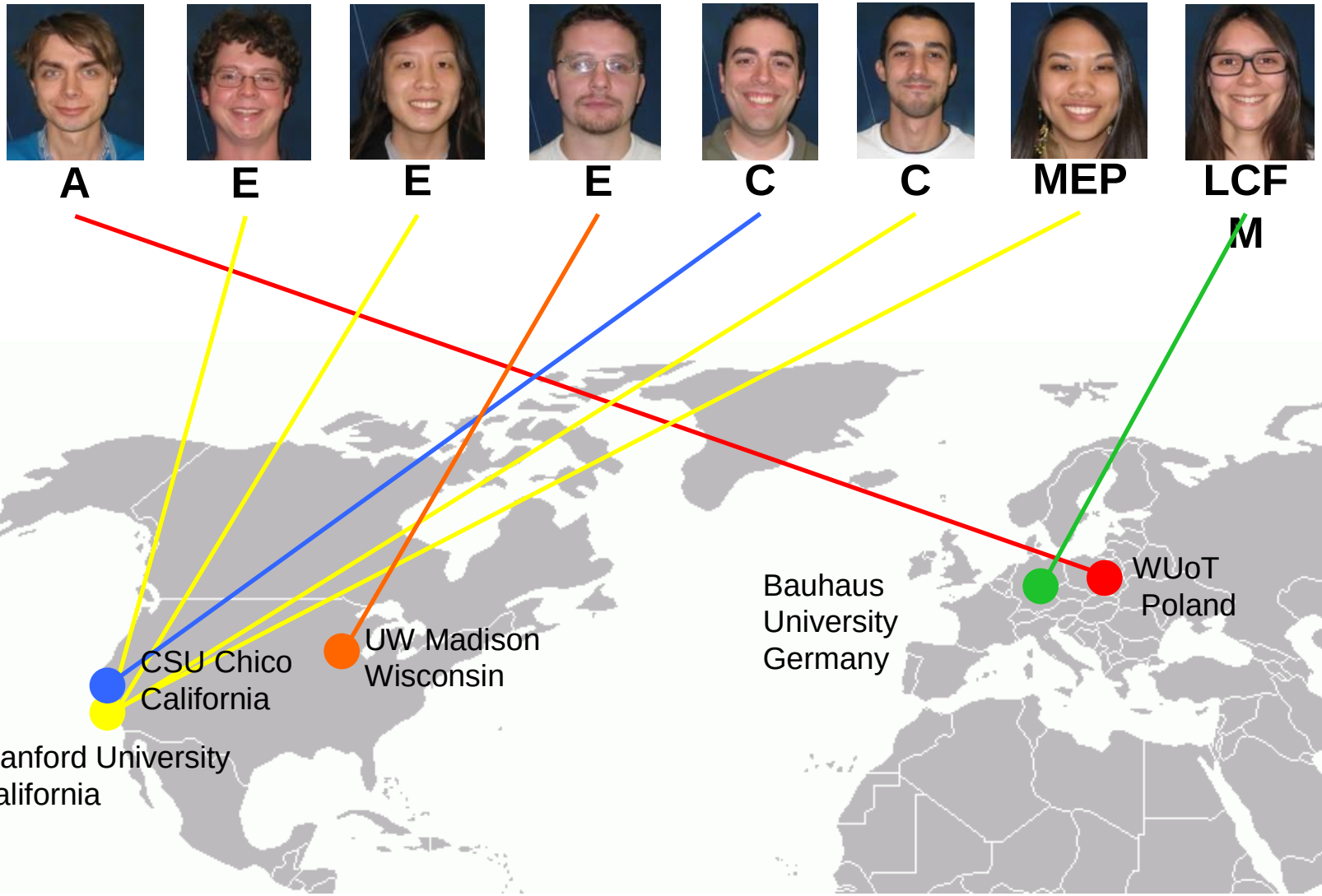
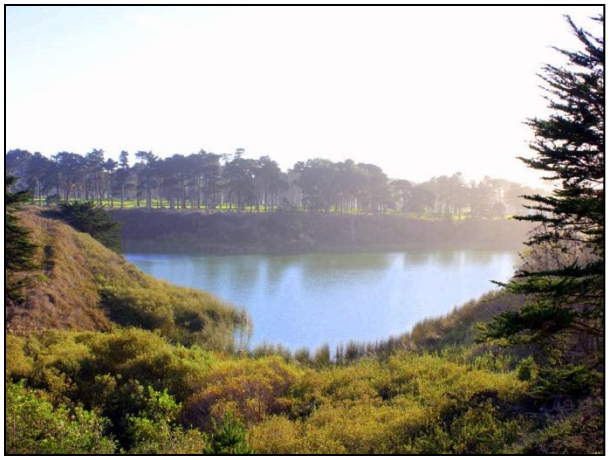
TEAM PACIFIC

Team Pacific



A E C M L

Site- San Francisco State University



Lake View

San Francisco State Campus

Our Site

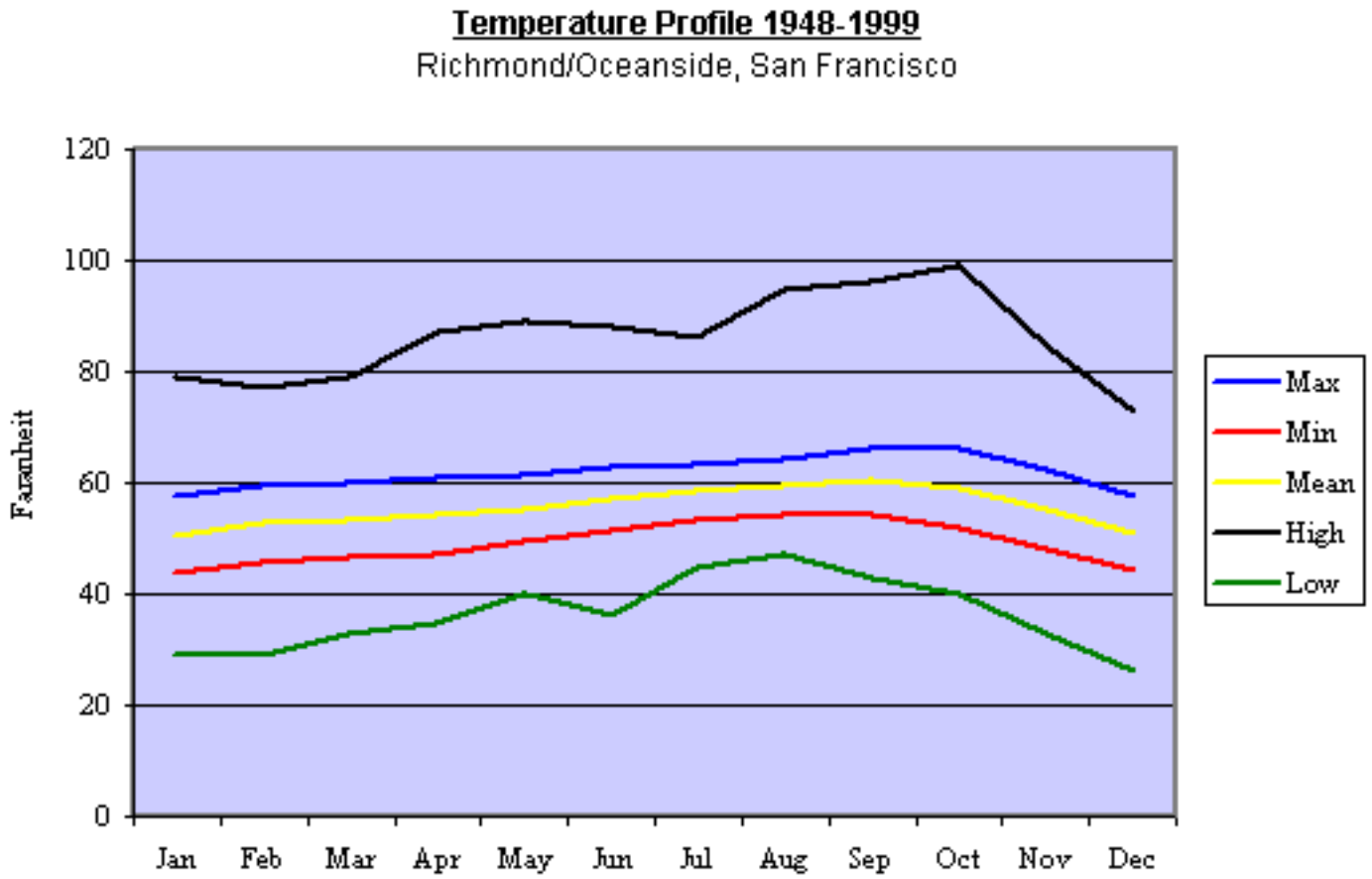
Seismic Challenge

A E C M L

Wind Rose

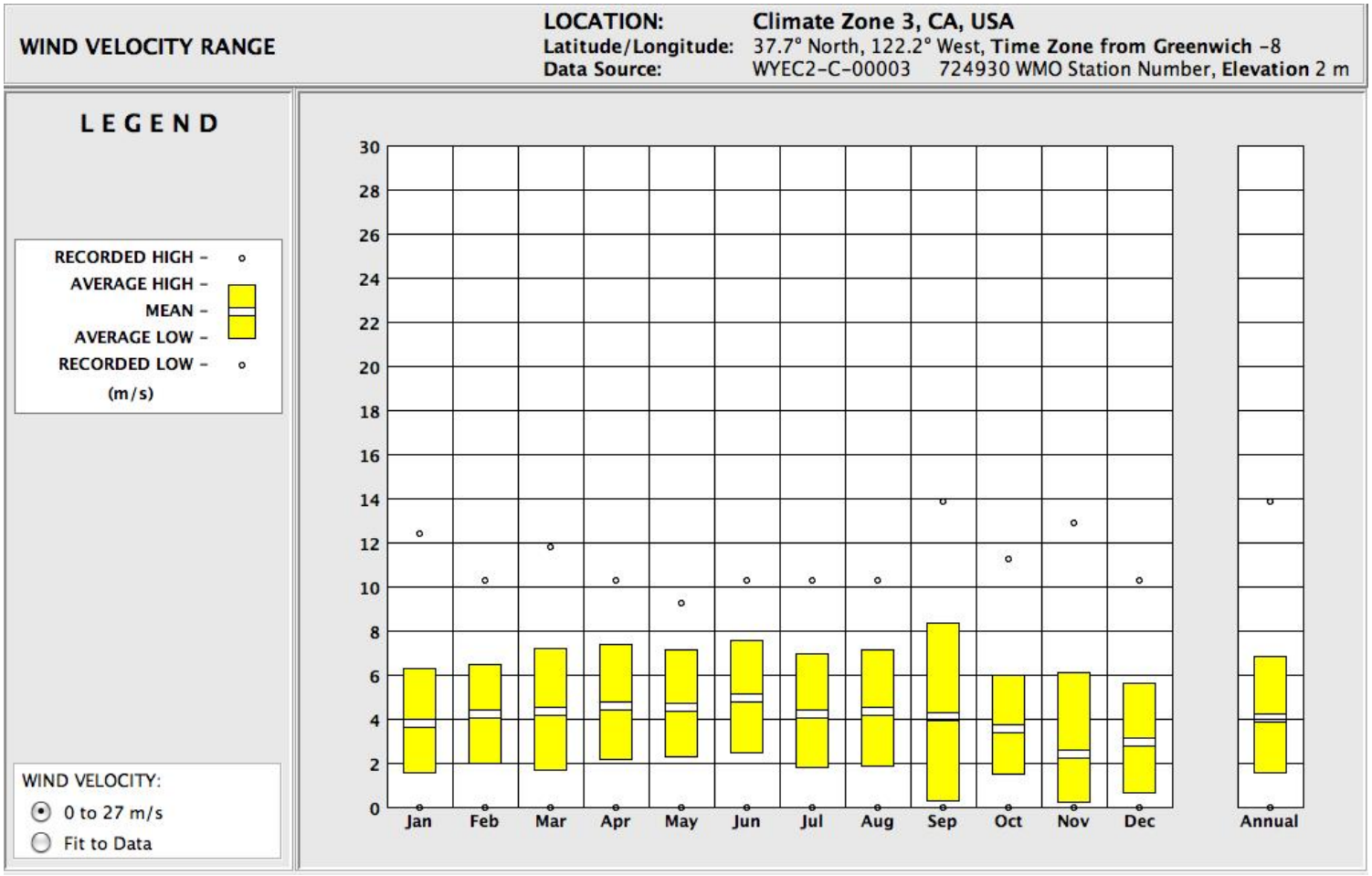
A
E
C
M
L

Climate Condition



Mean temperature of around 57 degrees Fahrenheit throughout the year (fairly stable conditions)

Climate Conditions

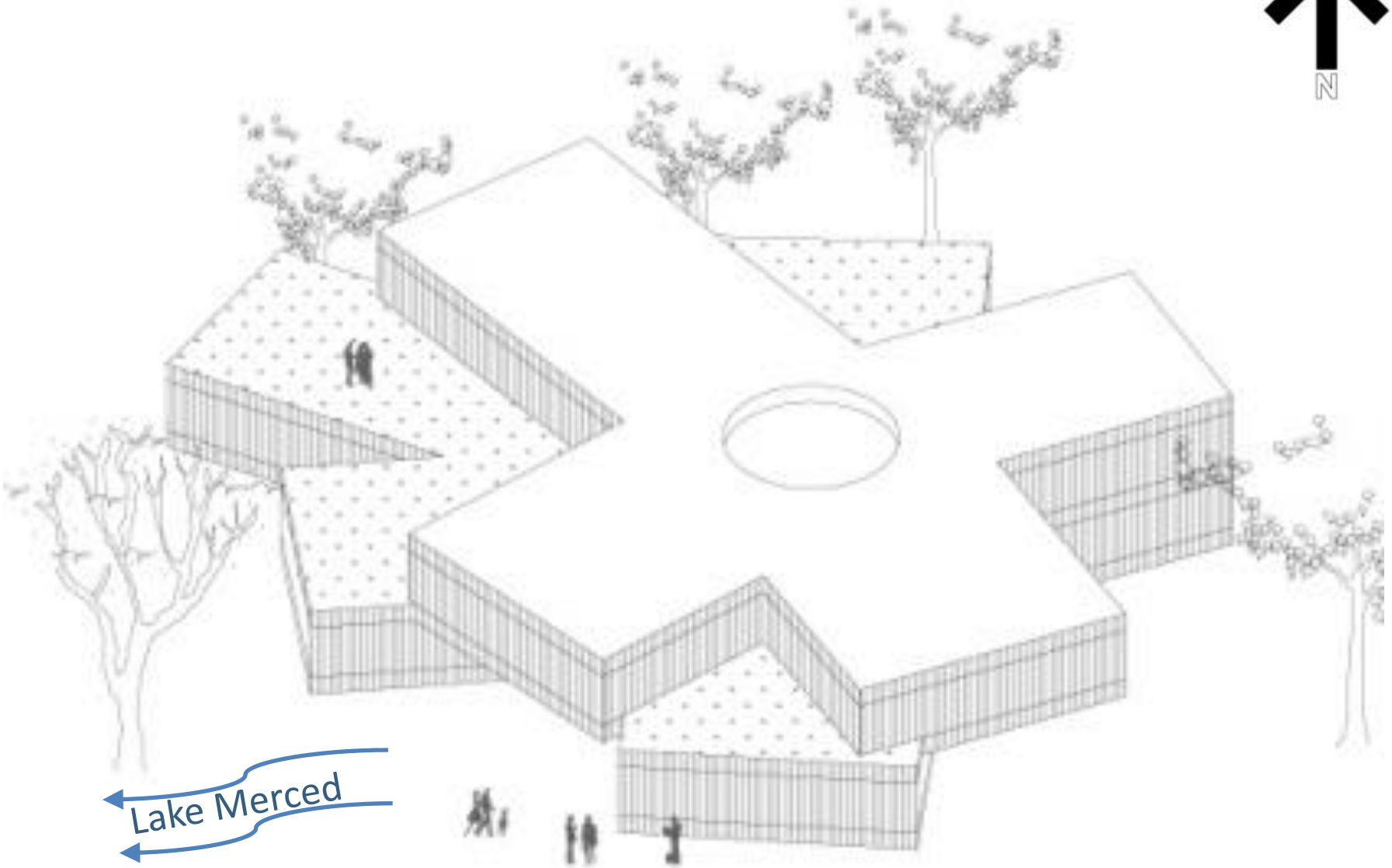


Wind velocity of around 4 m/s throughout the year (range: 2 m/s to 5 m/s)

