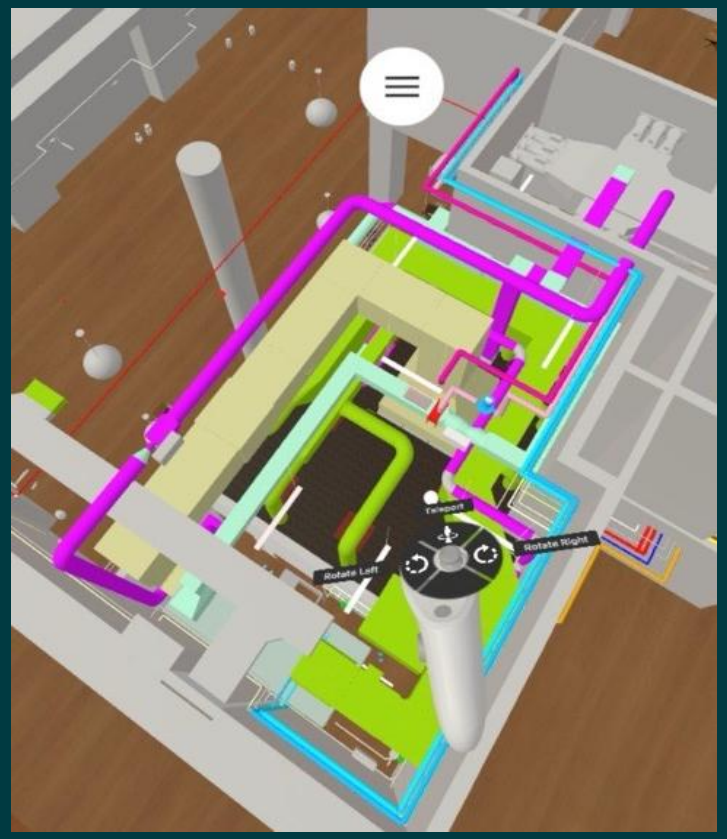
FLOORPLANS



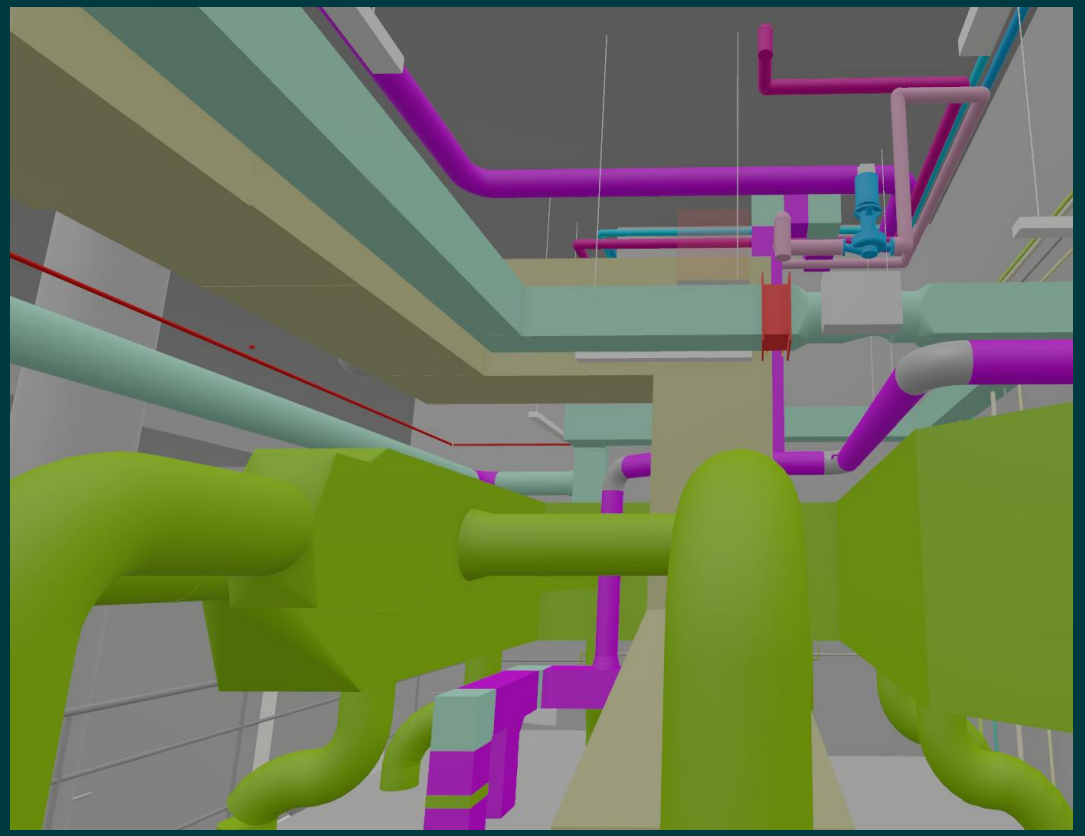




2D



3D scaled down



3D 1:1


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

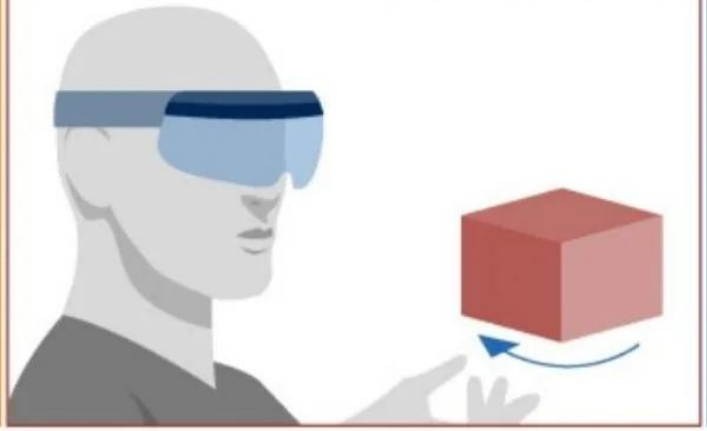
XR (Extended Reality)

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)

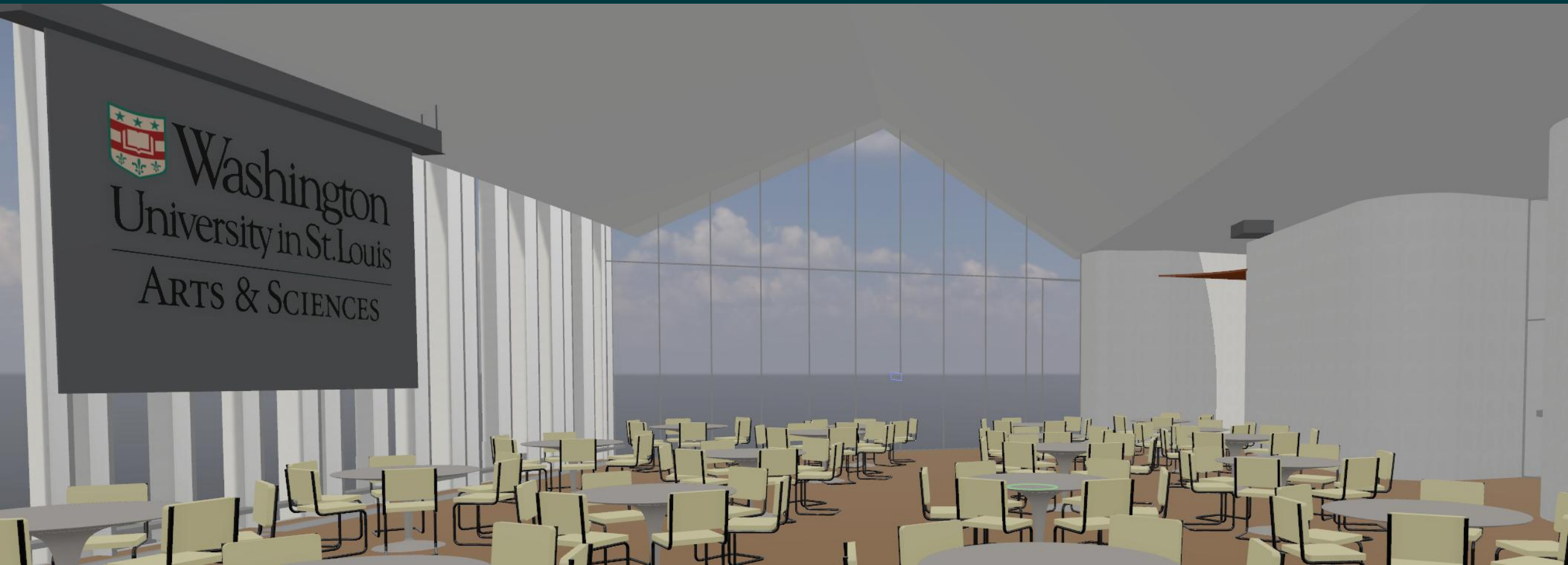


User interacts with responsive virtual elements integrated into the real environment