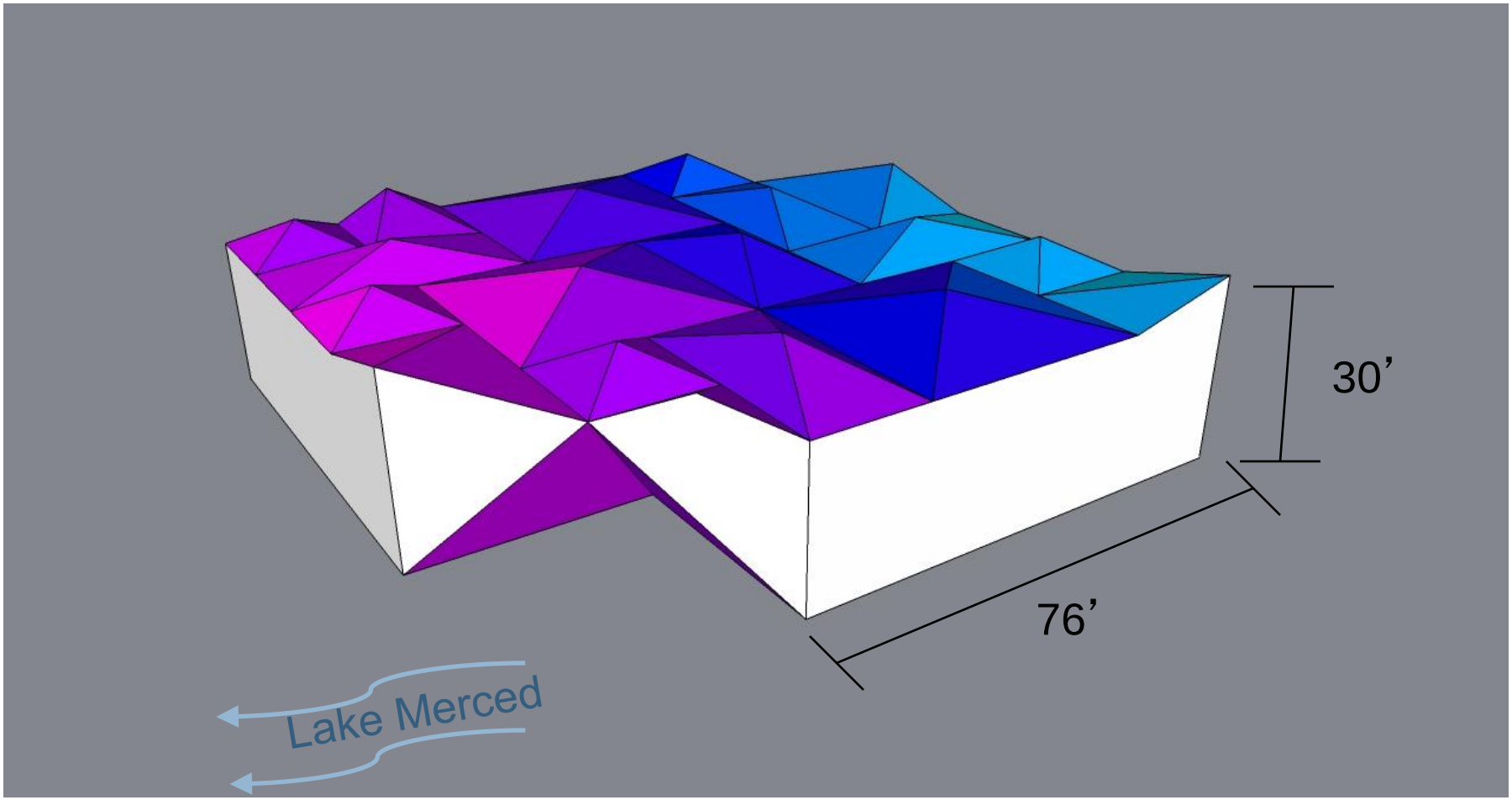
Winter Quarter Decision Matrix

	Mechanism		Houses	
	ConXtech	Concrete MF	Steel MF	EBF
Team Pacific	309	277	344	357
Björn (owner)	411	379	330	320
Anirudh (owner)	407	357	345	323
total	**1127**	**1013**	**1019**	**1000**

Mechanism Concept



Houses Concept



A
E
C
M
L

Team Pacific

A

E

C

M

L

Mechanism

A

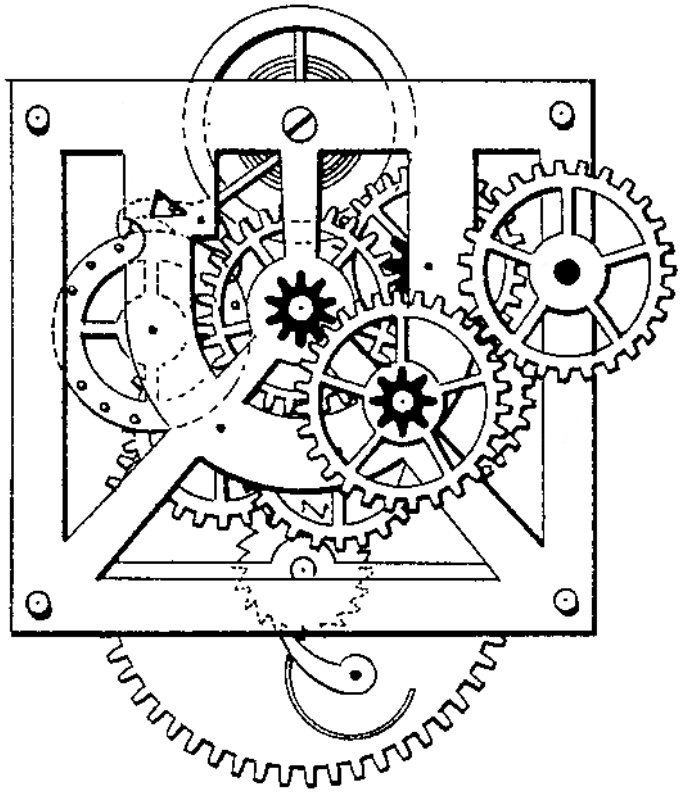
E

C

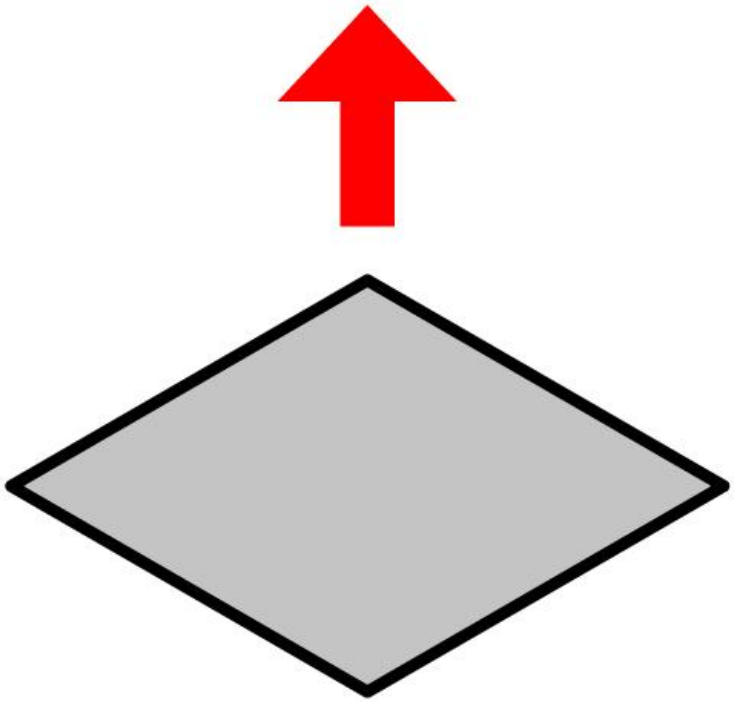
M

L

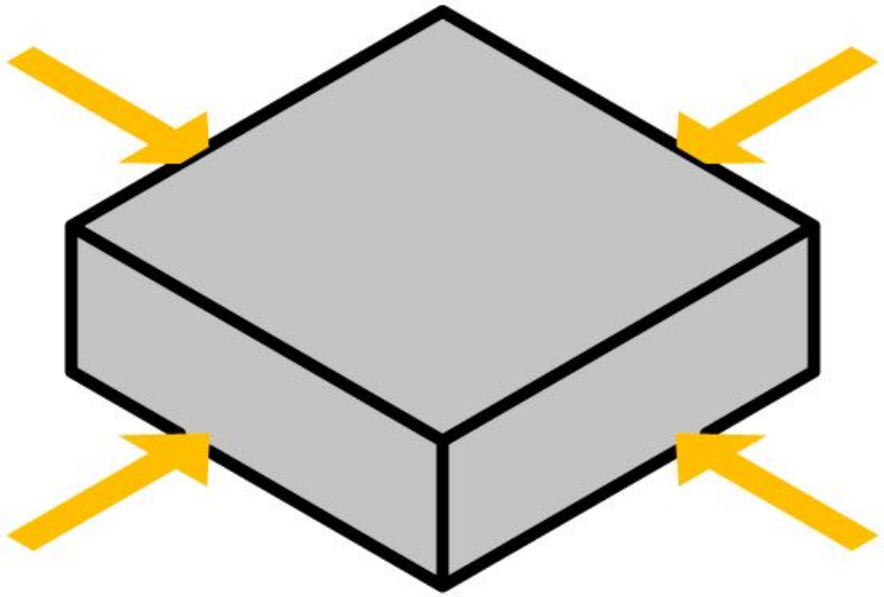
Mechanism: how does it work?



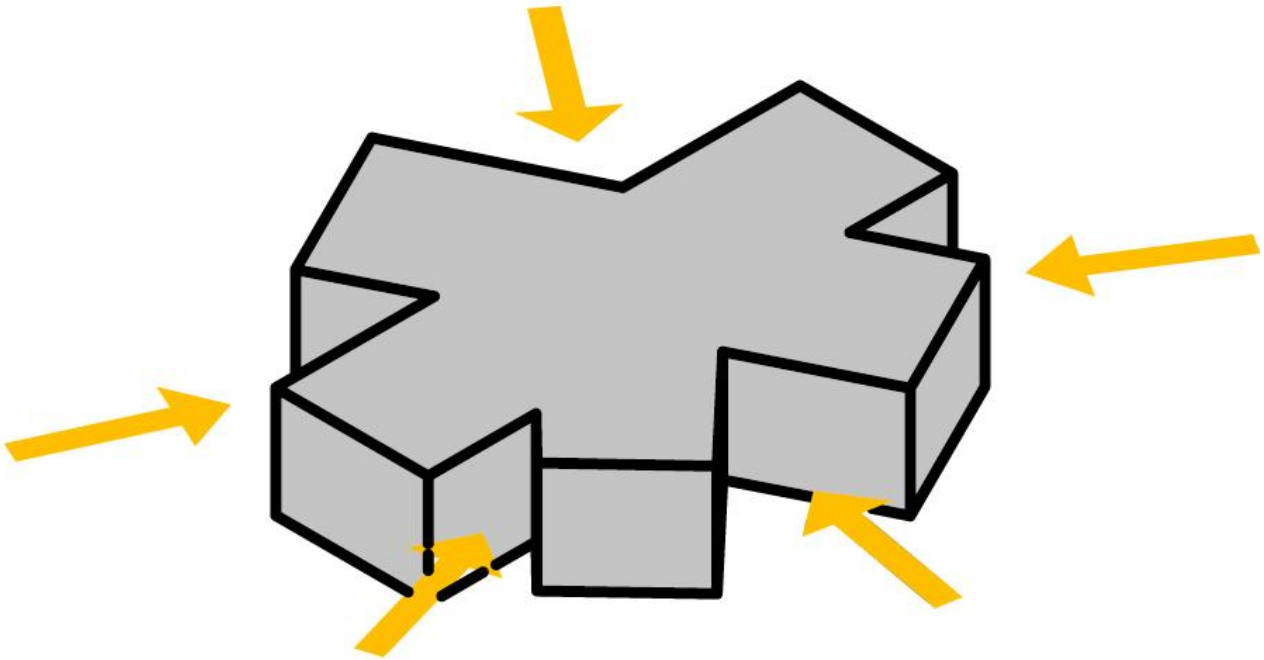
Extruded Footprint



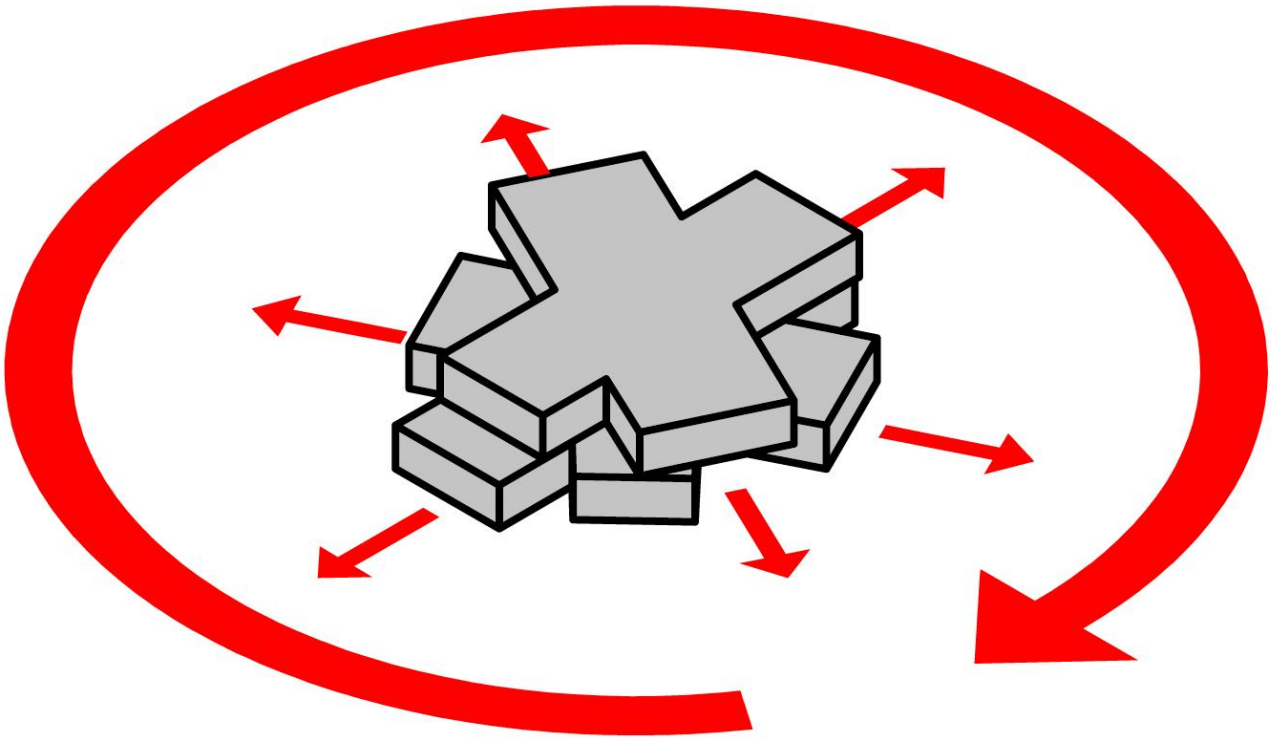
Natural Lighting



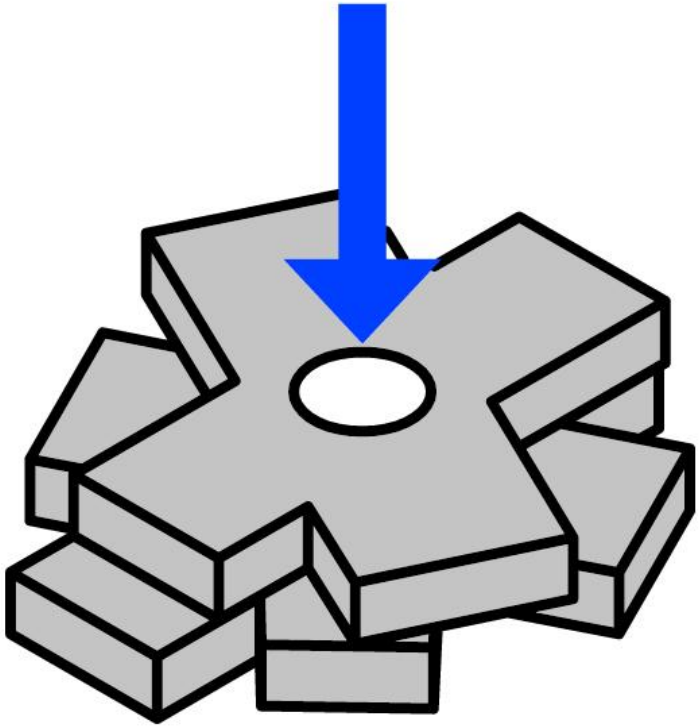
Natural Lighting



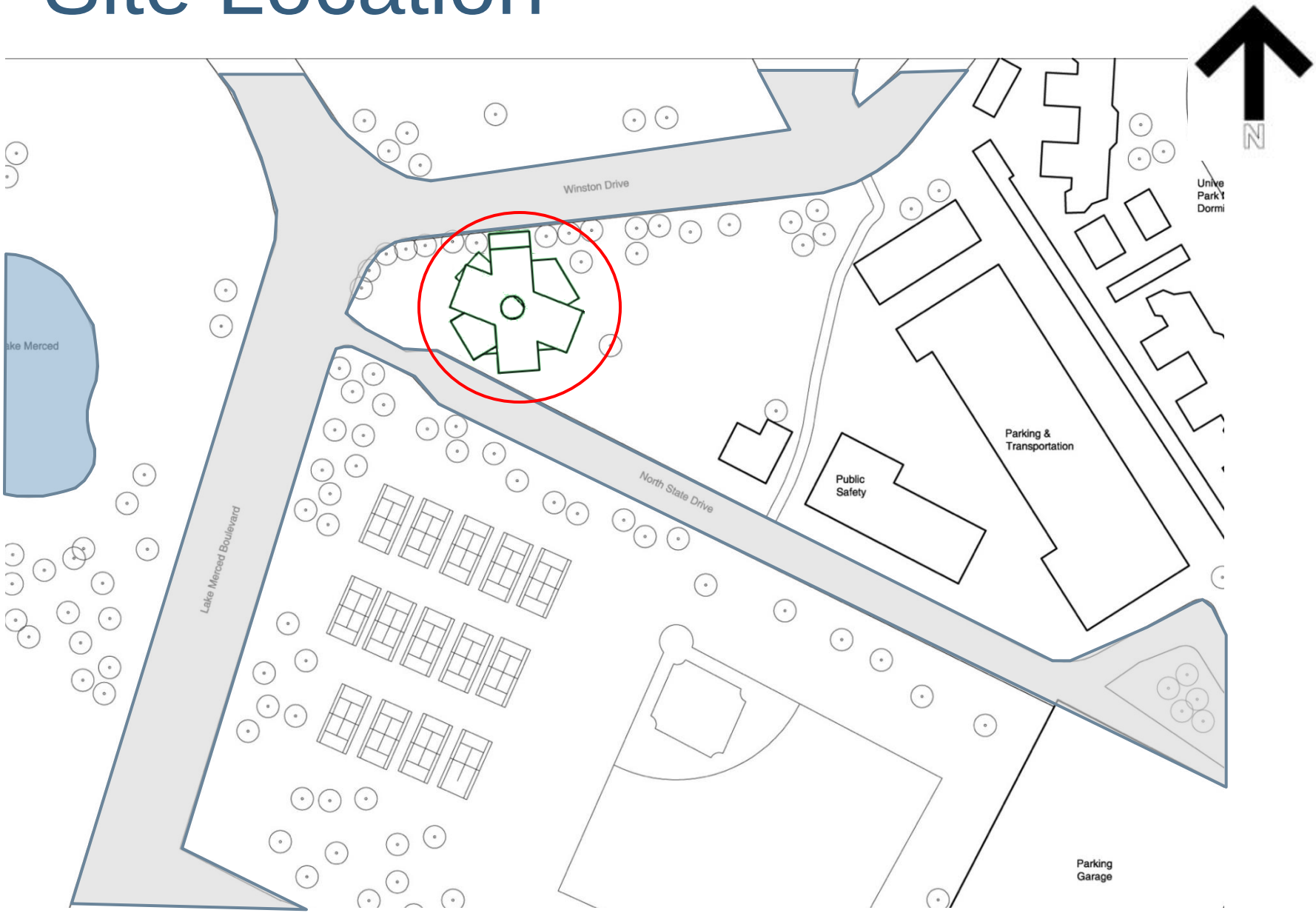
Views, Terraces



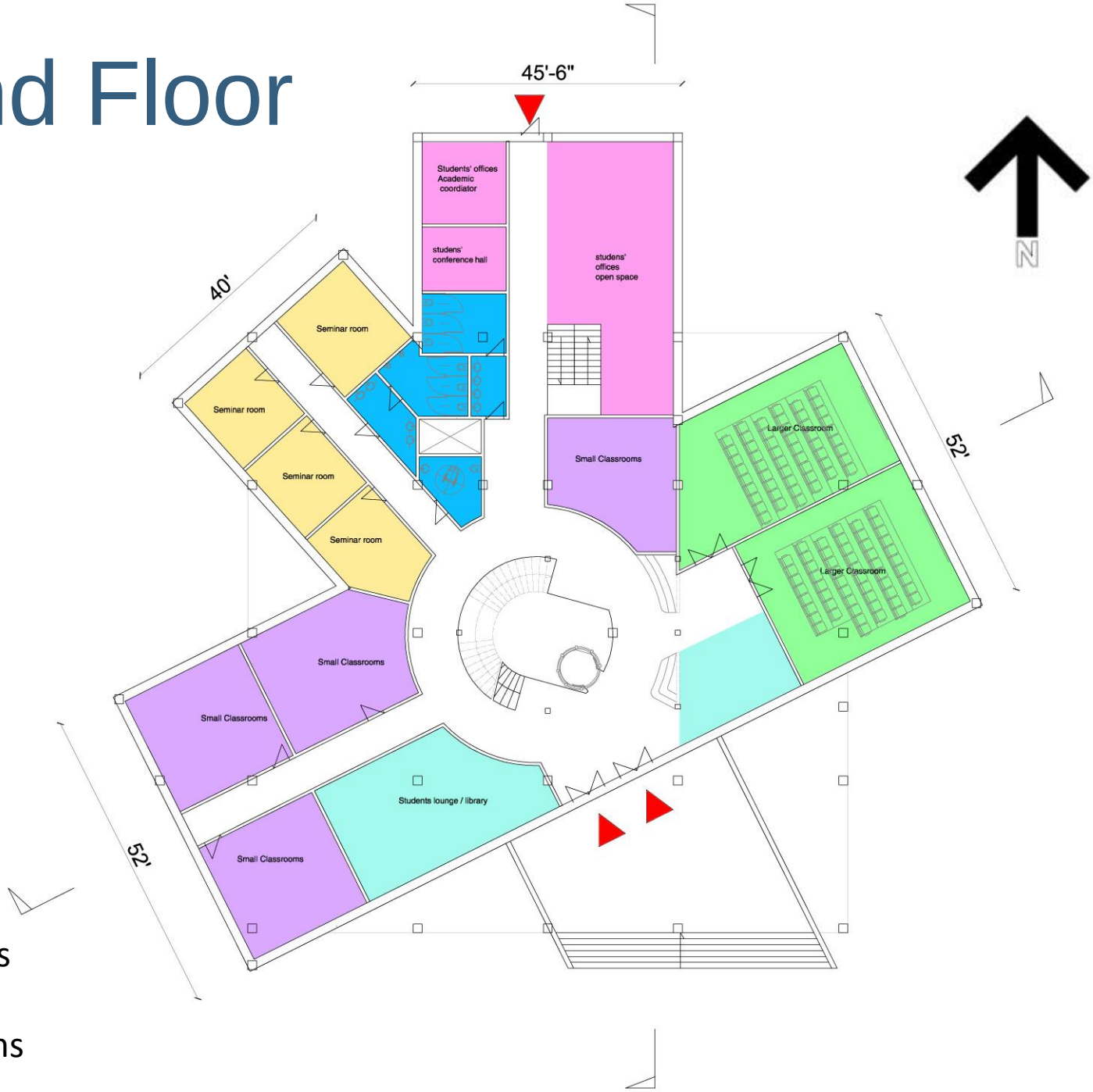
Natural Ventilation



Site Location

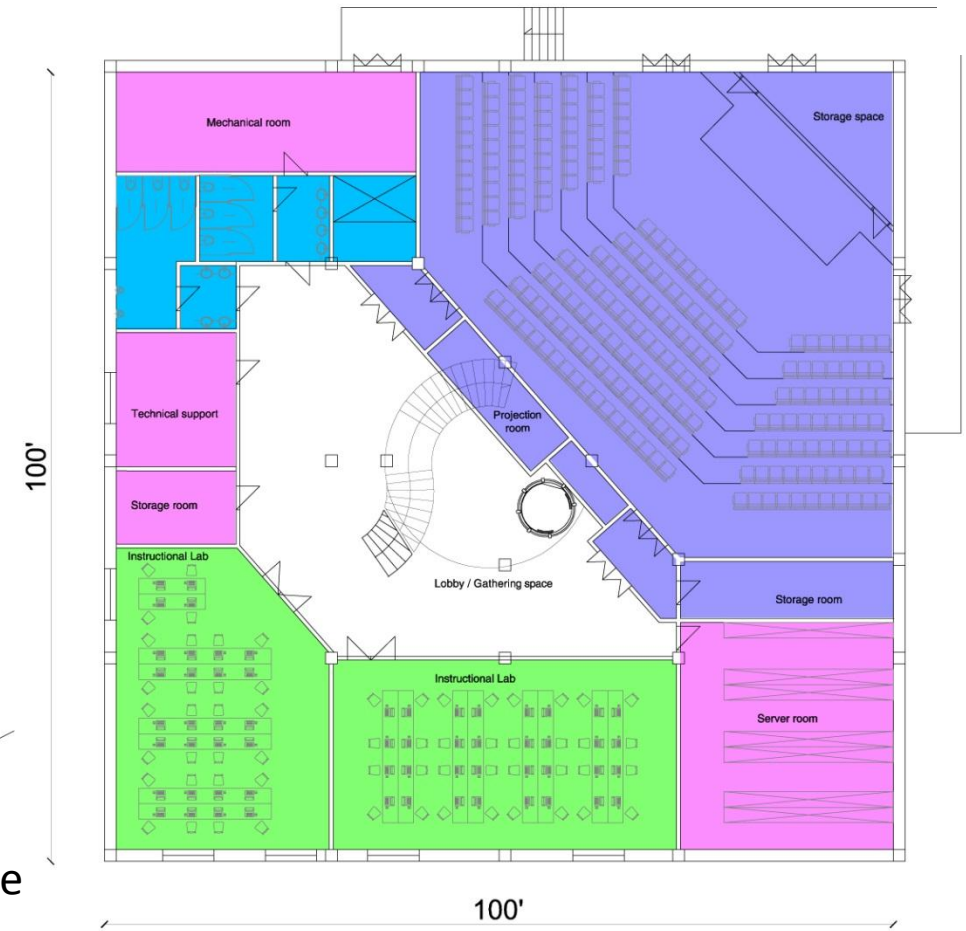


Second Floor



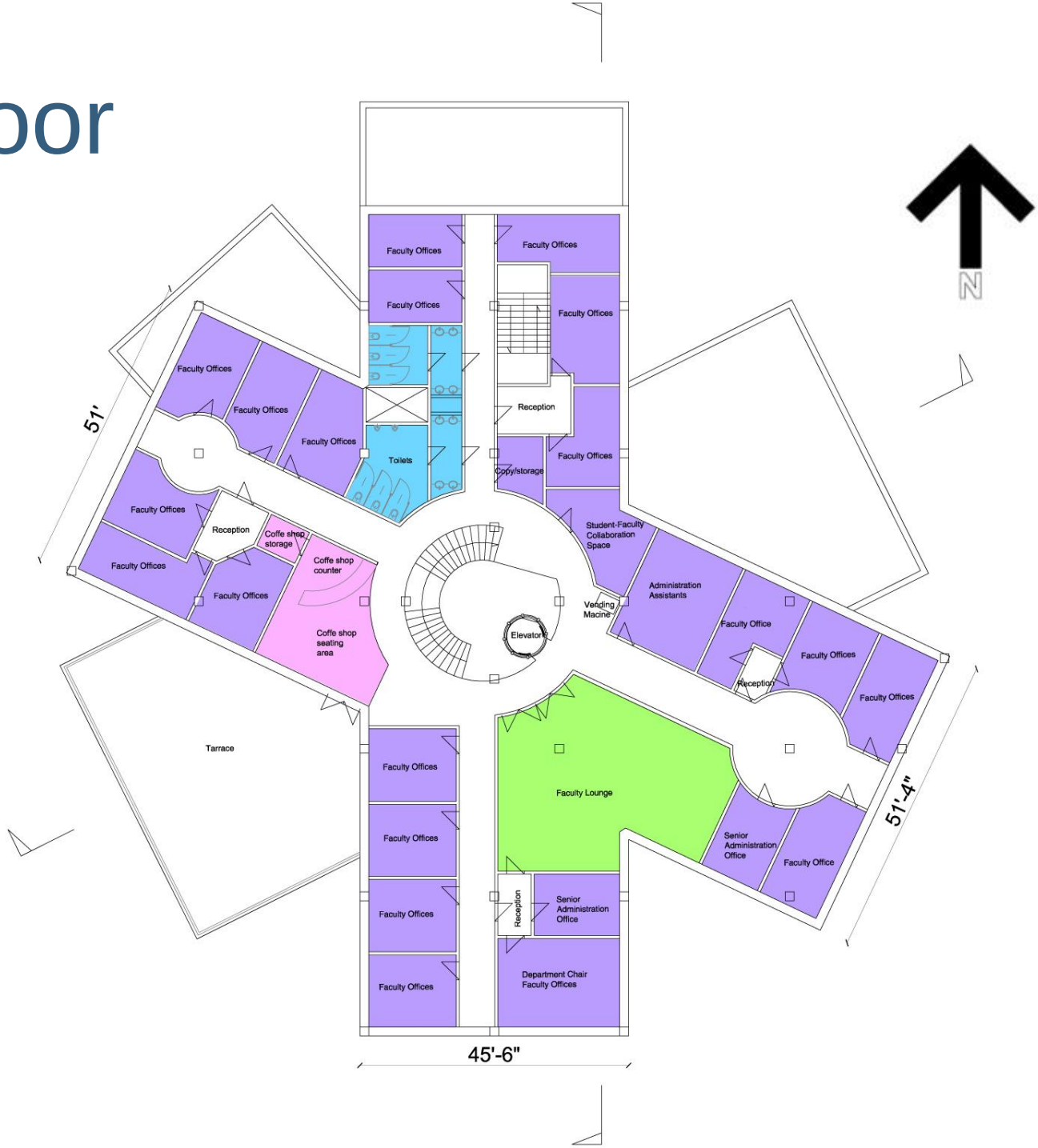
- Student Offices
- Restrooms
- Seminar Rooms
- Small Classrooms
- Student Lounge
- Larger Classrooms