VR
(Virtual Reality)

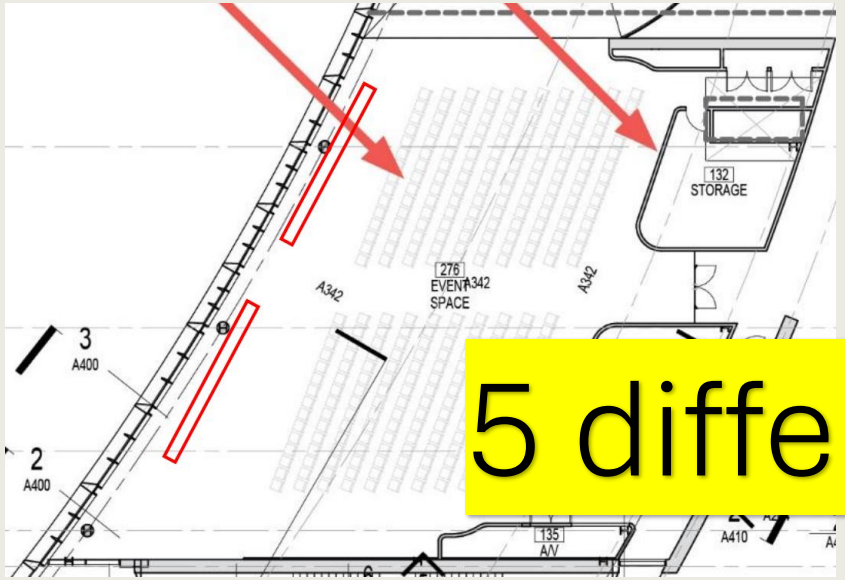
User is immersed in an interactive, digitally-generated environment

XR IN ACTION: DESIGNING

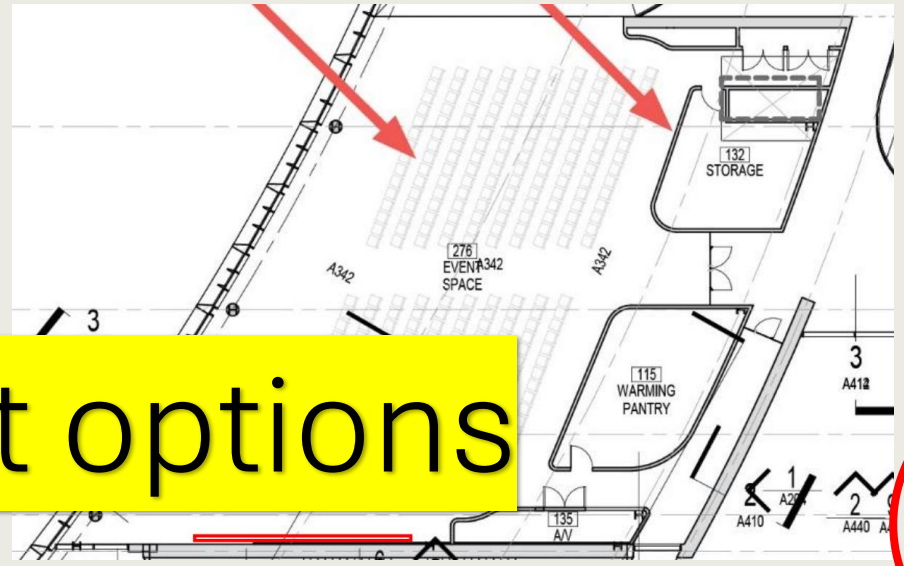


DESIGN OPTIONS PURPOSED

Option 1&2:



Option 3:



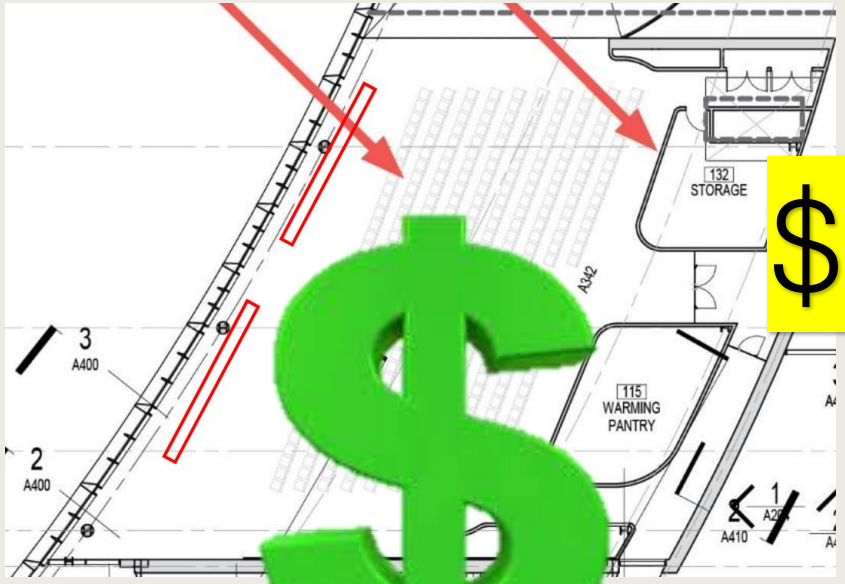
5 different options

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+

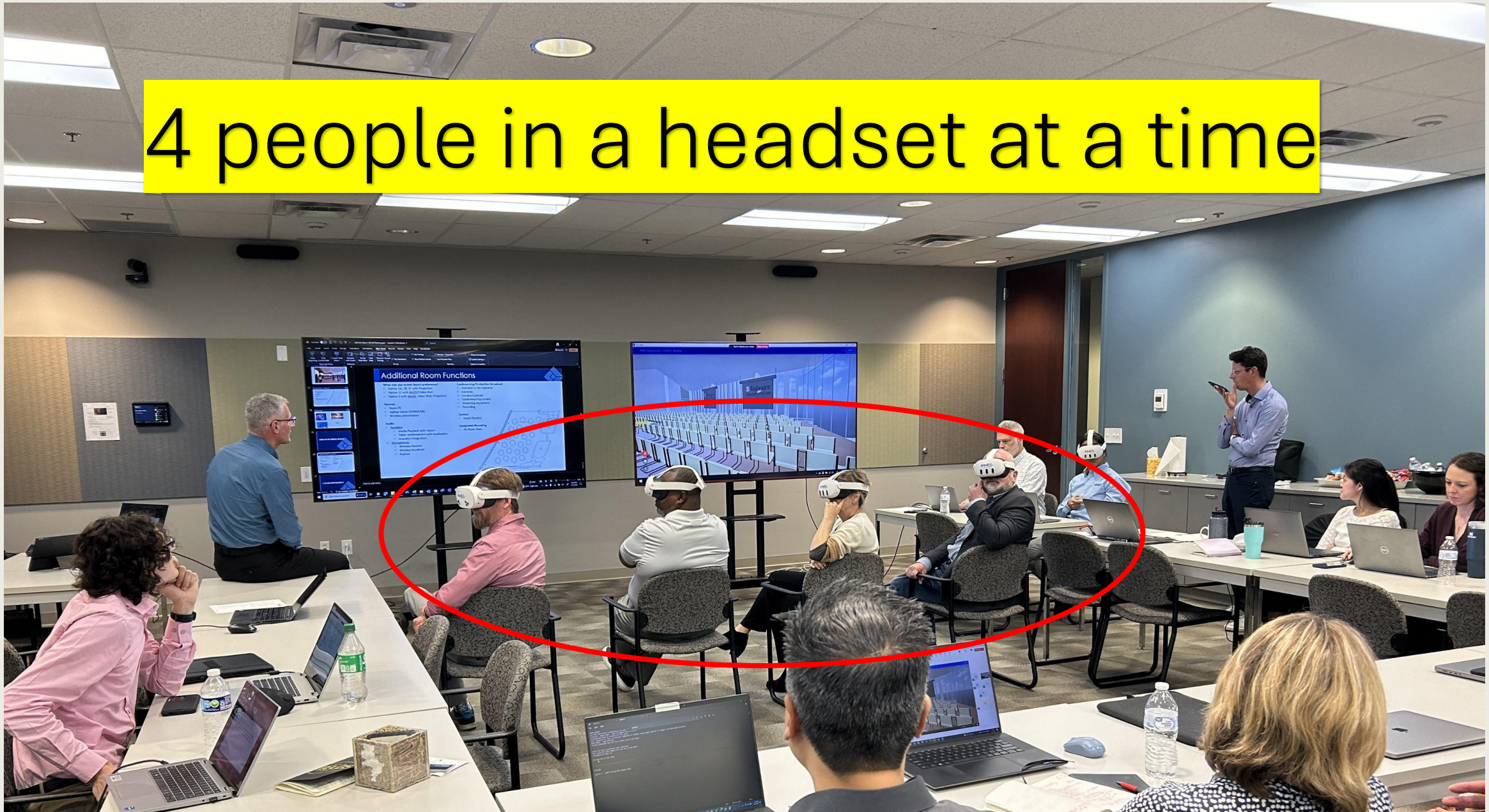
Option 3:

Screen Size

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

VR MEETING

VR MEETING



VR MEETING

Event Space

Event Space

RESULTS

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

Faster decision making

More confident decision making

Feedback

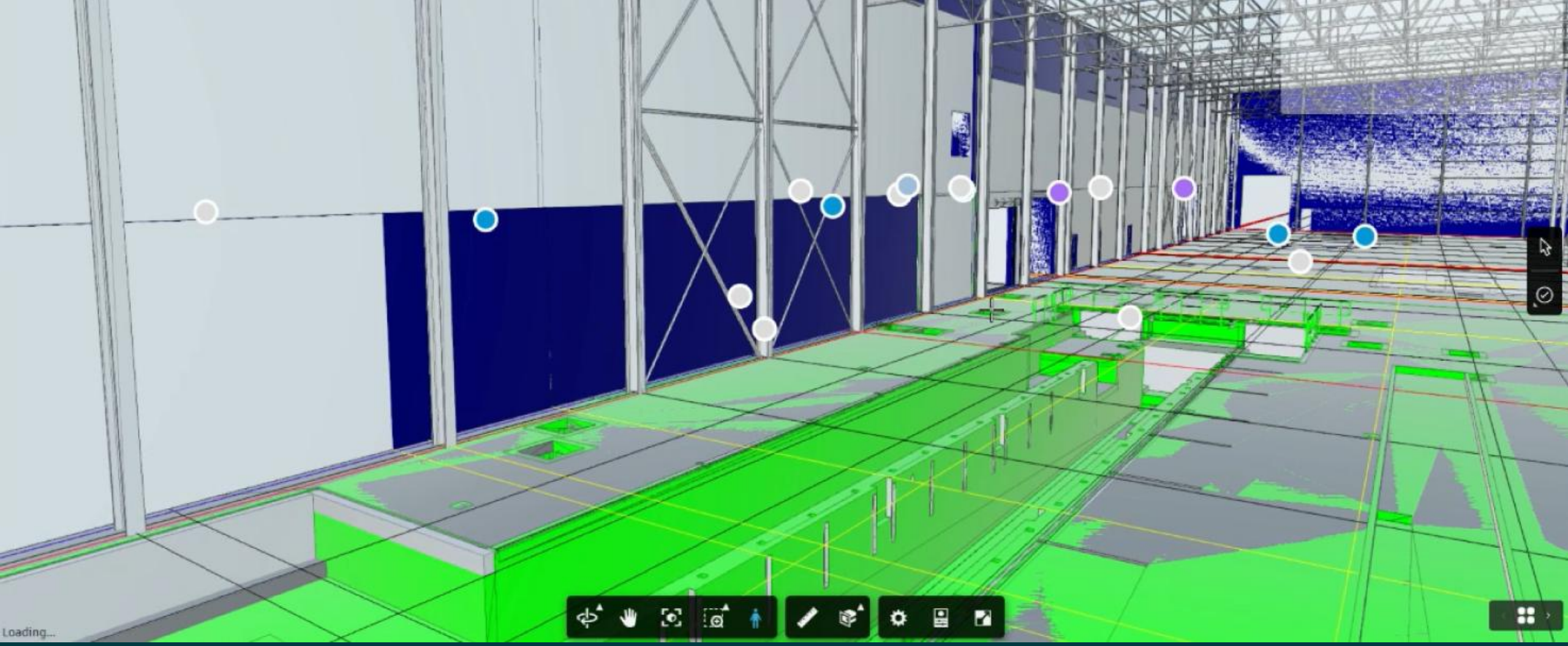
Scored 9.5/10

10 = Very Helpful

Would you like to utilize VR on future projects?