First Floor



- Technical Suport / Storage Space
- Restrooms
- Auditorium
- Instructional Lab

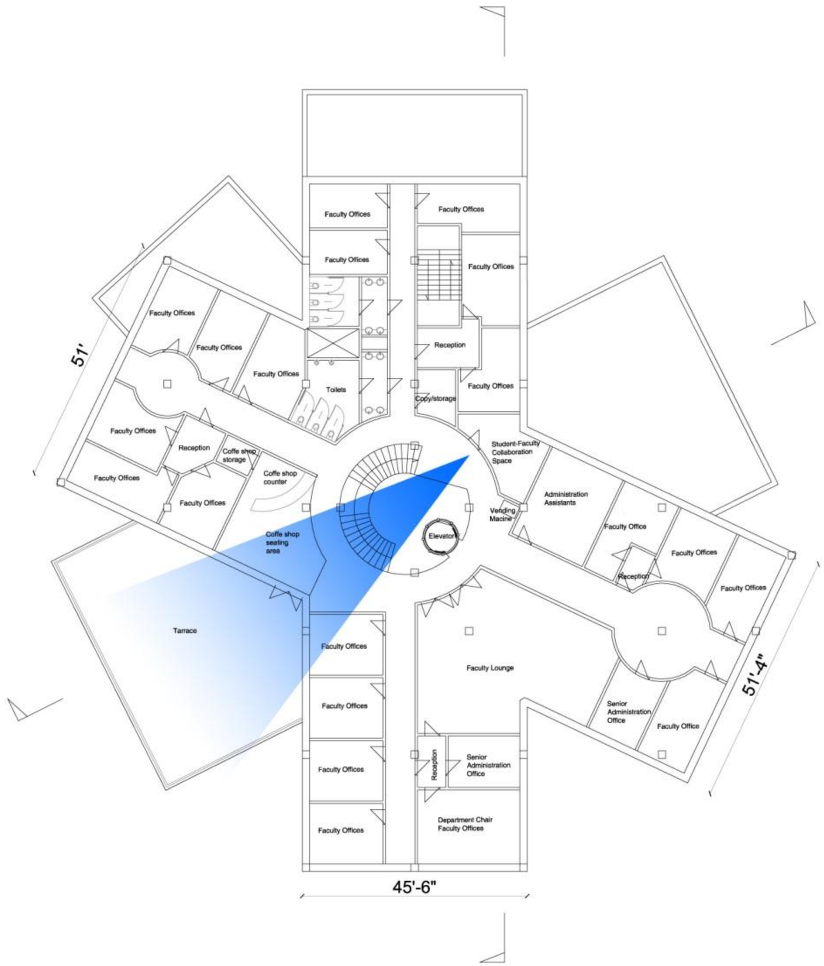
Third Floor



- Faculty Offices
- Faculty Lounge
- Cafe
- Restrooms

A E C M L

Interior Rendering



A

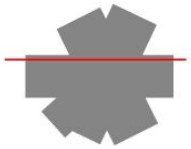
E

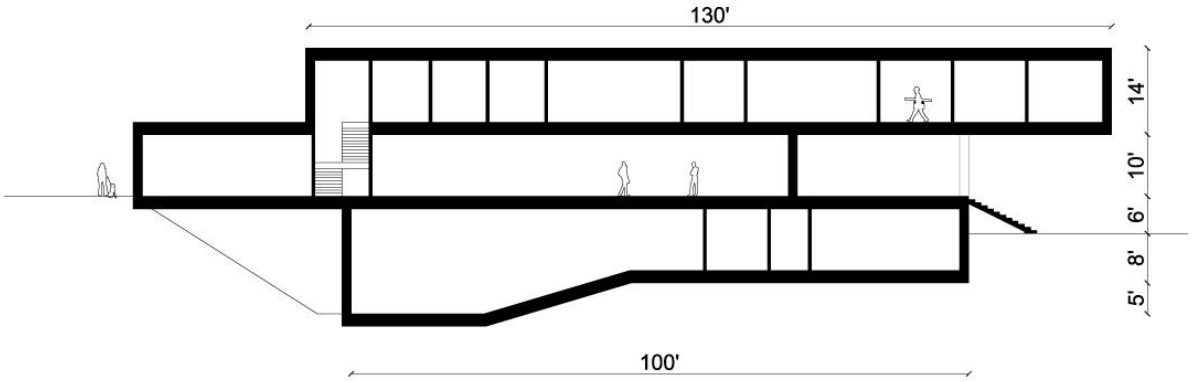
C

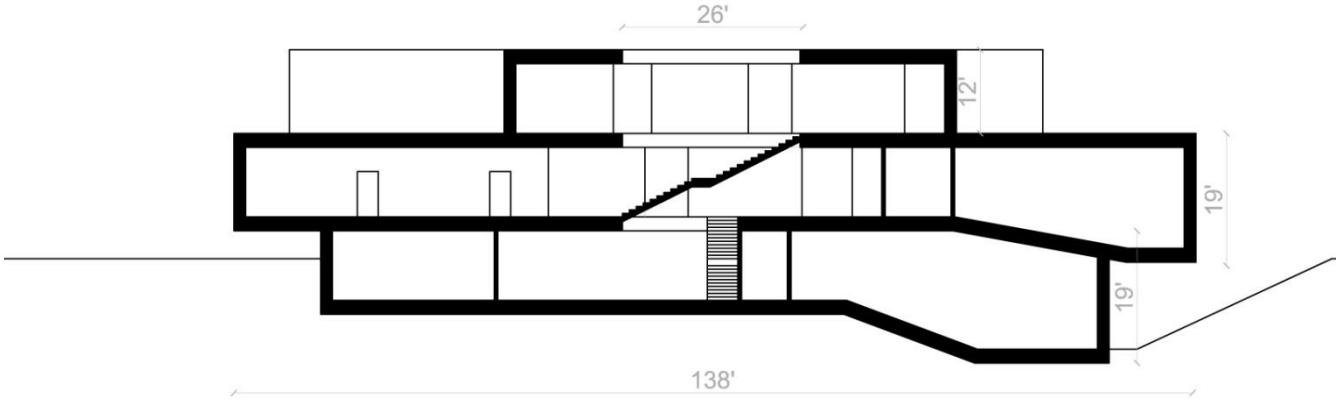
M

L

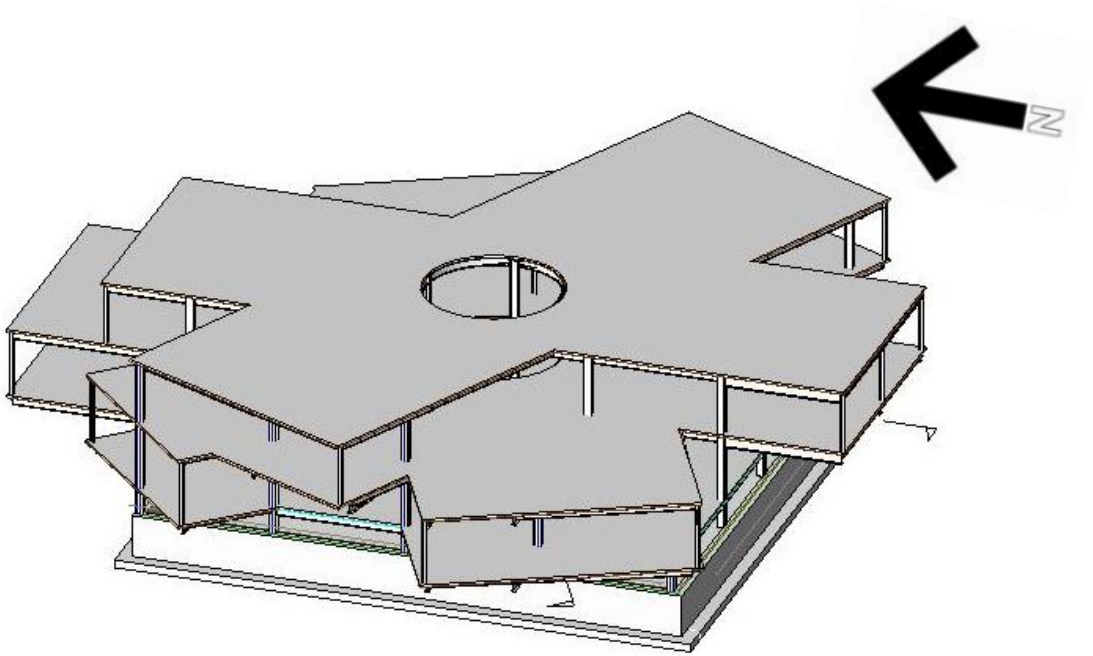
Sections

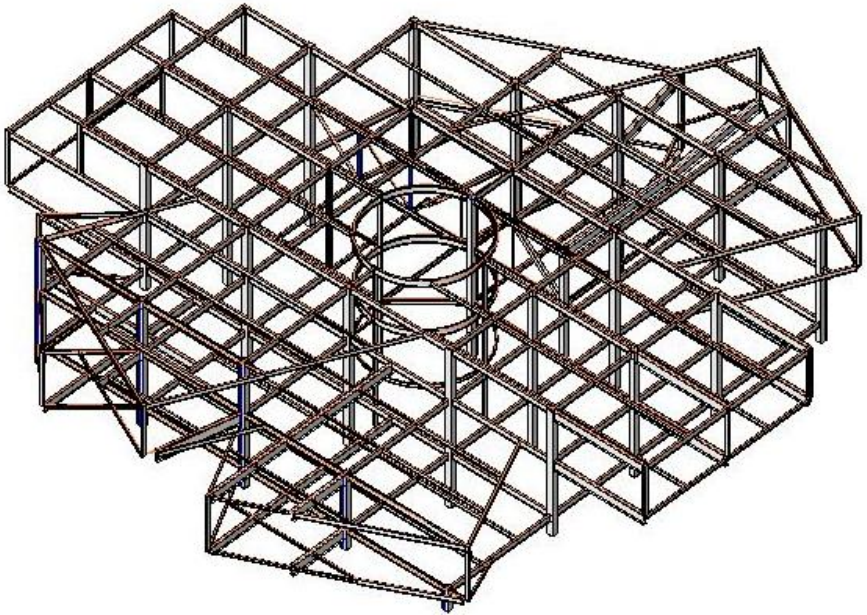






Structure





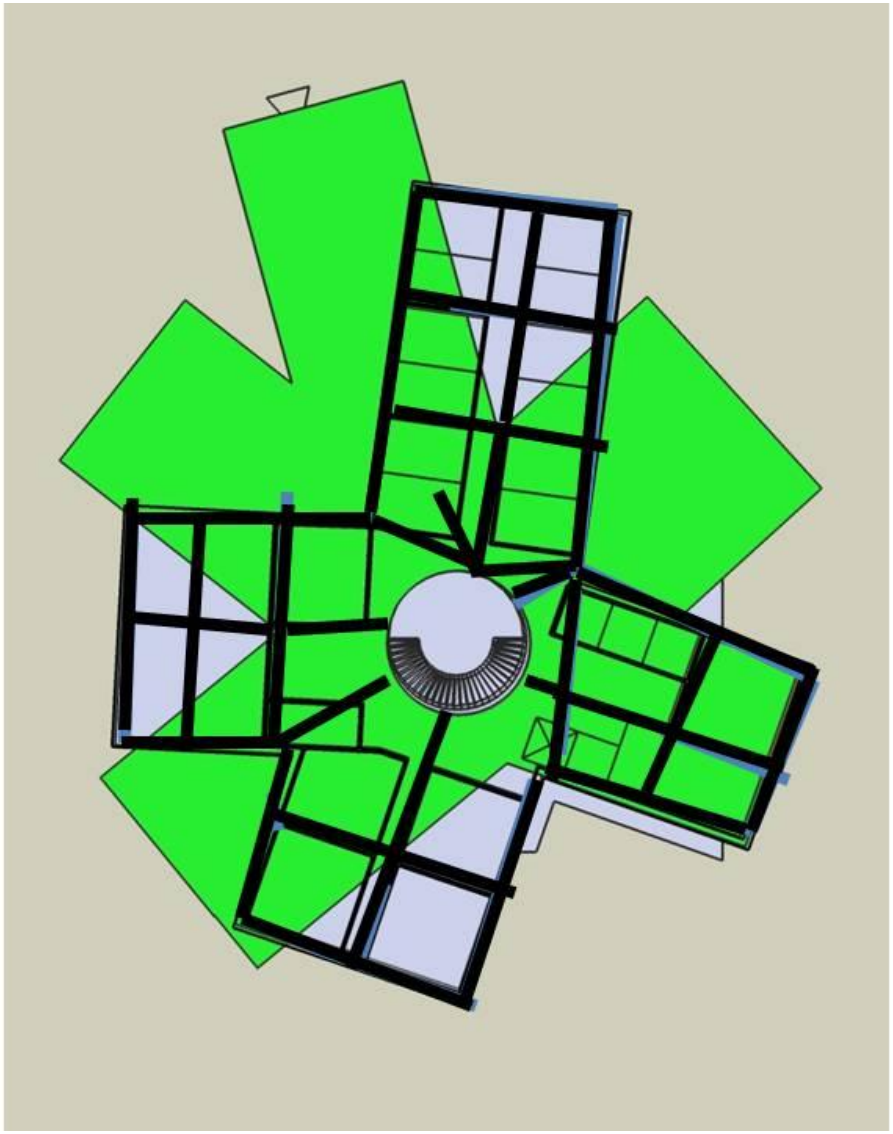
Loads & Soil Profile

Live Load	psf
Office	50
Classroom	40
Storage (light)	125
Large Classroom	60
Lobby	100
Construction	20
Corridors	80

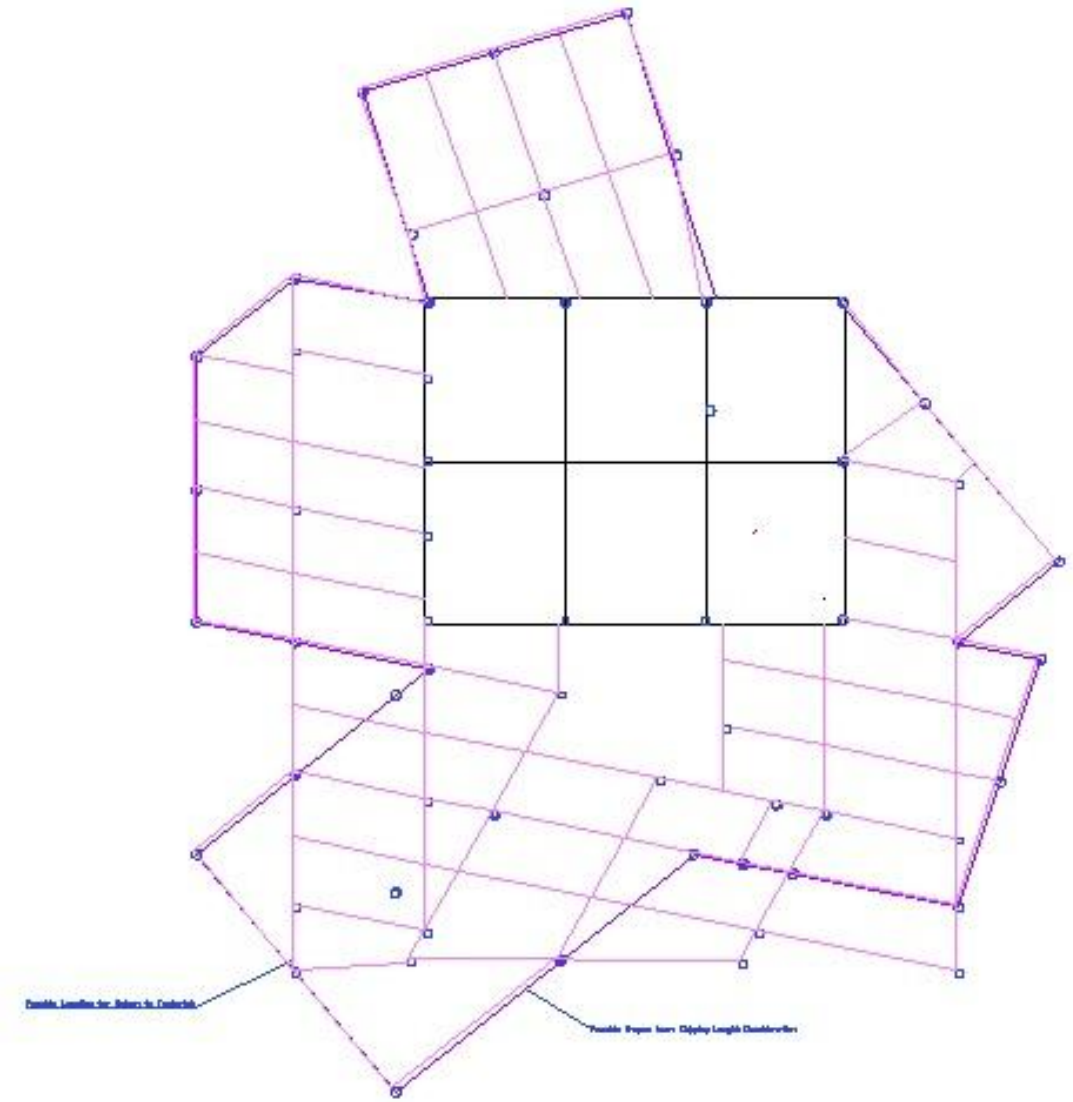
Seismic Loads	
S_{ds} = 1.349 S_{d1} = 1.085	Site Class D
Seismic Controls over Wind	

Soil Conditions
Well sorted fine to medium Sand
Bearing Capacity: 3500psf
Not in Liquefaction Zone
Water Table: 14ft below Grade

Initial Radial Grid



Initial “Skewed” Grid



Gravity System Decision Process

Challenge: Assign a functional grid to a very complex building shape

Radial Grid

- Accentuates architecture
- Very complex
- Many constructability issues with non-continuous columns

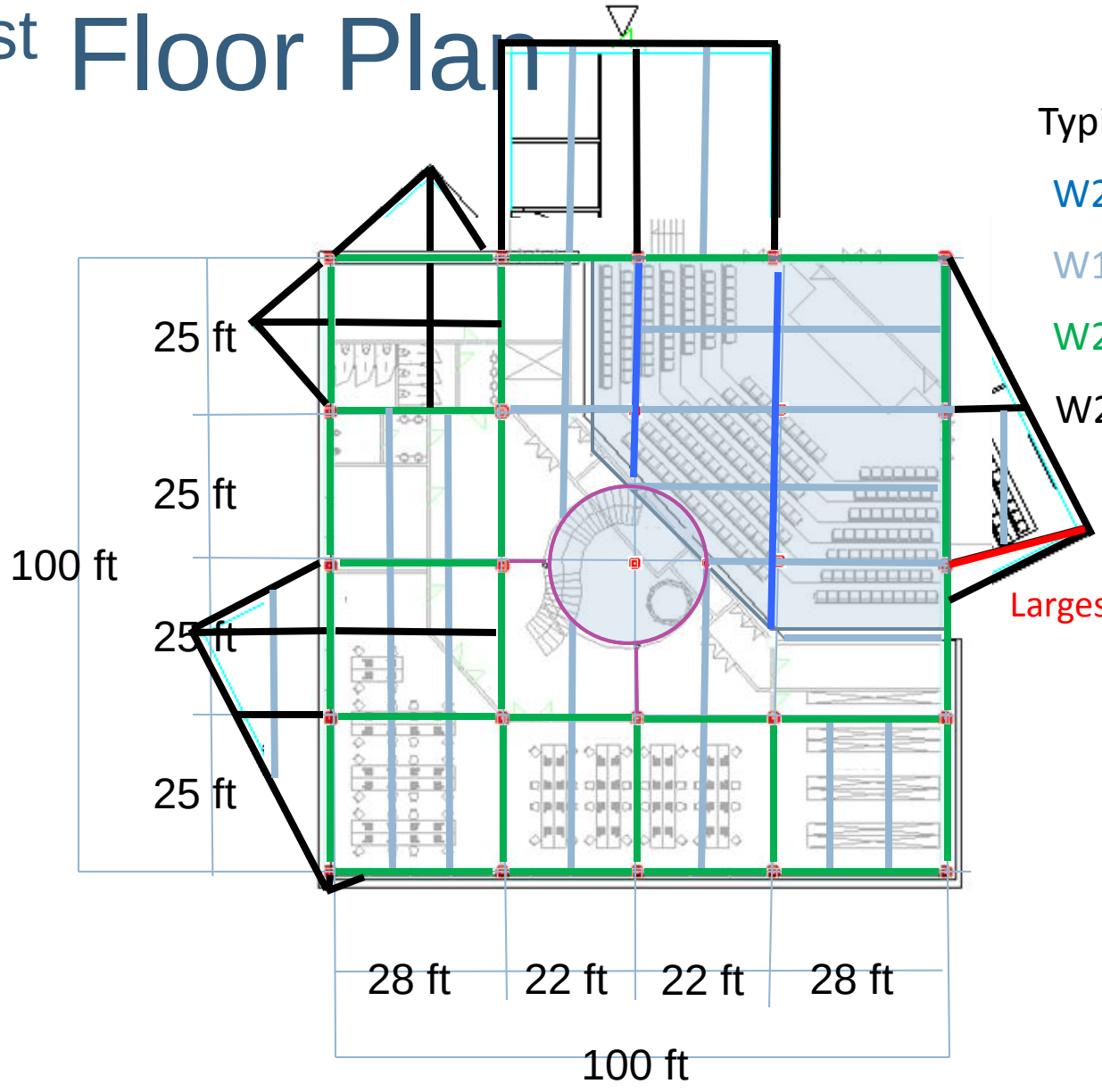
Skewed Grid

- Somewhat regular grid with high degree of repeatability
- Architectural adjustments needed

Rectangular Grid With Skewed Cantilevers

- Very regular grid
- Allows use of ConXtech
- However, relatively shallow bays required for cantilever attachment

1st Floor Plan



Typical Sections:

W21X101

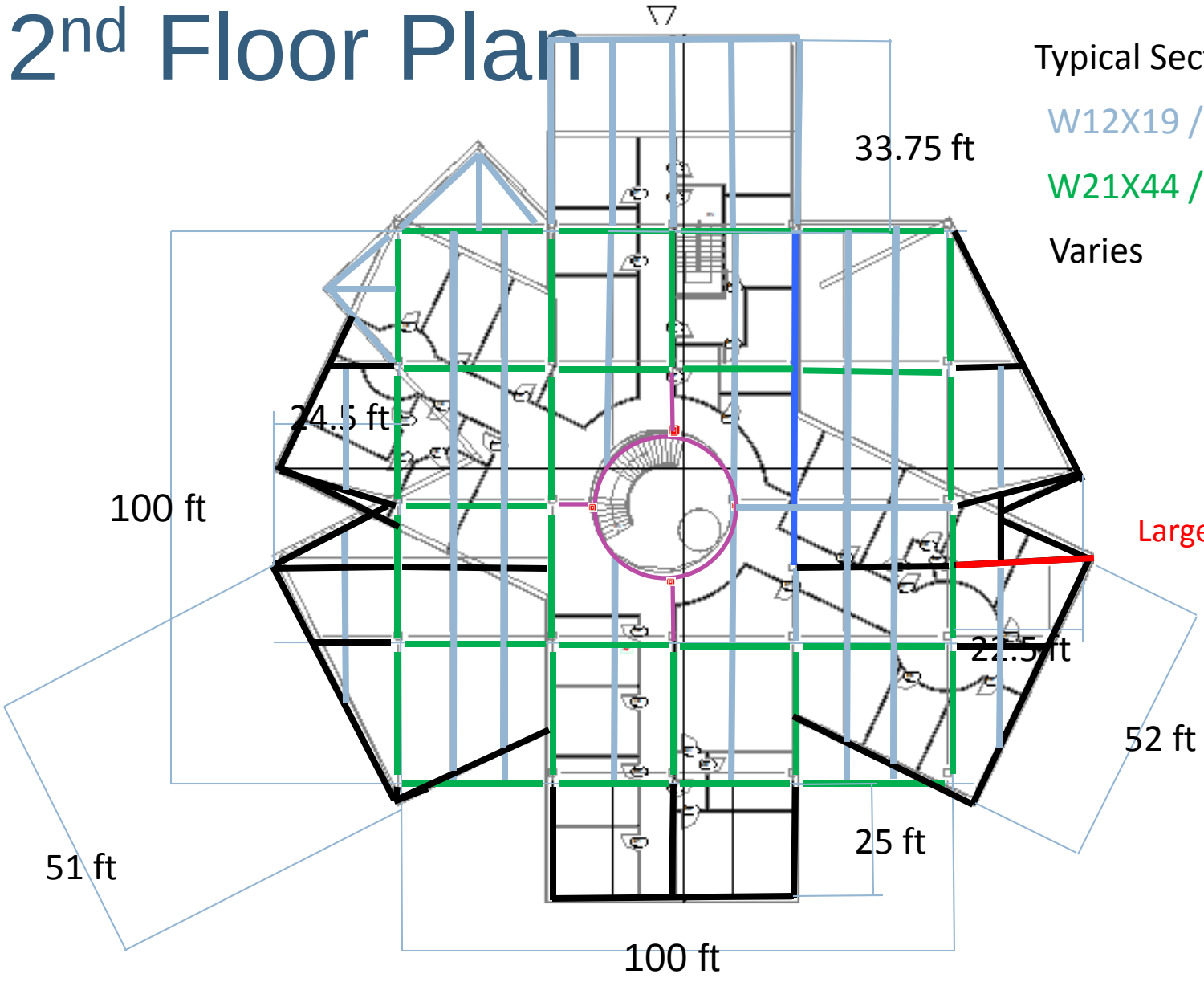
W12X19 / W12X22

W21X44 / W24X55

W27X84

Largest: W30X108

2nd Floor Plan



Typical Sections:

W12X19 / W12X22

W21X44 / W24X55

Varies

Largest: W30X173

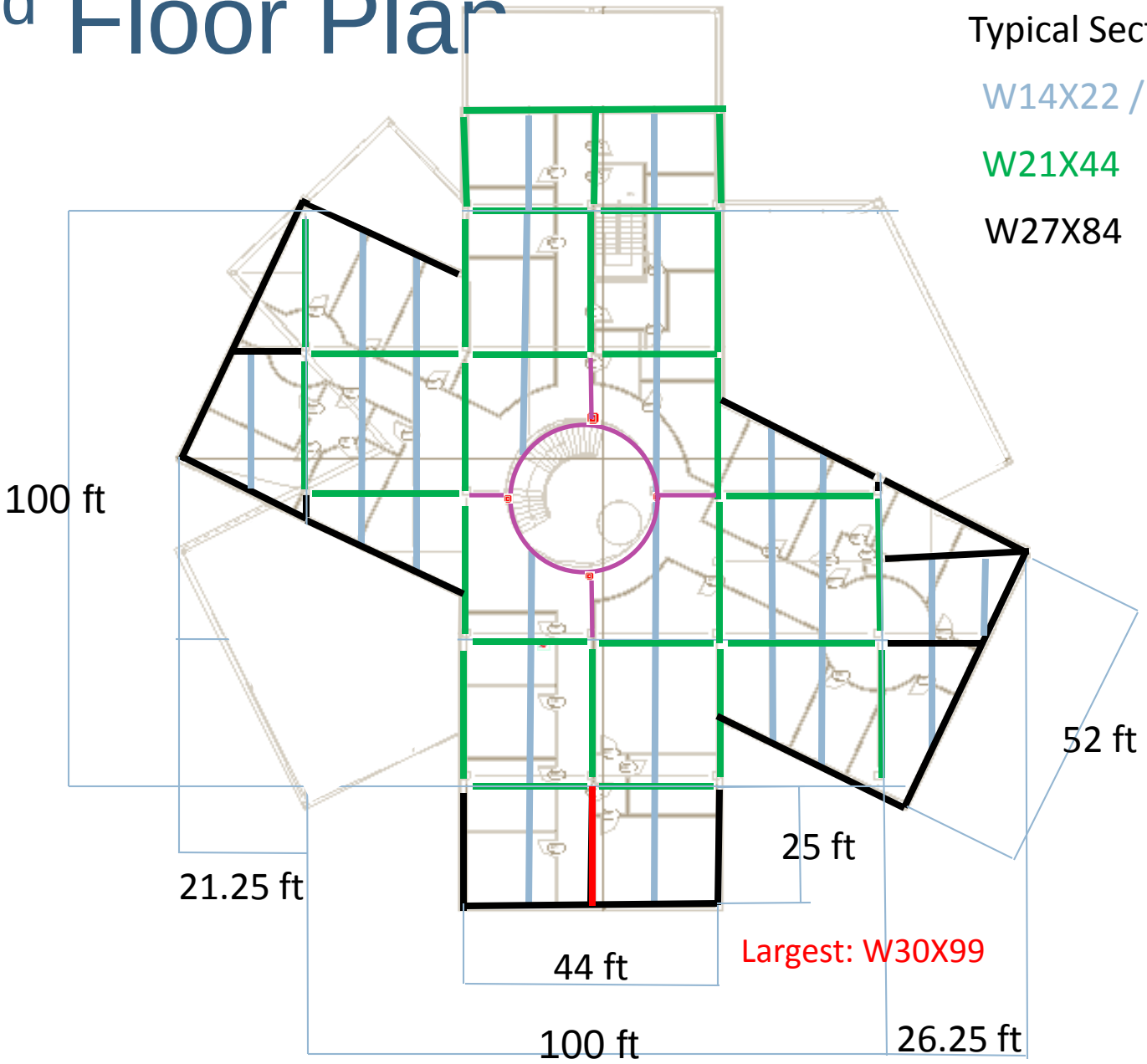
3rd Floor Plan

Typical Sections:

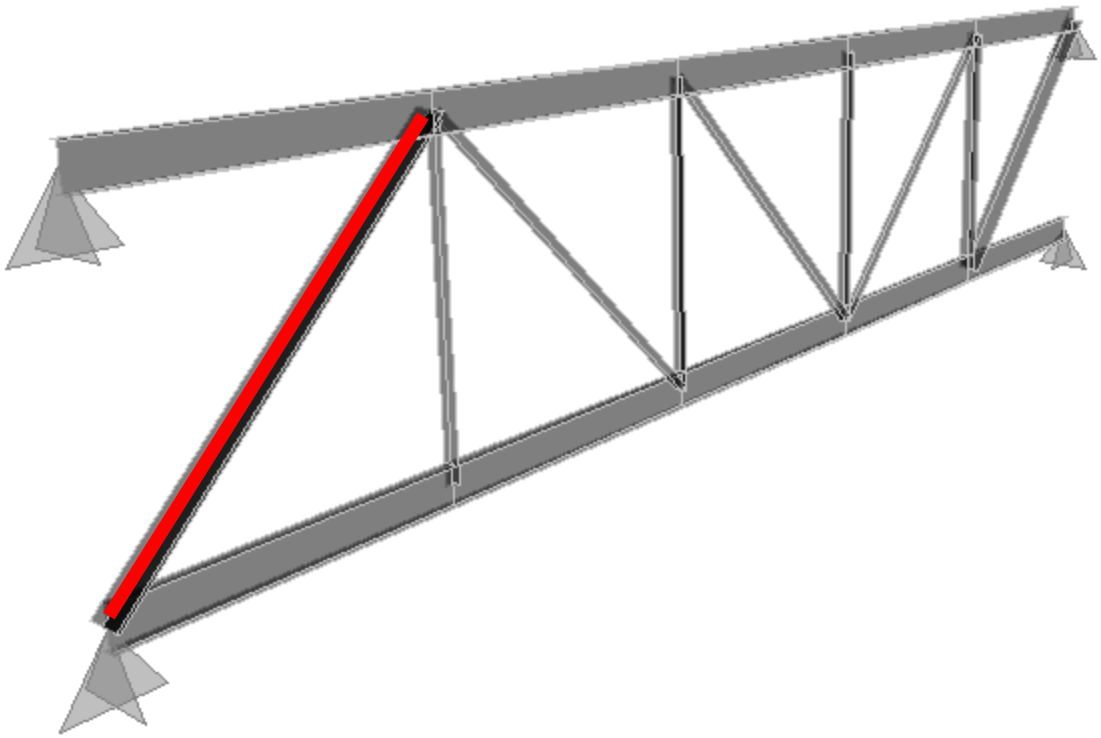
W14X22 / W14X26

W21X44

W27X84



62.5 ft Span Floor-to-Floor Truss



Typical Sizes

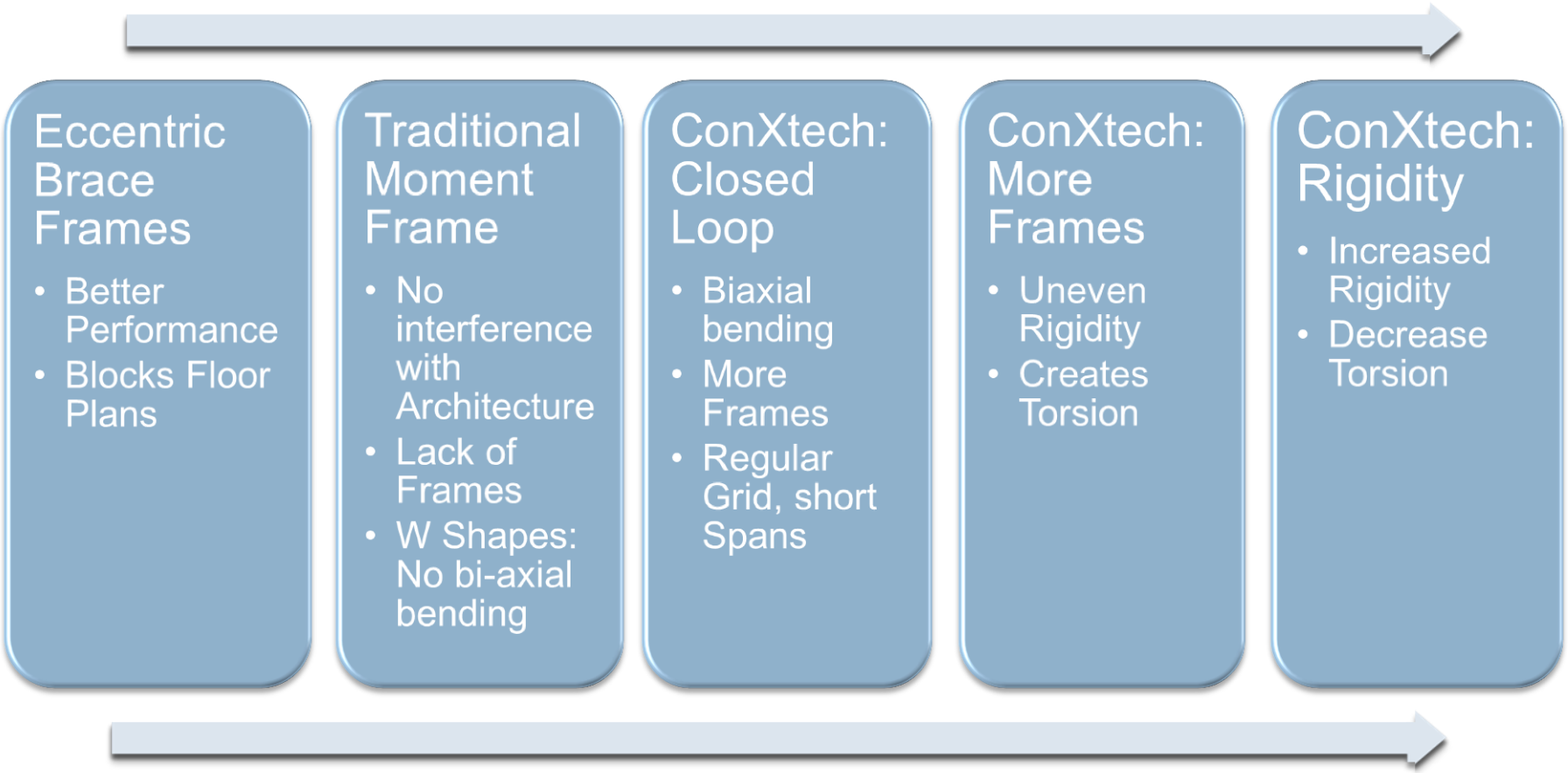
Top and Bottom Chords:
W18 X 35 (ConXtech Connected)

Web Members:
2L4 X 4 X 3/4

Critical Compression Member:
2L8 X 8 X 5/8

Lateral System Decision Process

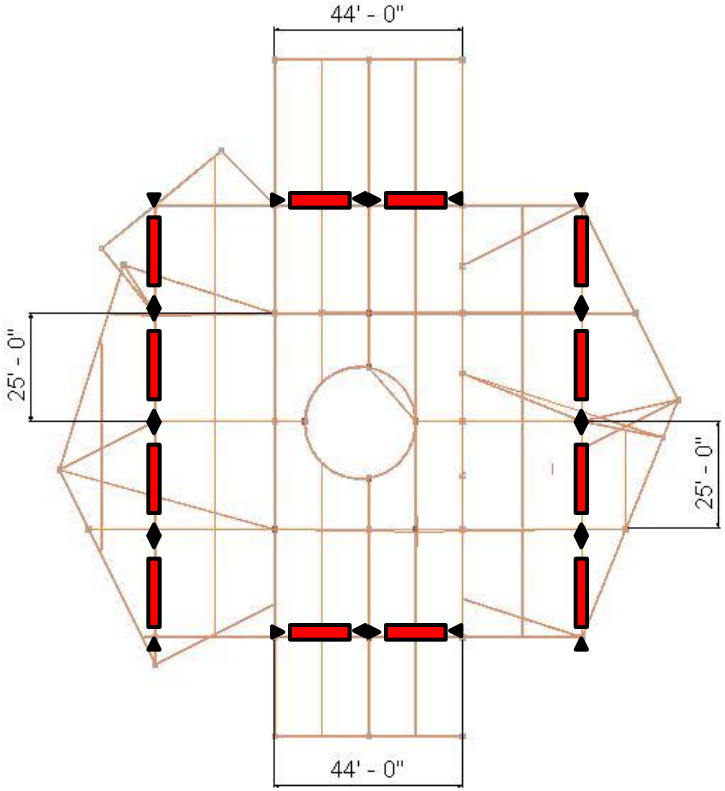
Challenge: Place lateral system with few continuous frames



Lateral System Decision Process

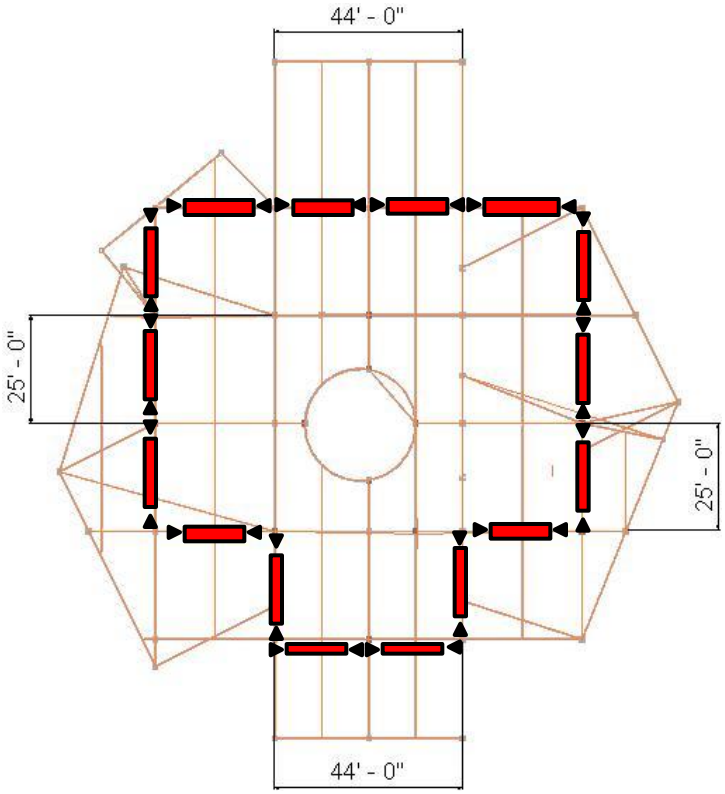
Challenge: Place lateral system with few continuous frames

Traditional Moment Frame



Short Frames in East-West Direction to avoid bi-axial Bending

ConXtech



Continuous Loop with Columns supporting bi-axial Bending

ConXtech Frame

- Local, innovative structural Steel System
- Prequalified, bolted special Steel Moment Connection
- Moment bearing Collar attaches Ends of Beams to Column
- Precision manufacturing

Pros	Cons
• Center has regular Floor Plan	• Large Auditorium Span
• Less Welding	• Lack of continuous Columns
• Faster Erection Time	
• Allows for open Floor Plans	

ConXtech Frame

Photo source: ConXtech
Kaiser Permanente

A
E
C
M
L

Lateral System

- ConXL
  - Columns: Concrete filled HSS 16”x16”x5/8”

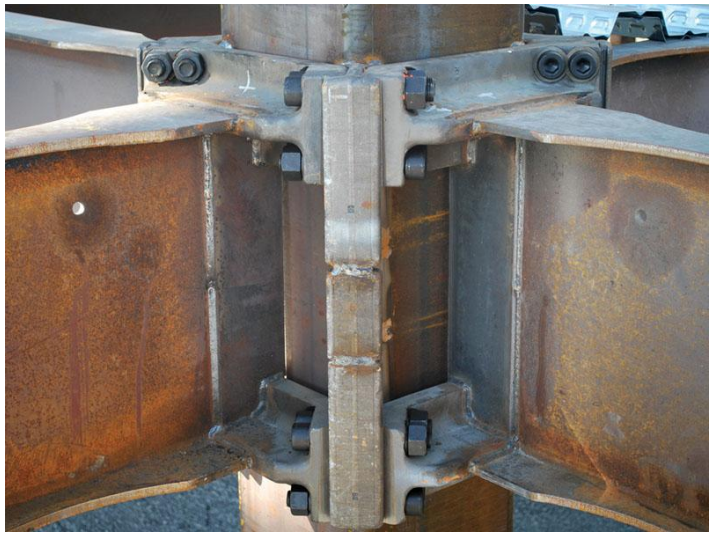
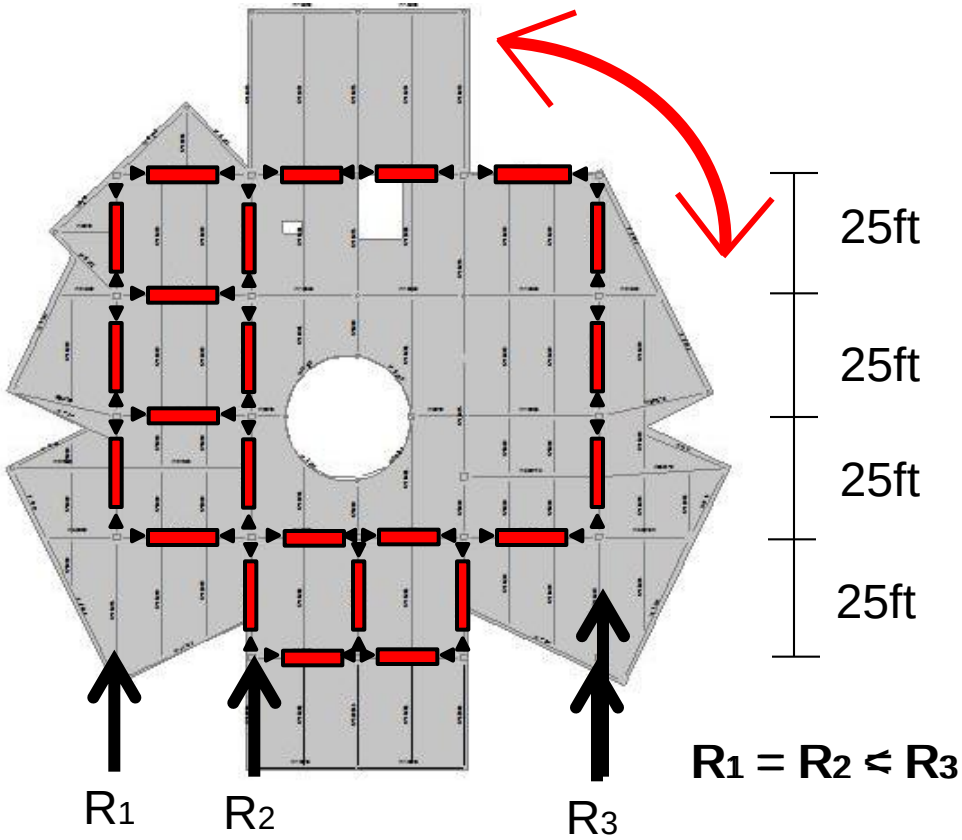
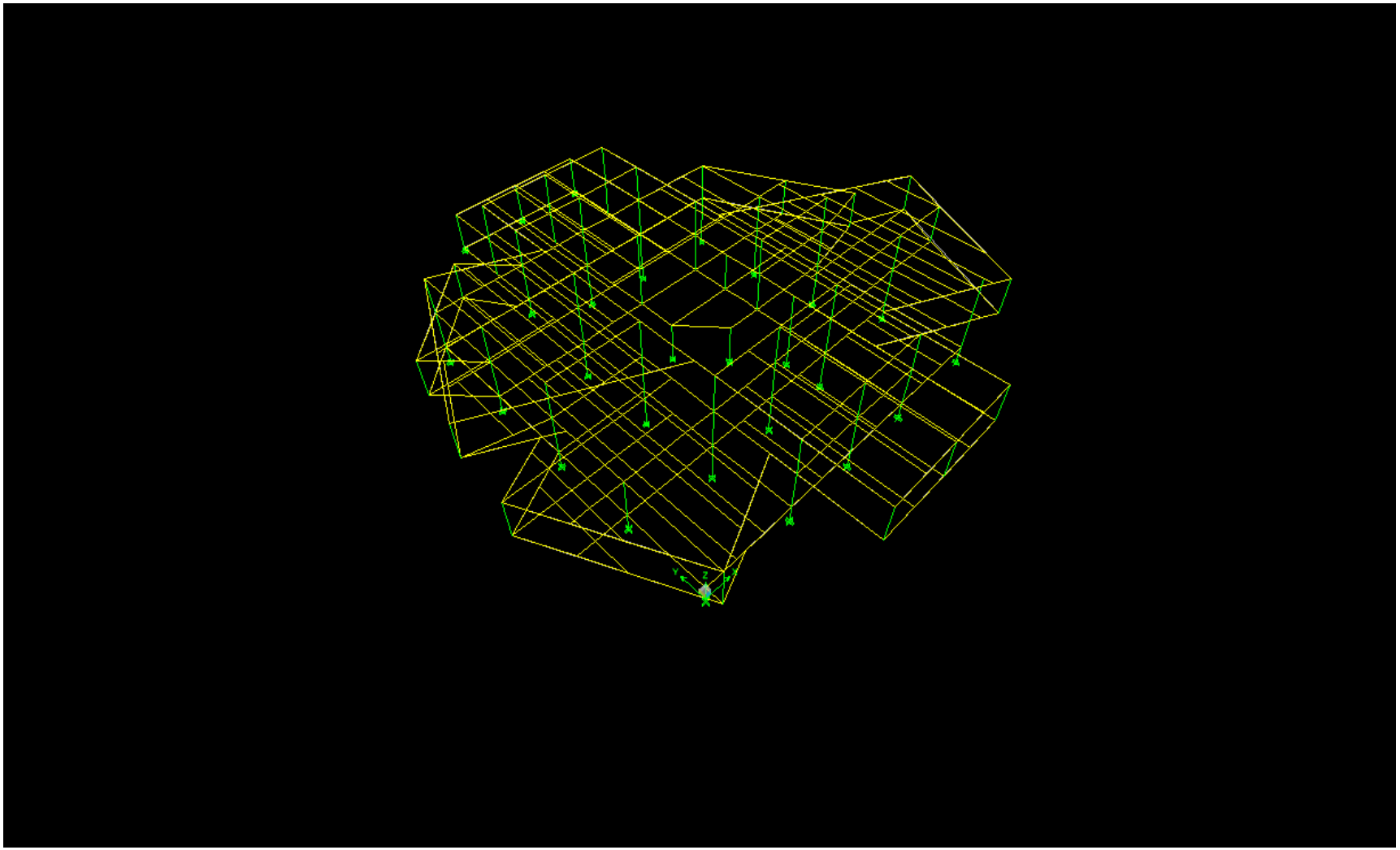


Photo source: ConXtech

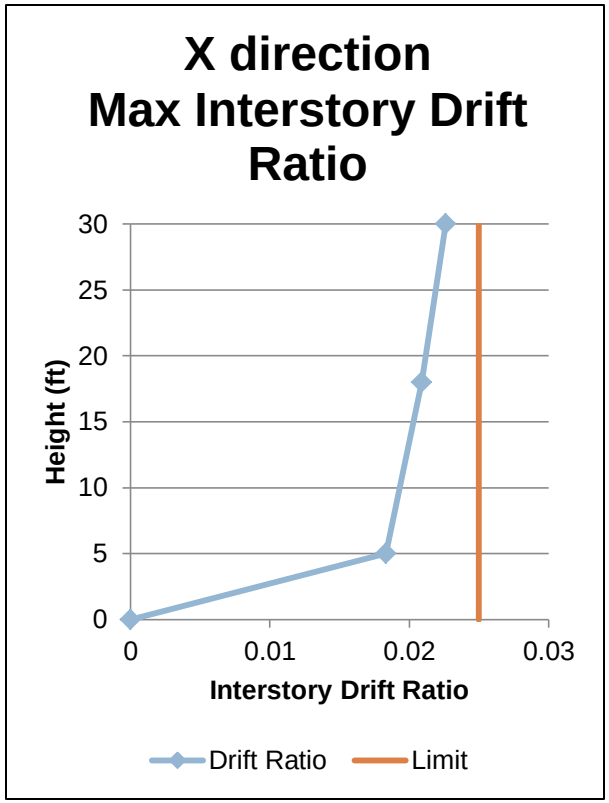


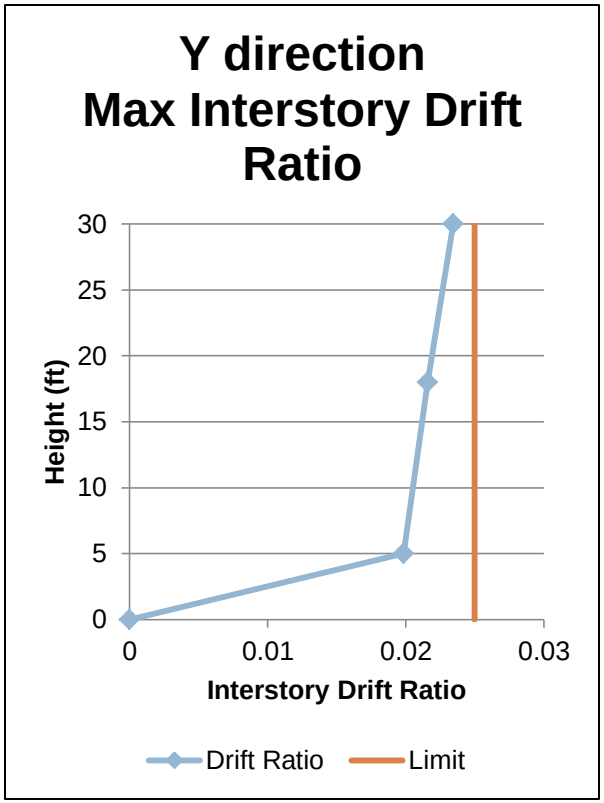
Dynamic Characteristics



Dynamic Analysis Results

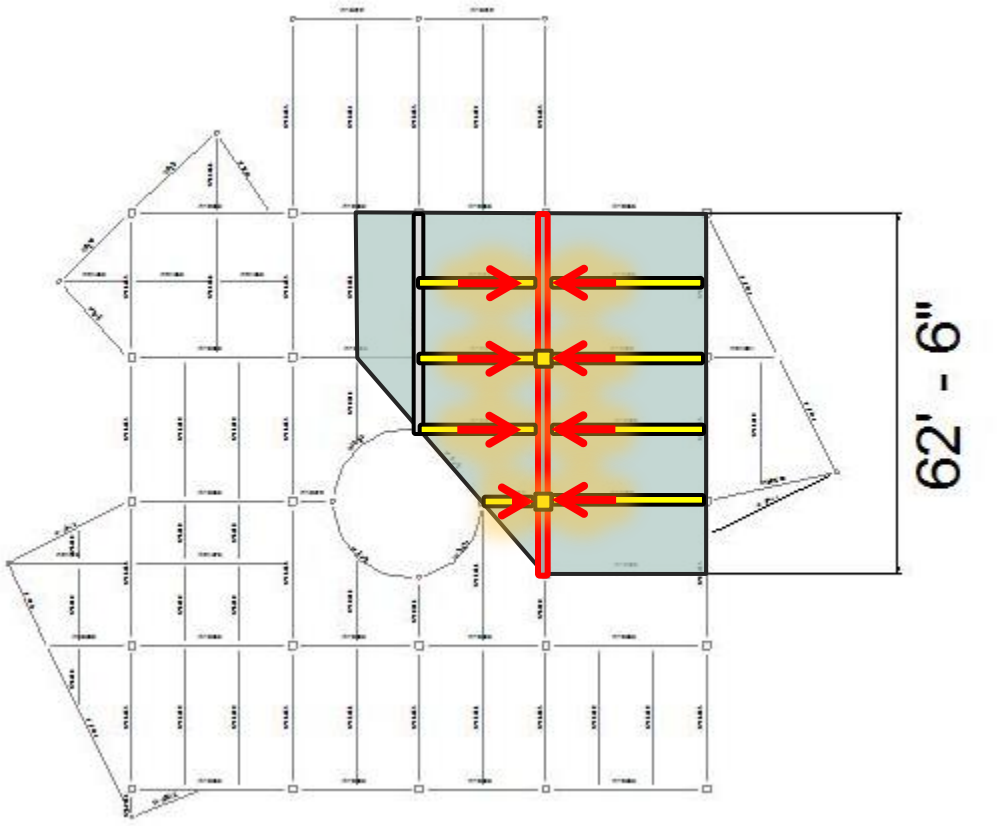
- Time History: El Centro 7.1 Magnitude (1940)
- Limiting Interstory Drift Ratio – 0.025
  - (4 stories or less with consideration of partitions for drift amounts ASCE 7-05 Table 12.12.1)





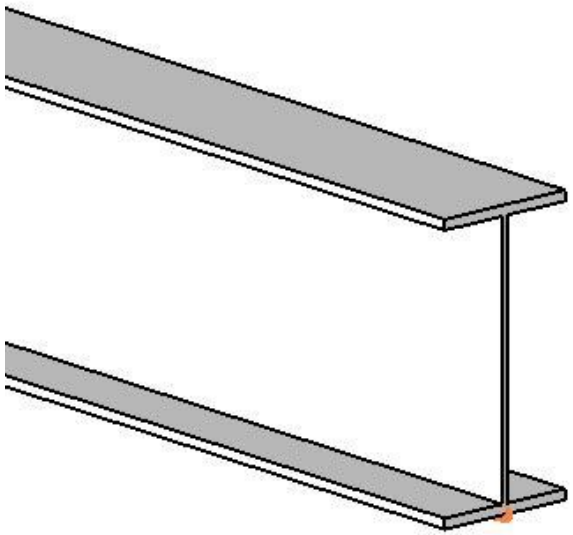
Enabling Detail: Auditorium Span

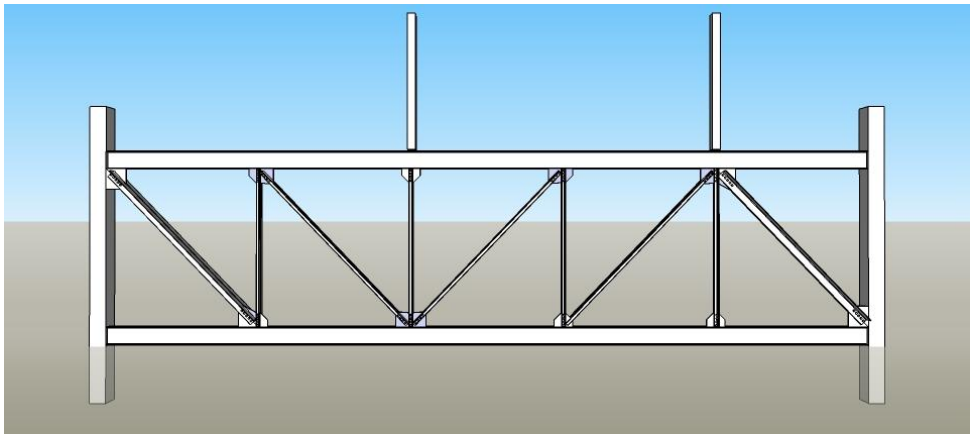
- 62.5ft long Span over Auditorium

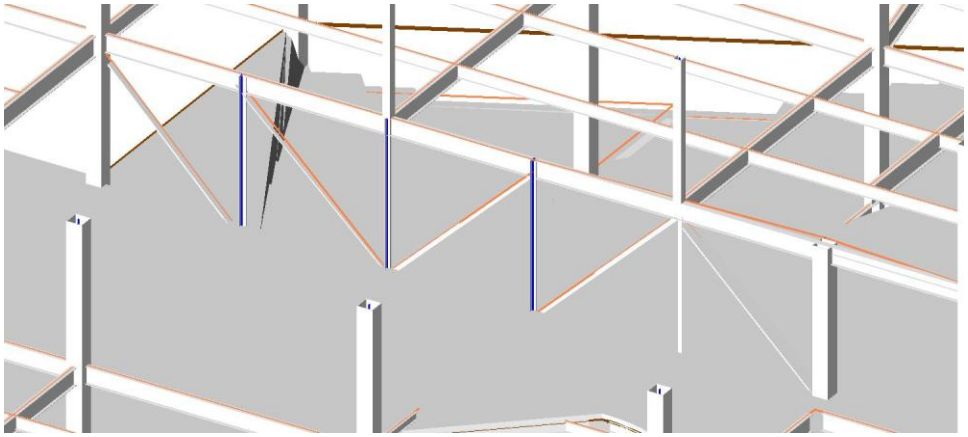


Enabling Detail: Auditorium Span

- Deep Beam or Floor-to-Floor Truss





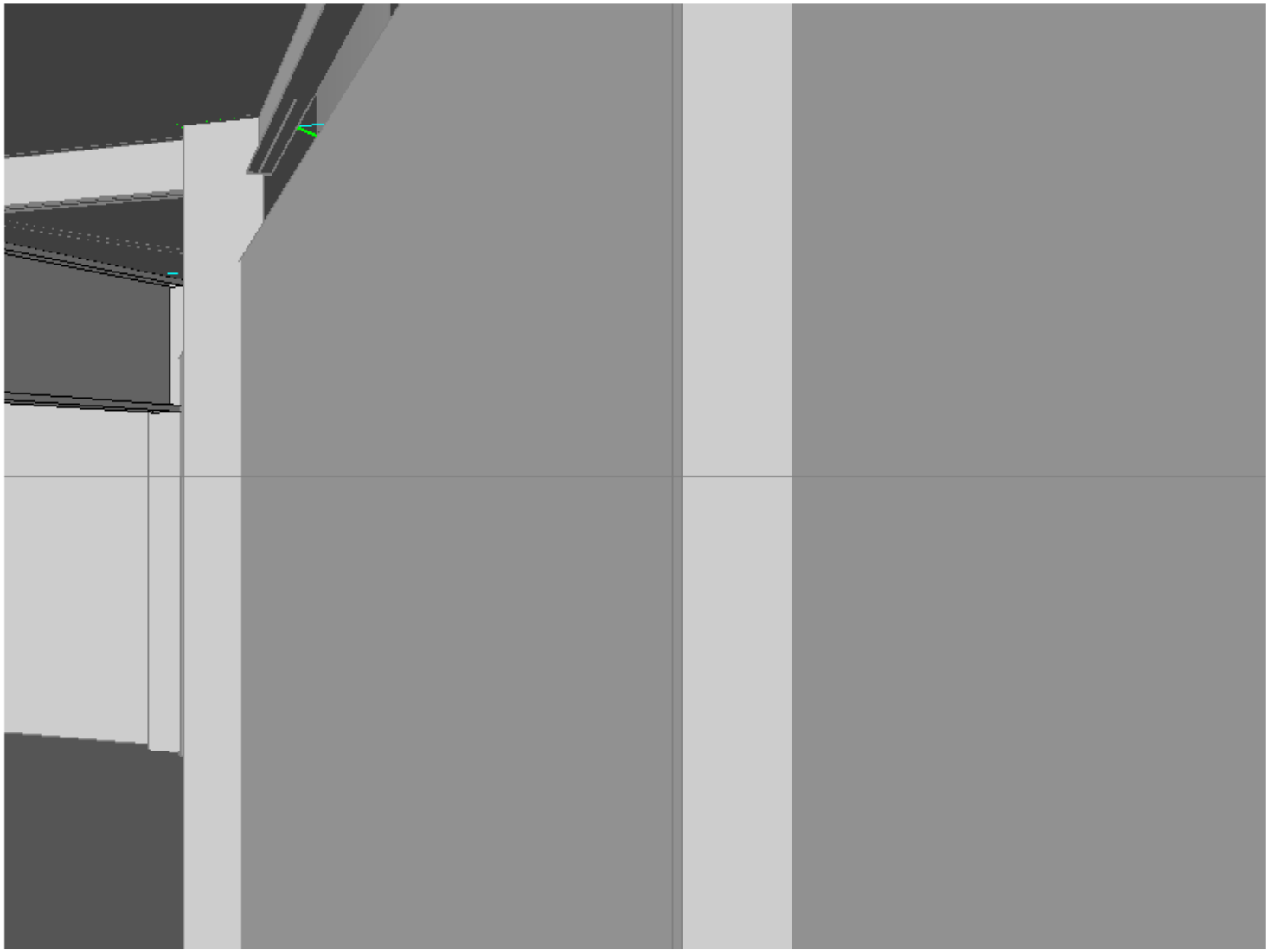


Enabling Detail: Auditorium Span

- Deep Beam

Pros	Cons
Single Member	Block Site Lines in Auditorium
Bolt Ends	Clash with MEP
	Needs larger Column, Custom