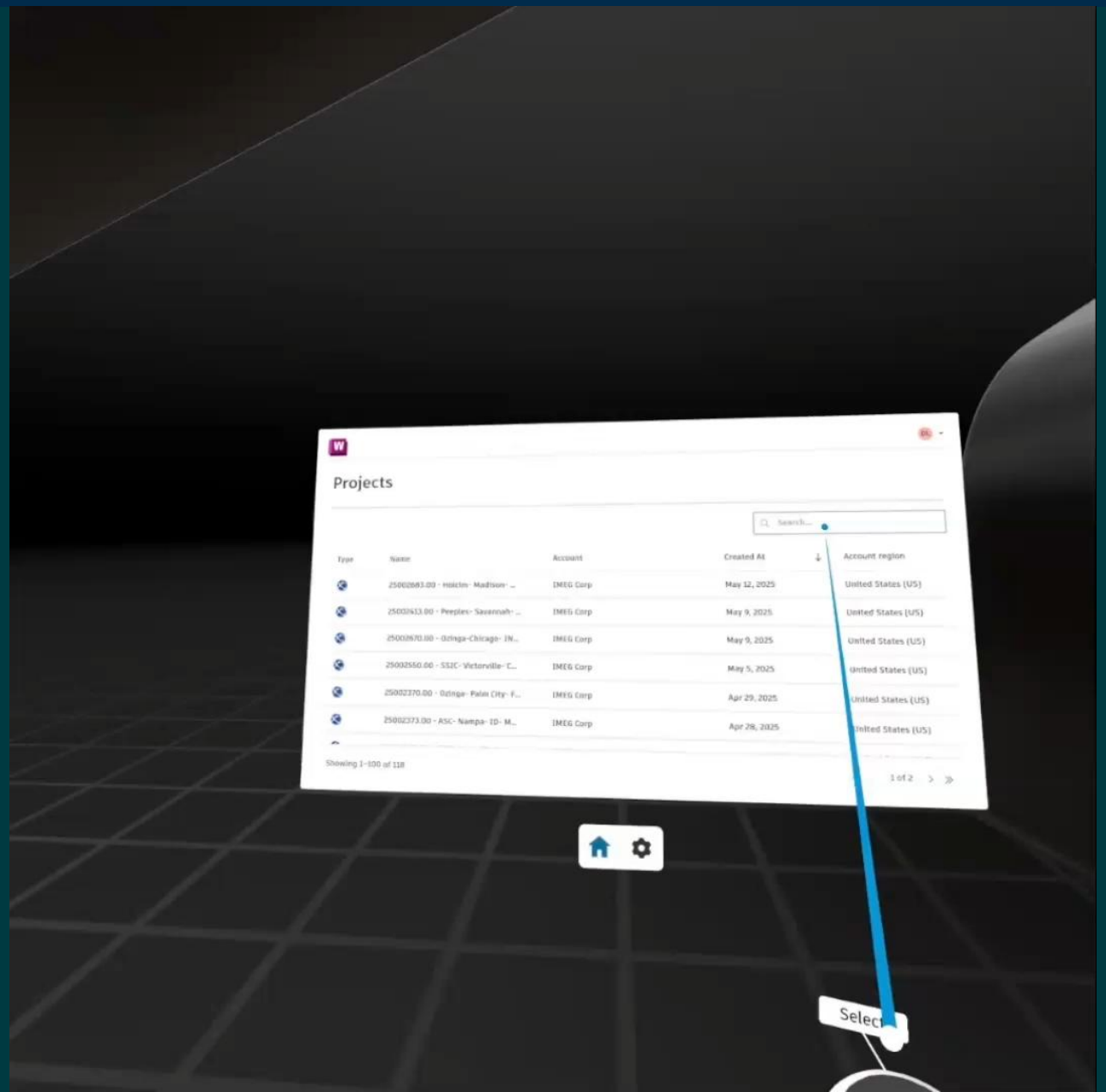
100% said "Yes"