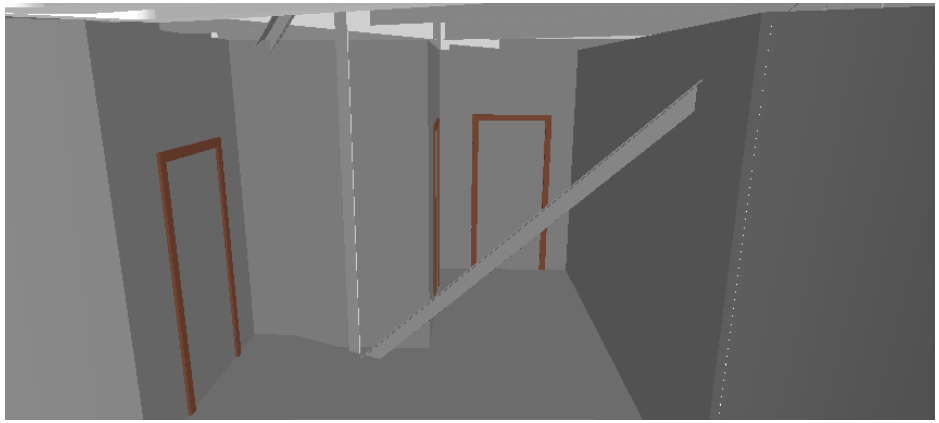
Deep Beam



Enabling Detail: Auditorium Span

- Floor-to-Floor Truss

Pros	Cons
Stiffer, less Deflection	More Fabrication
Top and bottom Chords small	Blocks Hallway to Classroom
Does not block Site lines	

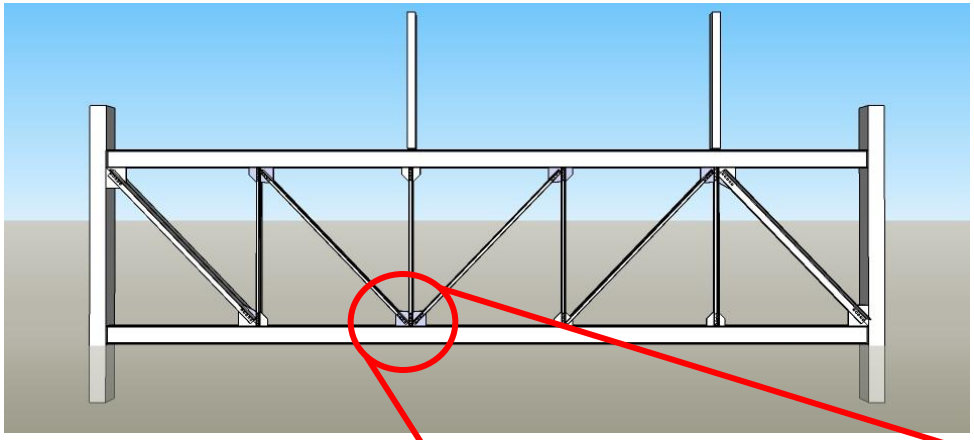


Enabling Detail: Auditorium Span

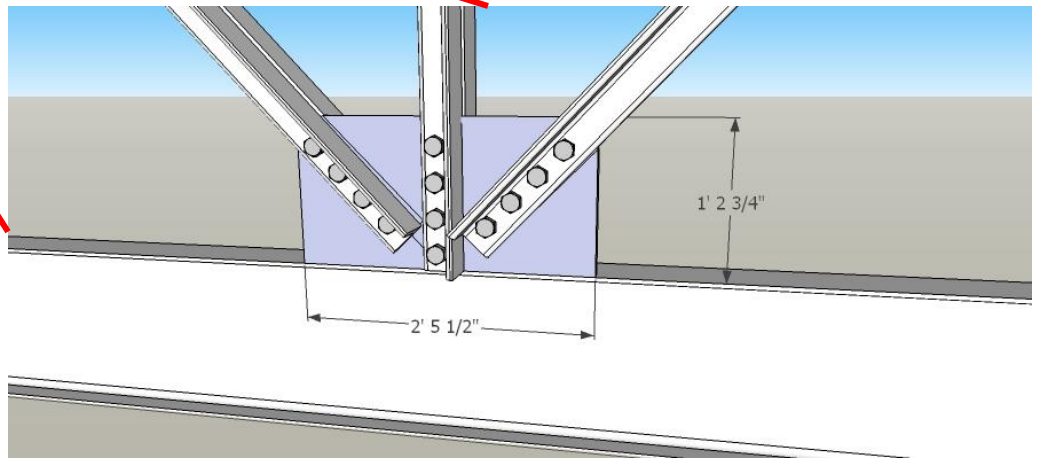
- Floor-to-Floor Truss
  - Doors fit under chevron truss
  - Glass walls expose truss elements

Enabling Detail: Auditorium Span

- Typical Truss Connection

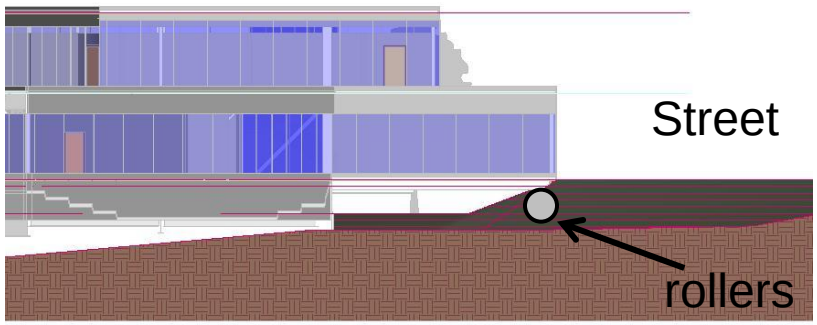


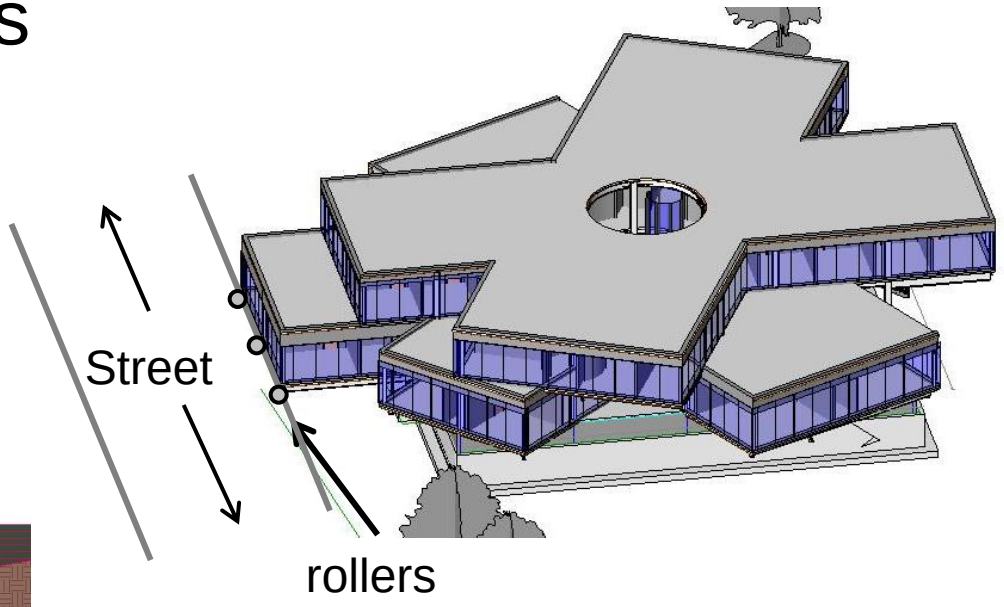
- Simple, Bolted Connections
- 1 1/8” A490 Bolts
- 1 ¼” A36 Steel Gusset Plate



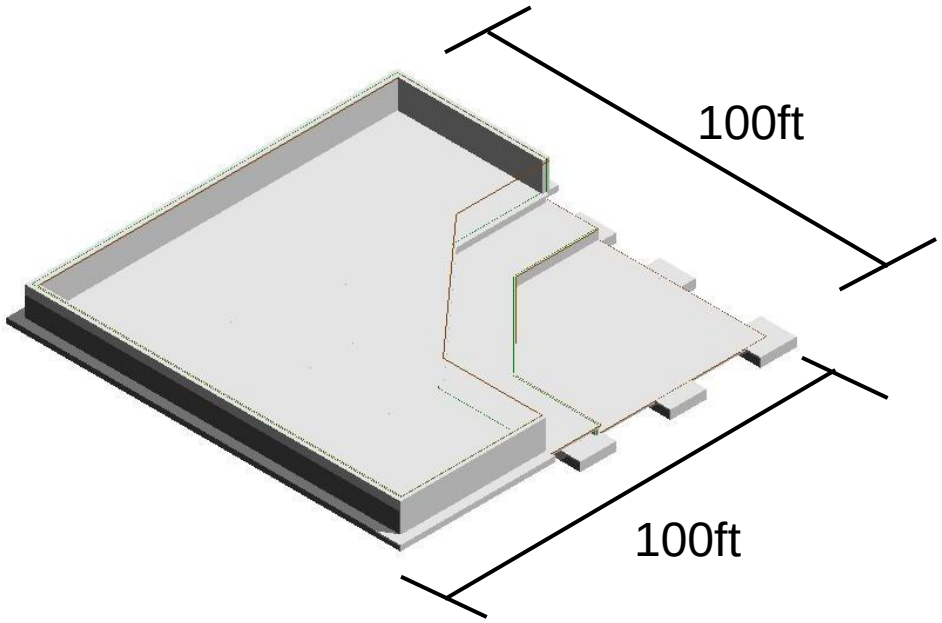
Bridged Entrance Connection

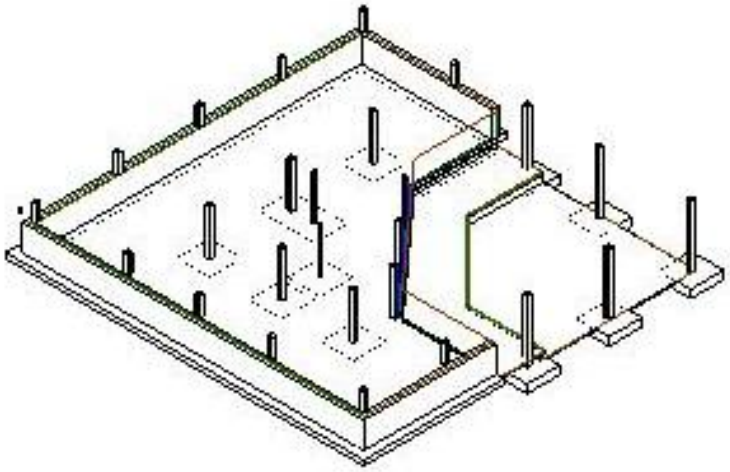
- Objective: connect building to street
- Goal: allow lateral movement during earthquake
- Solution: create a roller connection on street side
- Use: neoprene pads

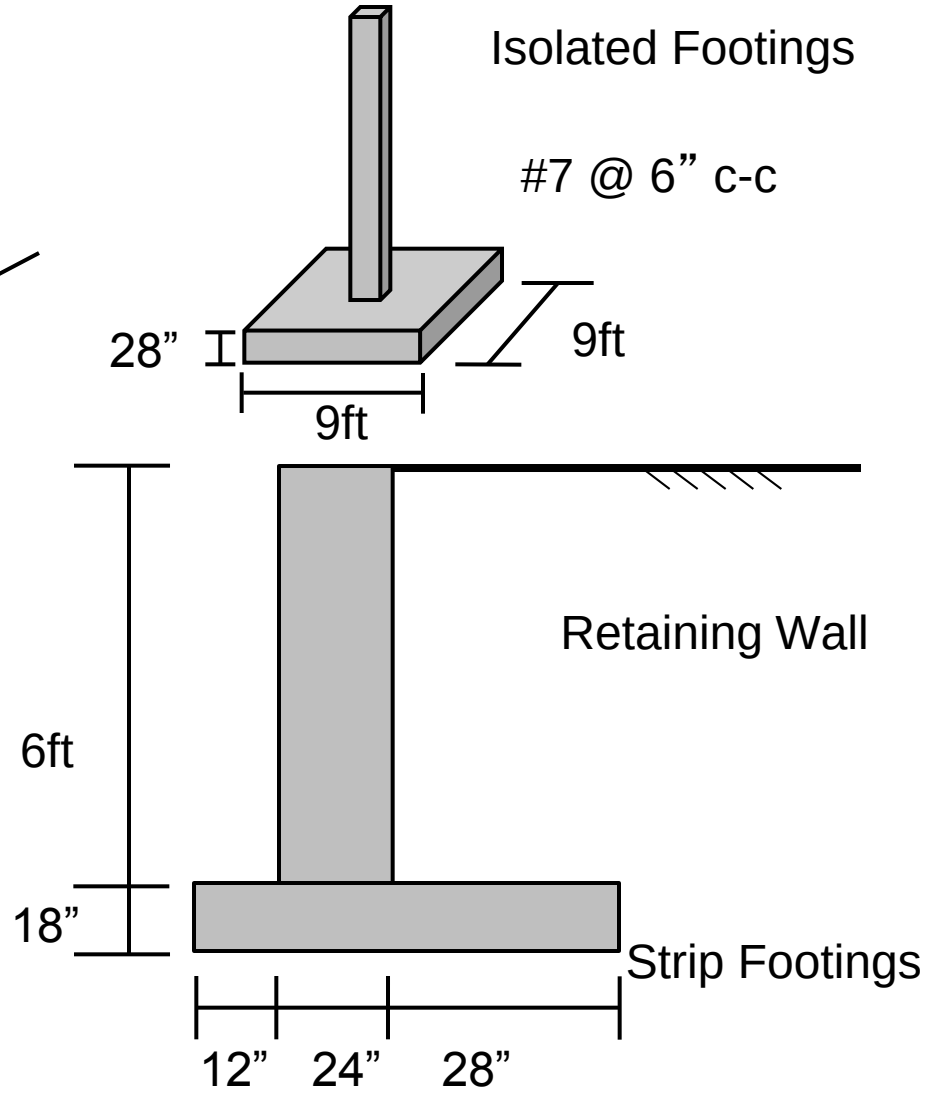




Foundation and Retaining Wall







MEP Design

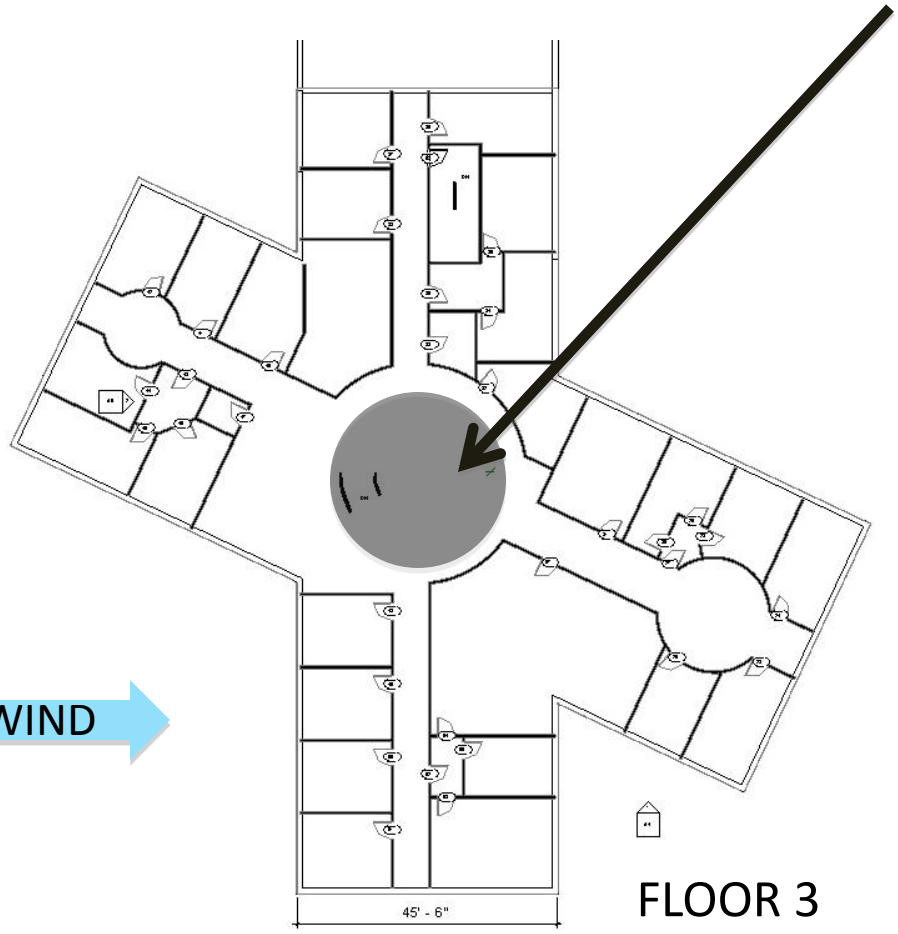
- Natural Ventilation Focus
  - Stack Effect
  - Windows
- Mechanical System Back-up
  - Active Multi-Service Chilled Beams
- Daylight Controls
  - Timers, Dimmers, Motion Sensors