- ***"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"***

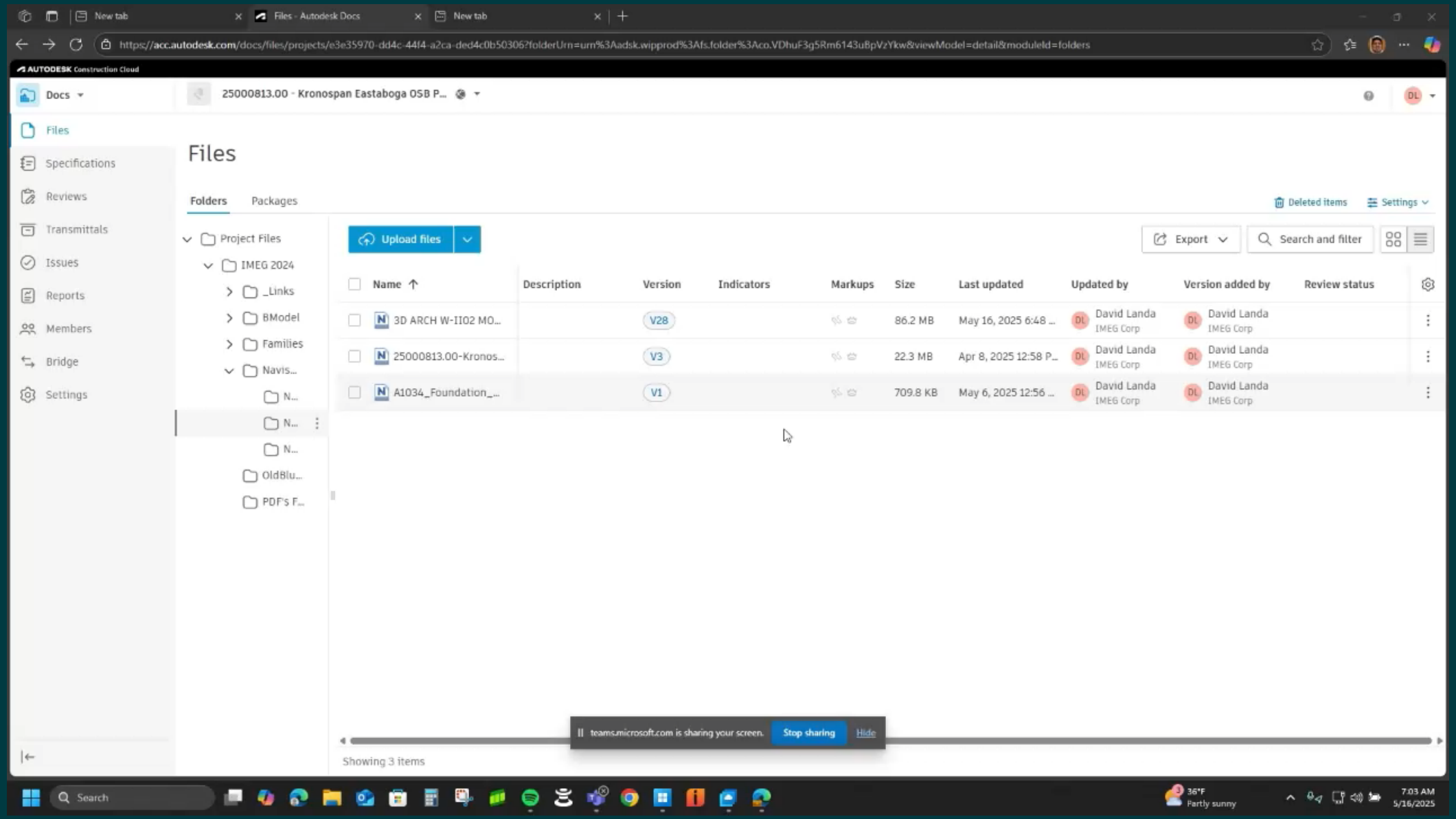


XR IN ACTION: REVIEWING

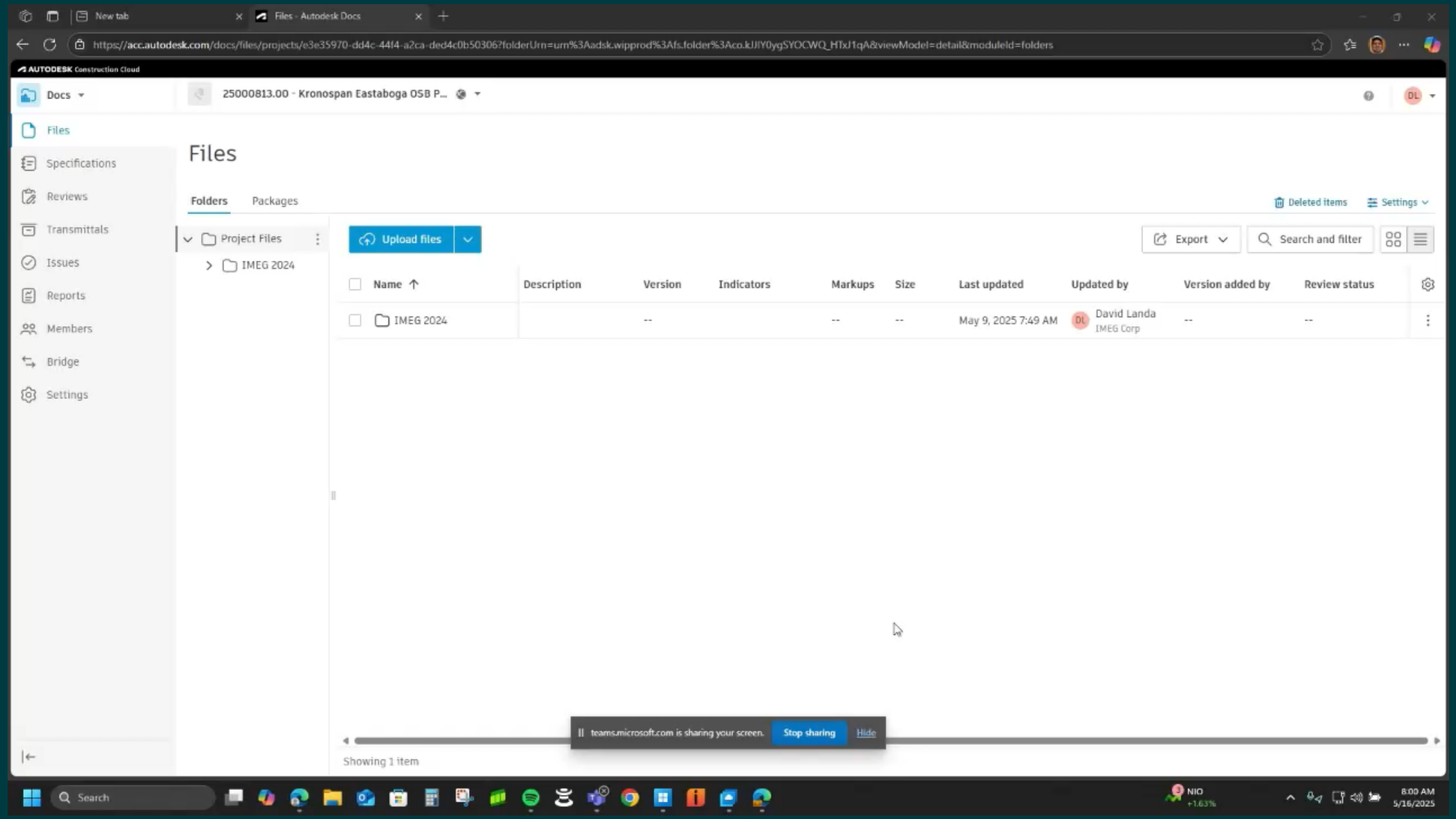
XR Design Review



Collaboration



ACC Issues List



RESULTS

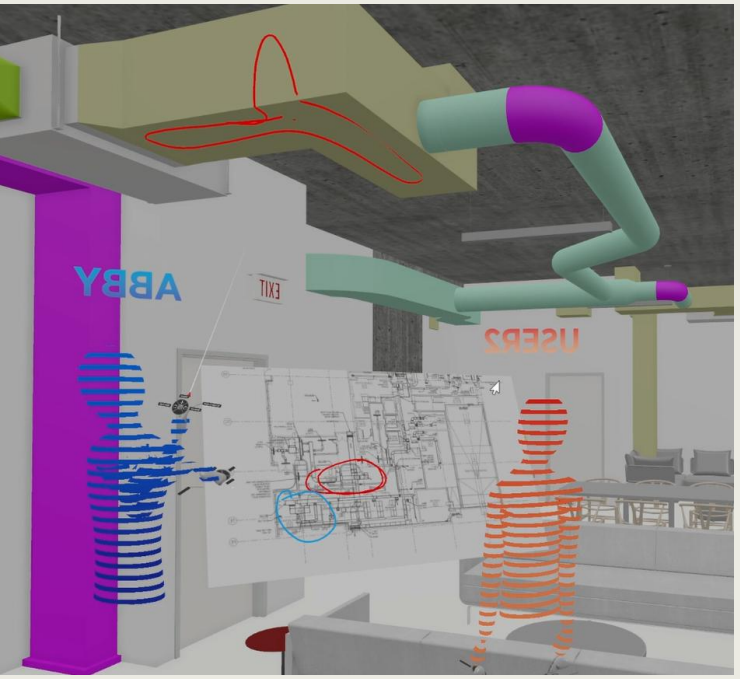
VR walkthrough at least **once a week**

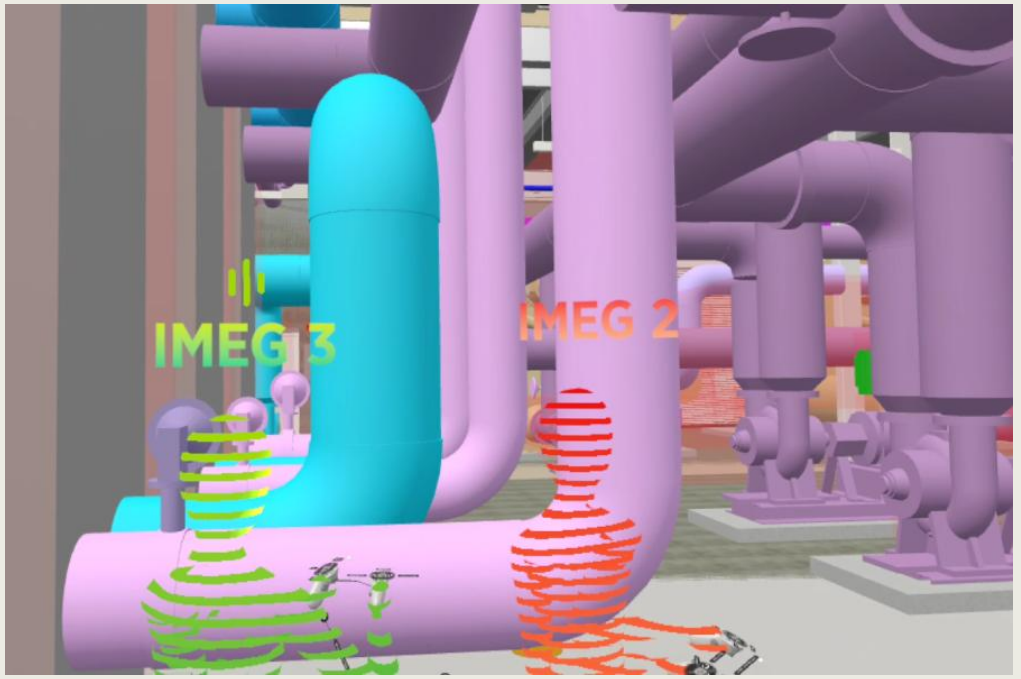
2-3 errors per VR walkthrough

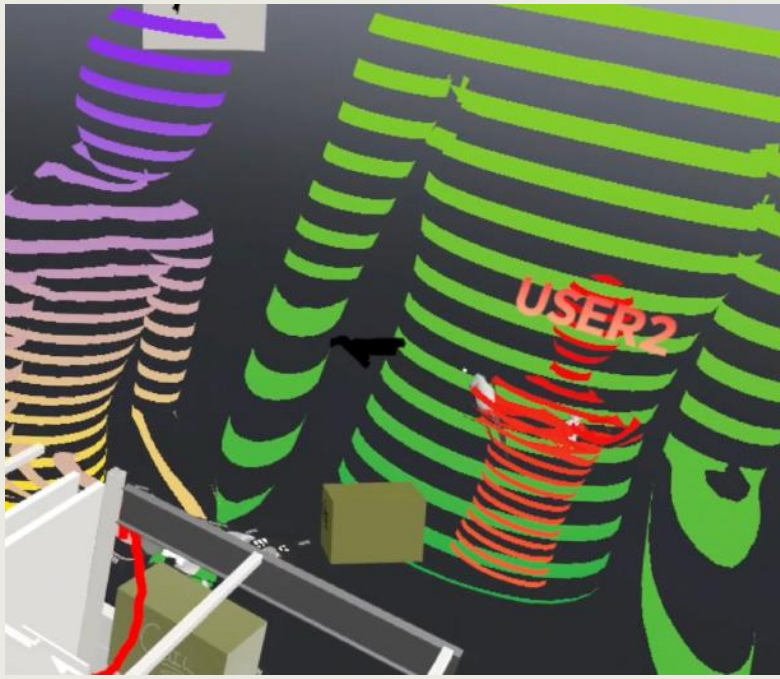
100+ issues per project

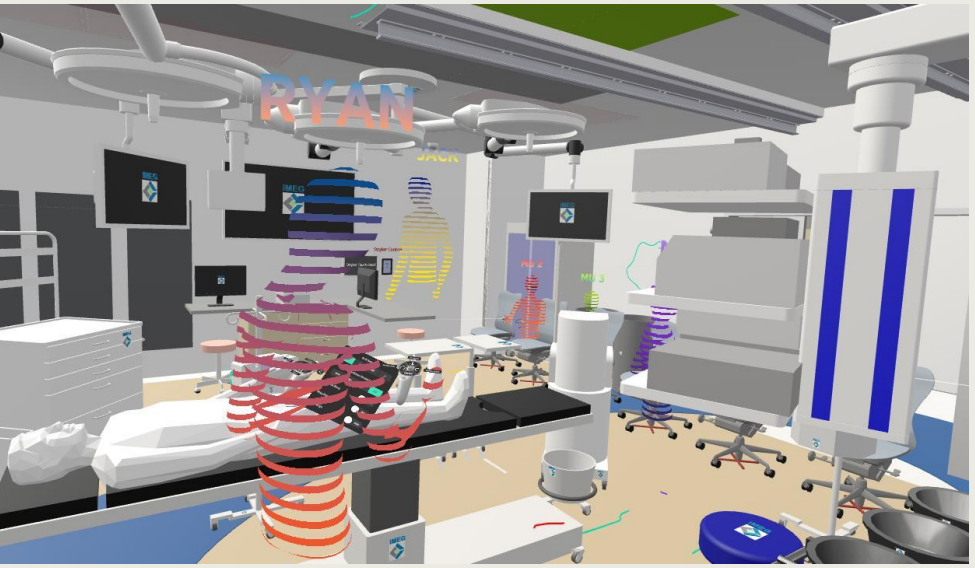
$150,000+ saved per project

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

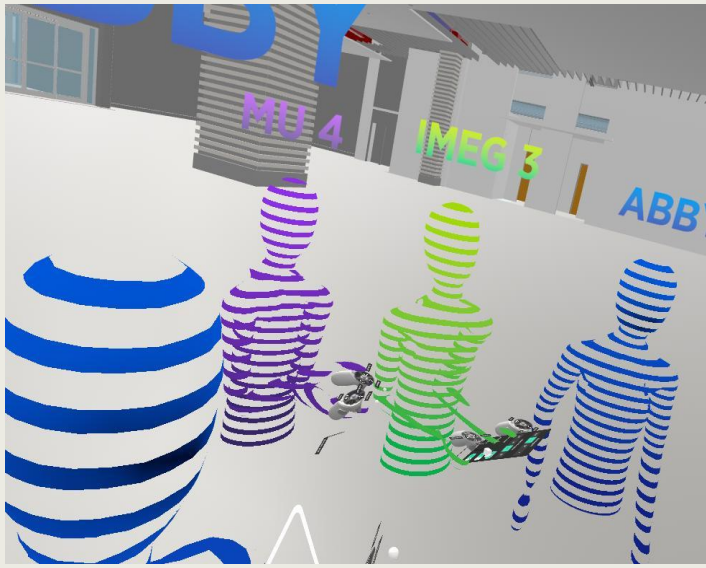

ABBY
EXIT
USER2


IMEG 3
IMEG 2

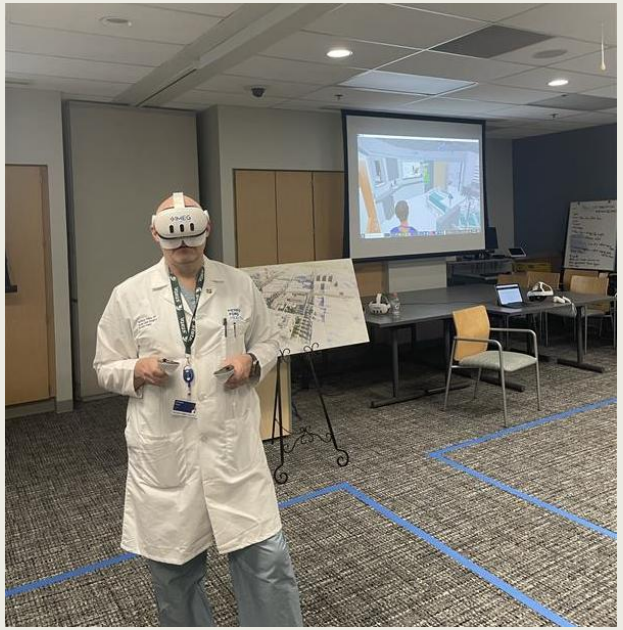

USER2


RYAN

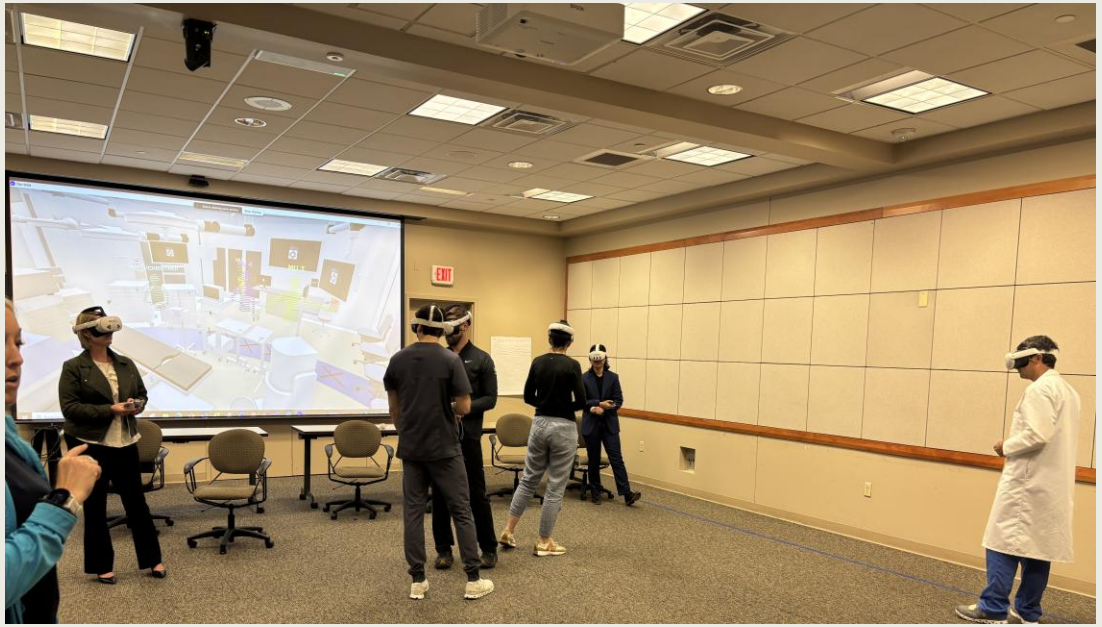

JACOB


MU 4
IMEG 3
ABB


Additional Room Functions




LIVE FROM DETROIT
06.06.24
Michigan Central
AND
GREAT WESTERN
DETROIT
CHICAGO


EXIT

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.

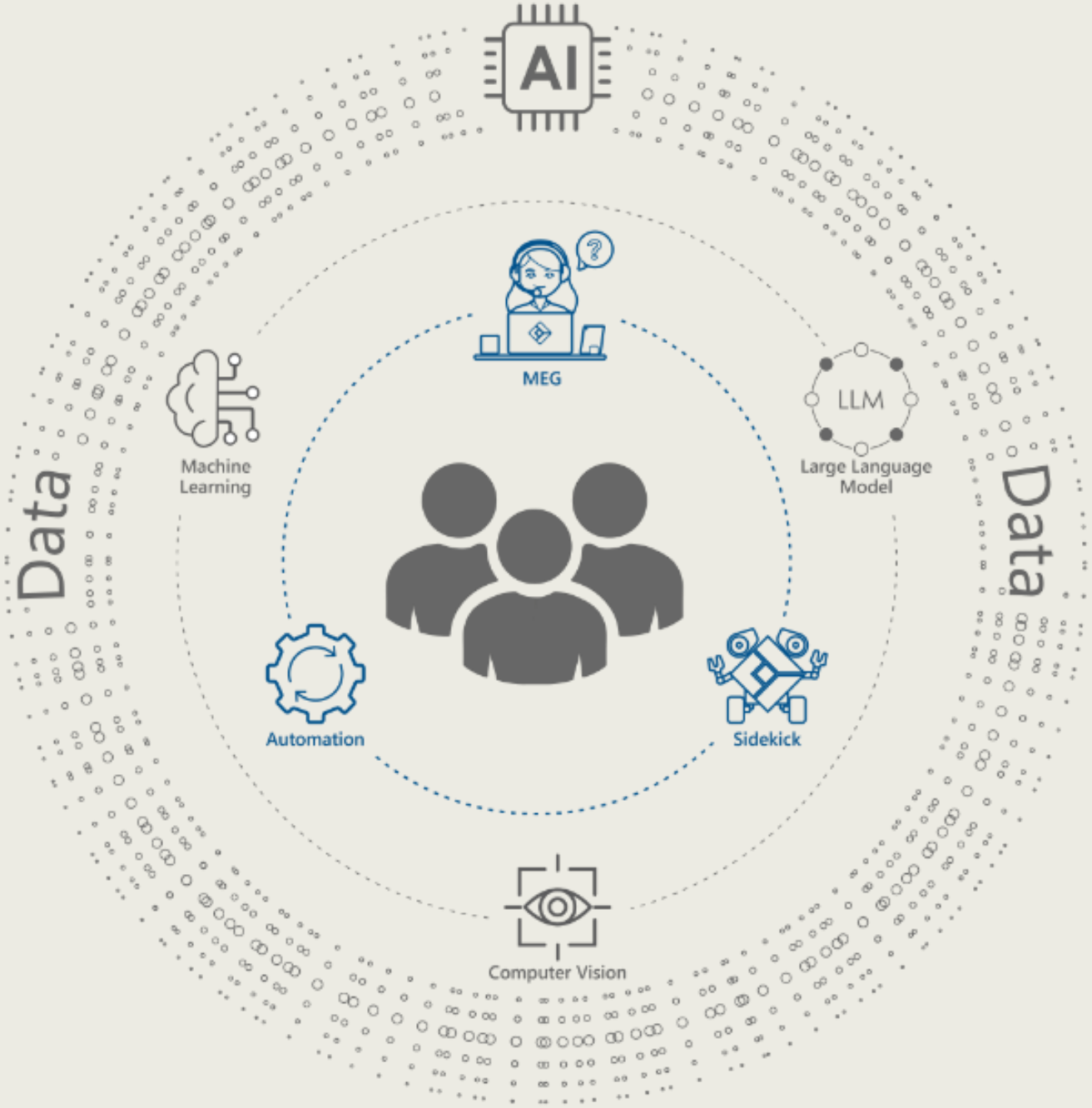
AI CAPABILITIES

Good

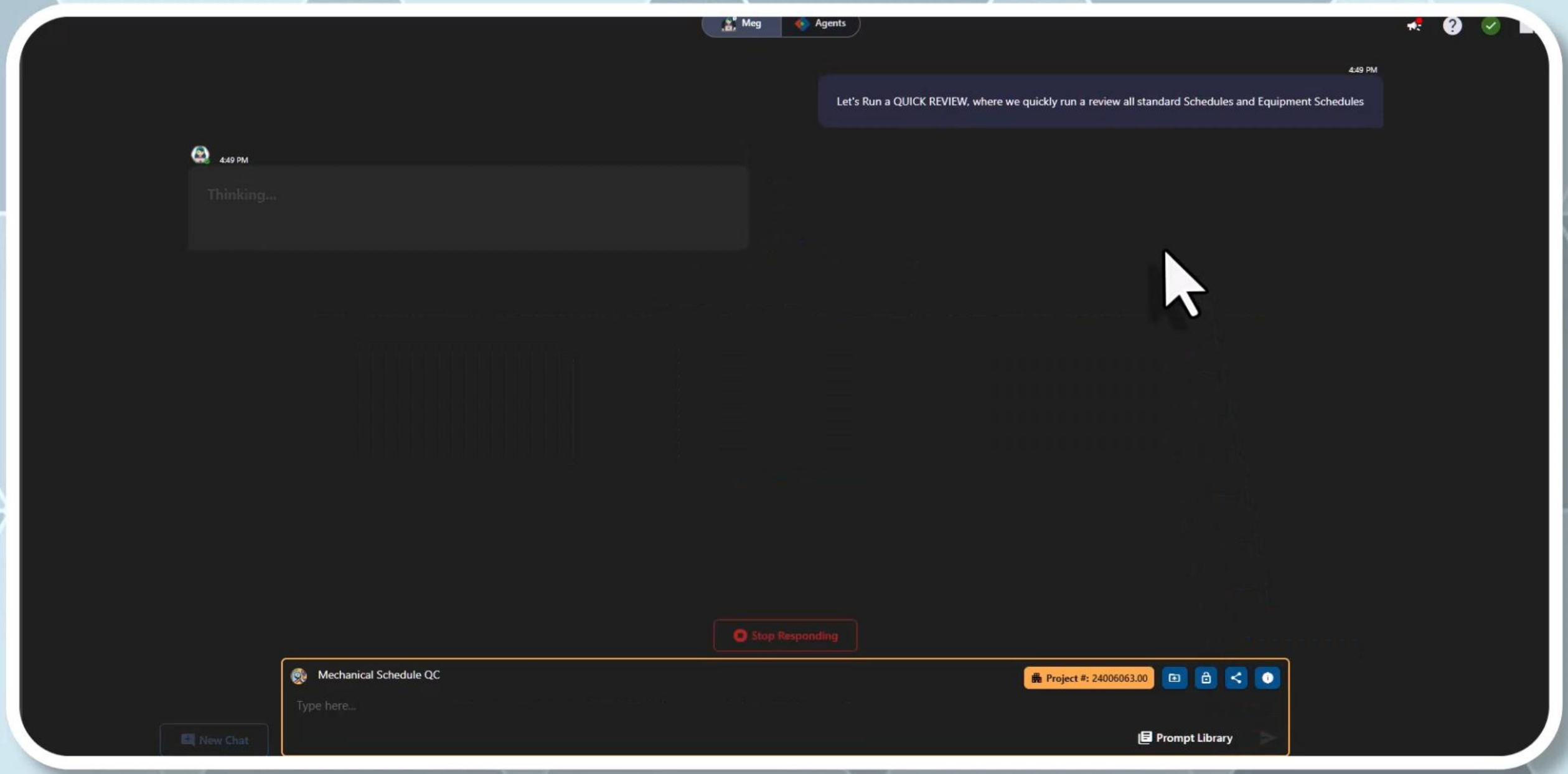
- Repetitive tasks & first-pass reviews
- Spotting errors, patterns, and trends quickly
- Turning complex data into simple outputs

Bad

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

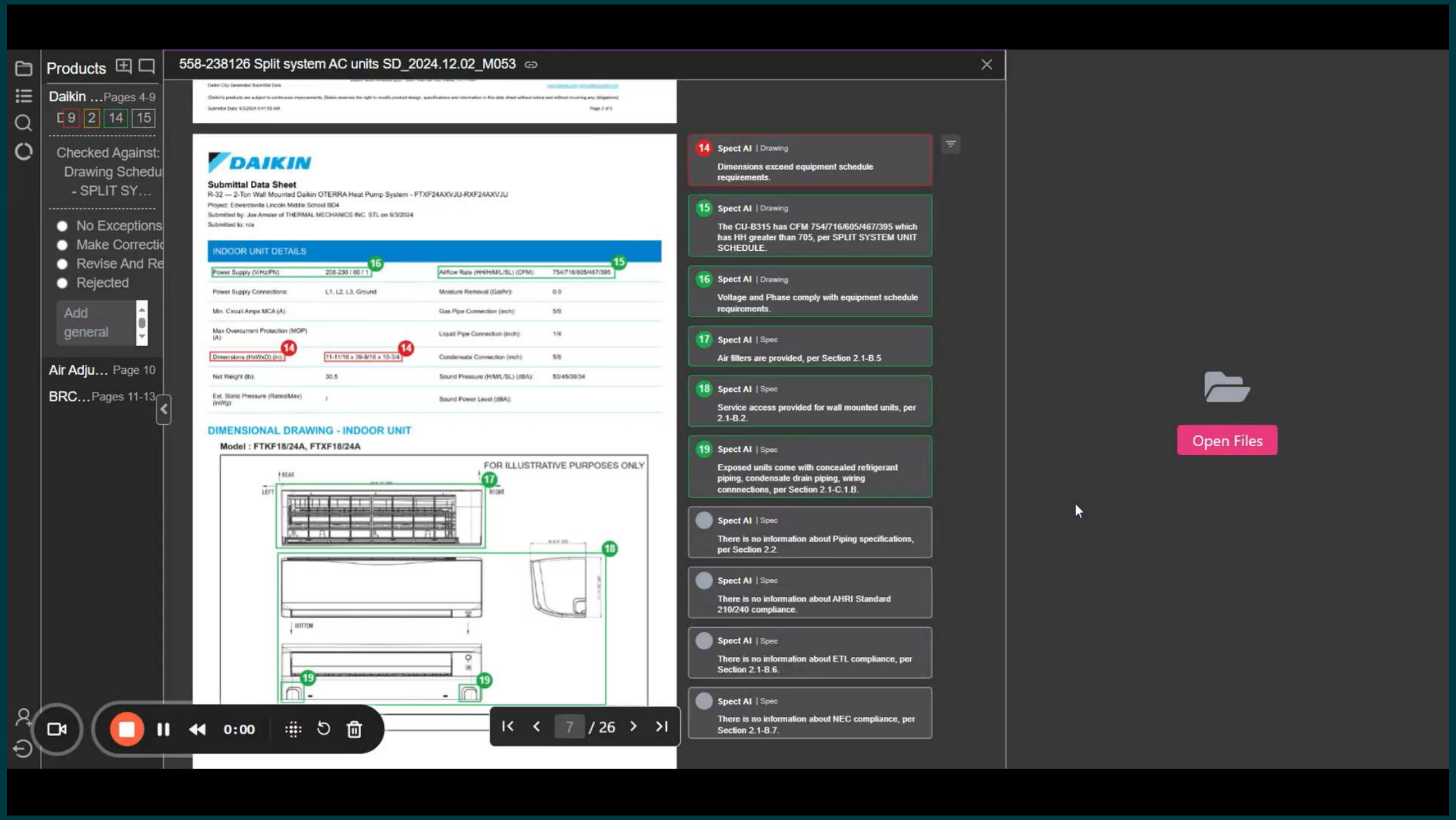

AI
MEG
Machine Learning
LLM
Large Language Model
Data
Data
Automation
Sidekick
Computer Vision

CUSTOM QA/QC AGENT



FIND THE DIFFERENCE

AI SHOP DRAWING REVIEW



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.

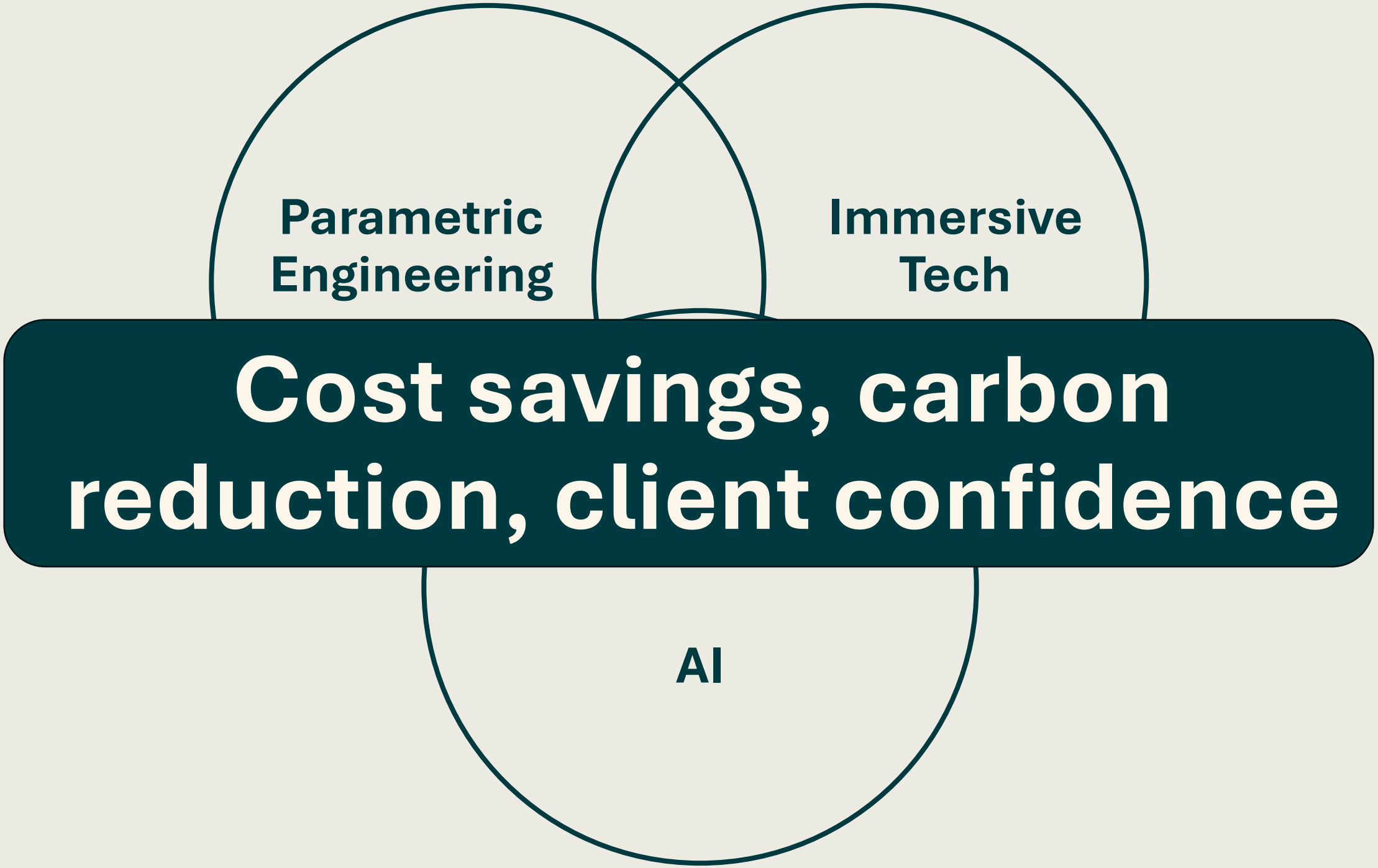
Deficiencies:

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 REPORTS

AI INTEGRATION

- Catching errors early
- Reducing rework
- Saving time
- Cost efficiency


Parametric Engineering
Immersive Tech
AI
Cost savings, carbon reduction, client confidence


Veo

QUESTIONS