Ecotect for Analysis

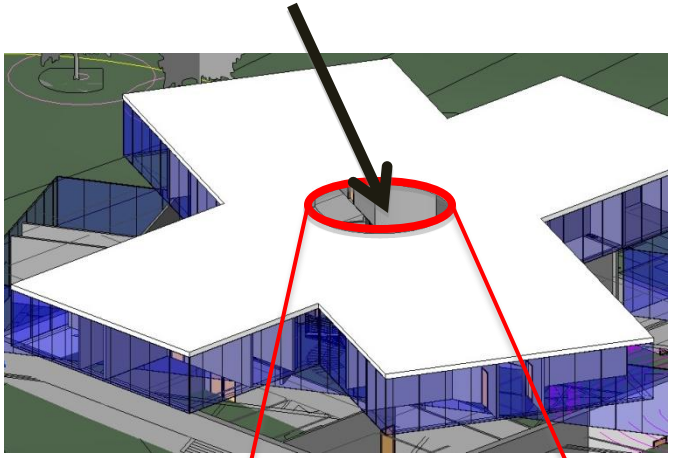
Natural Ventilation

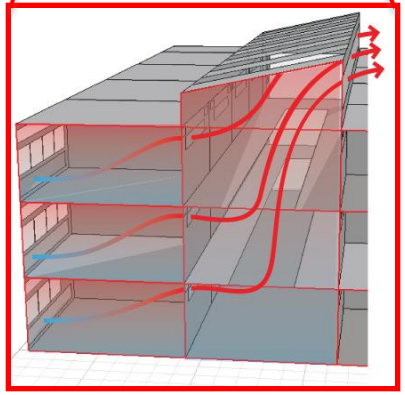
Stack Effect

Central Atrium:
Automatic Louvers and Fans at the Top



FLOOR 3





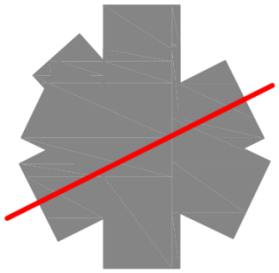
Natural Ventilation
Stack Effect

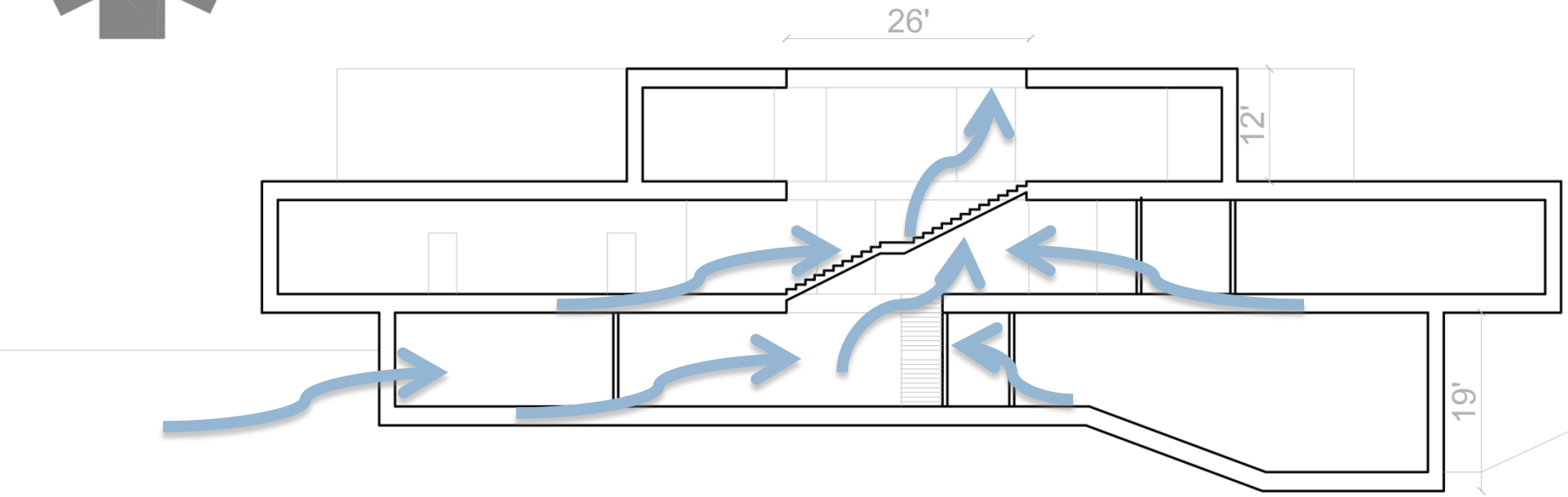
- Automatic Louvers
  - Open Toward Leeward Side
  - Let Enough Air Out for Stack Eff
  - Prevents Air from Entering

- Fans
  - Help With the Air Flow Up the Building

Natural Ventilation

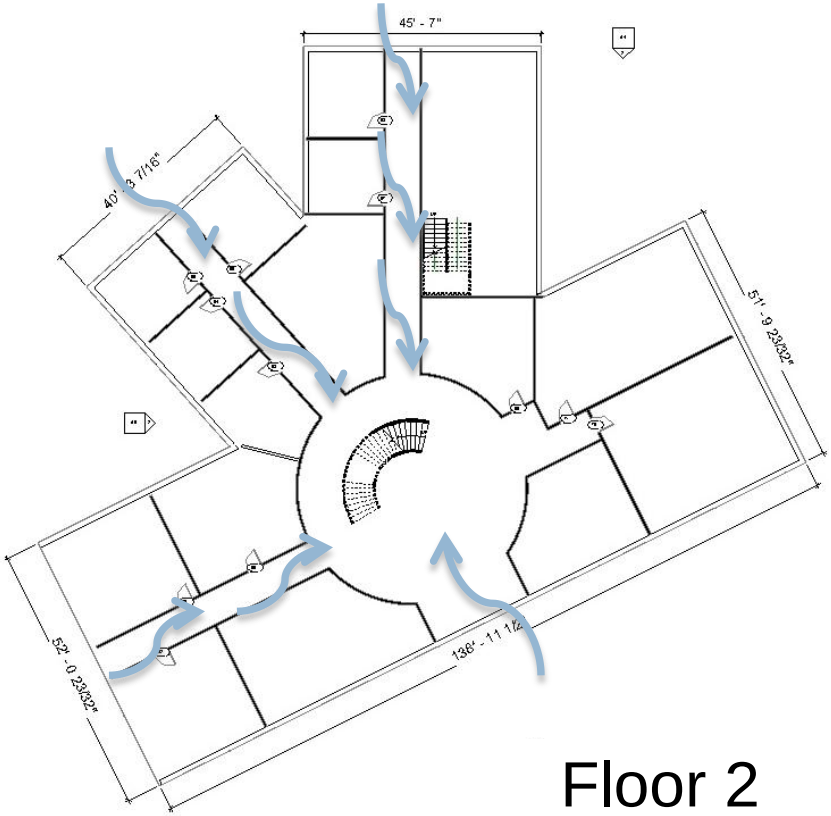
Stack Effect



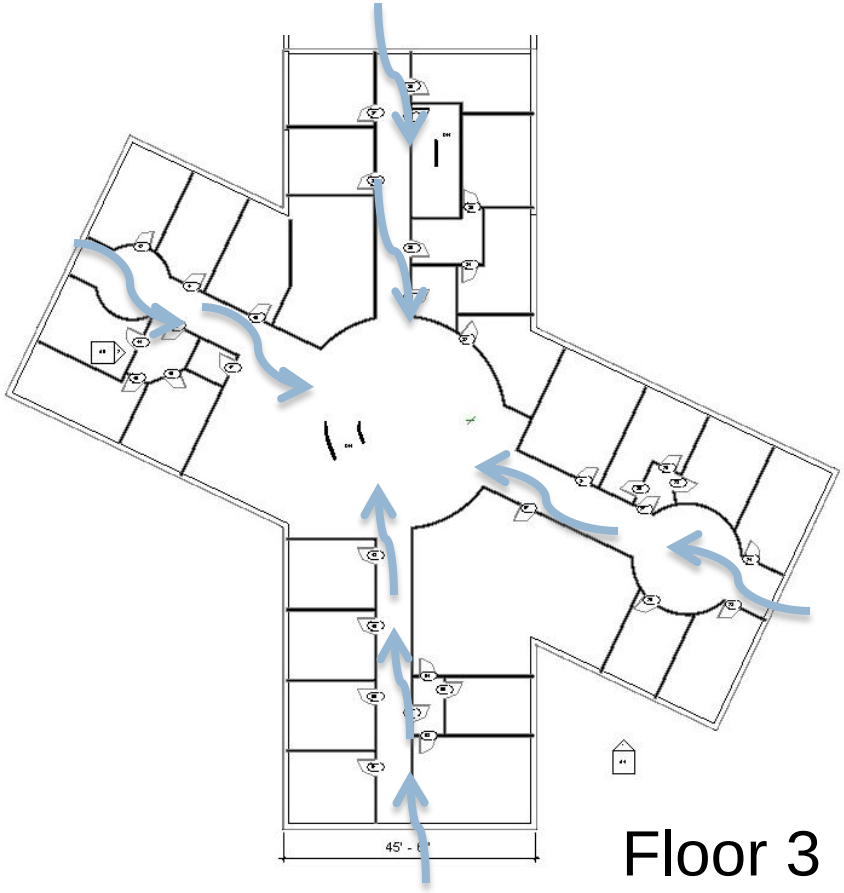


Natural Ventilation

Stack Effect



Floor 2

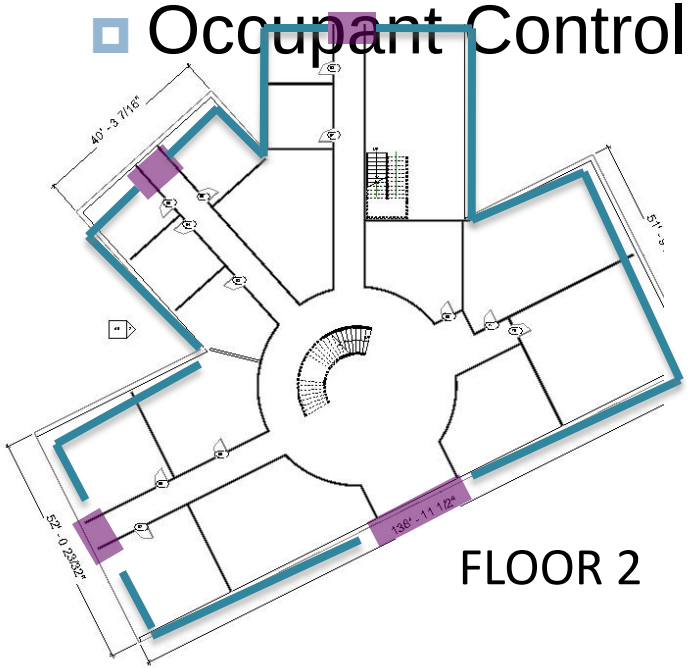


Floor 3

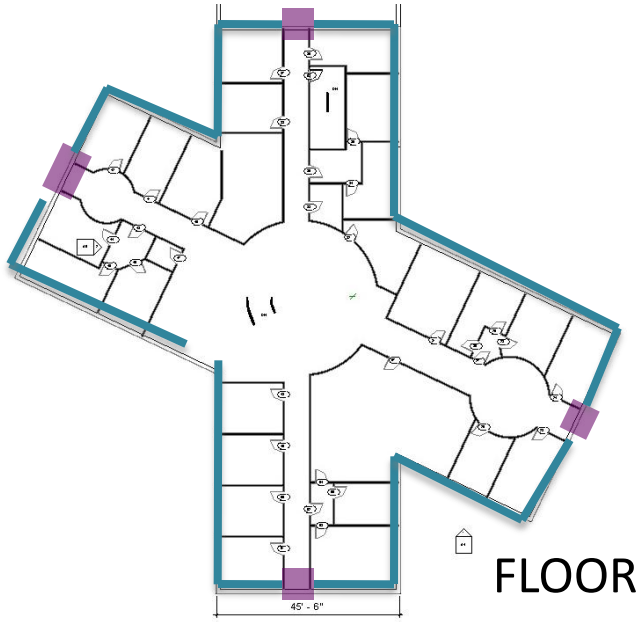
Natural Ventilation

Windows

- Windows that open to corridors: Automatic
  - Facilitate Stack Effect
- Windows that open to rooms: Manual Operable
  - Occupant Control



FLOOR 2

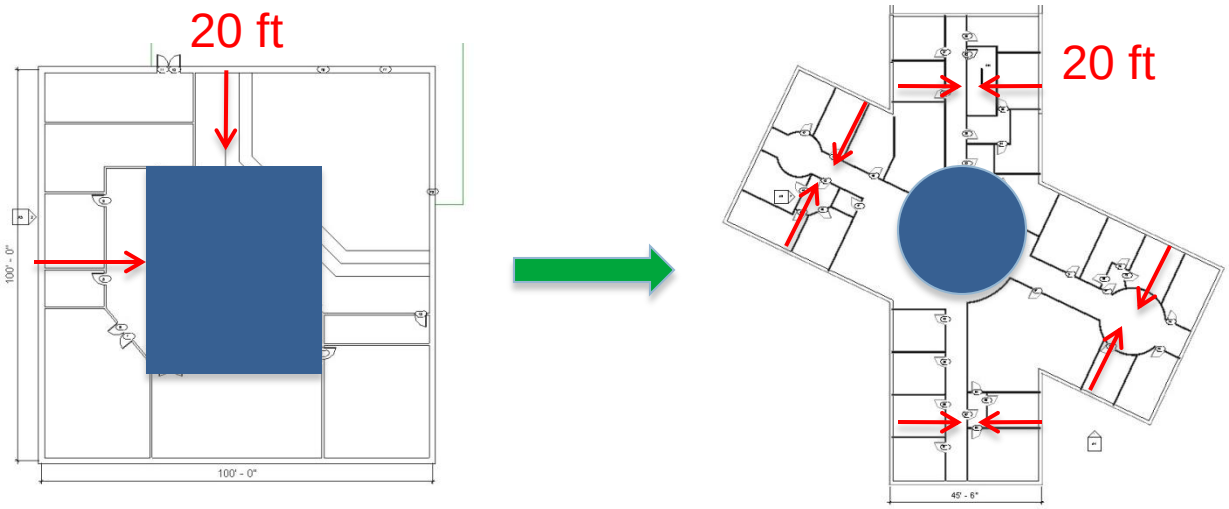


FLOOR 3

CA Title 24 Requirements

Natural Ventilation

- All spaces within 20 ft of an operable window
- Openings at least 5% of floor area



Development of arms helped with natural ventilation reaching more parts of the building

ASHRAE
WWR Standard

- Window-to-Wall Ratio: 40 % Limit

Mechanism's WWR: 60%

Shading

Lighting Efficiency

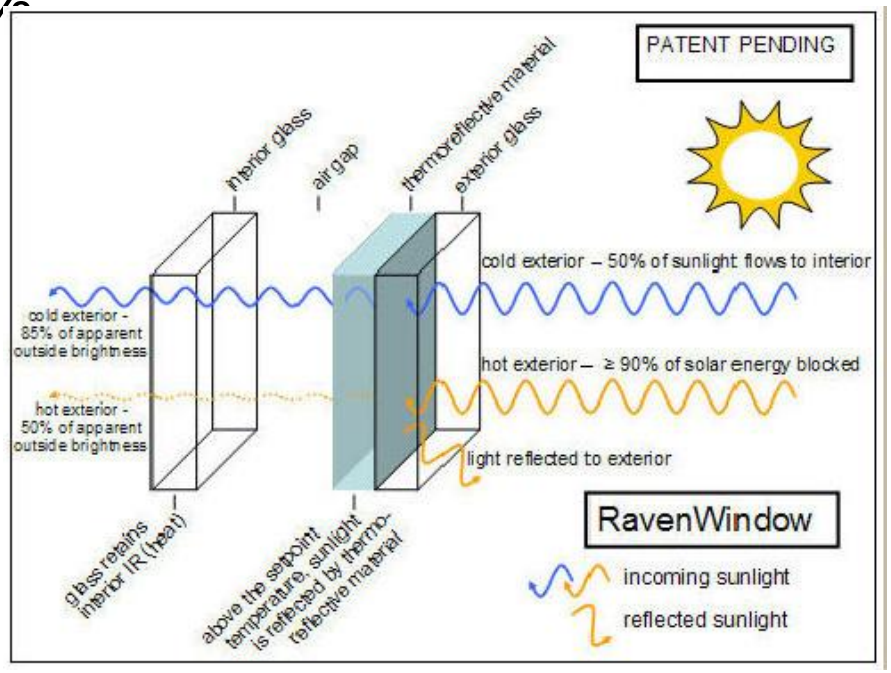
Mechanical System

Smart Windows

- Architect: “no shading devices”
- Hot Days: (tinted) reflect solar Heat away from Building
  Cold Days: (transparent) allow solar Heat into Building
- Reduce Energy Bills by 30%

Cold Days

Hot Days



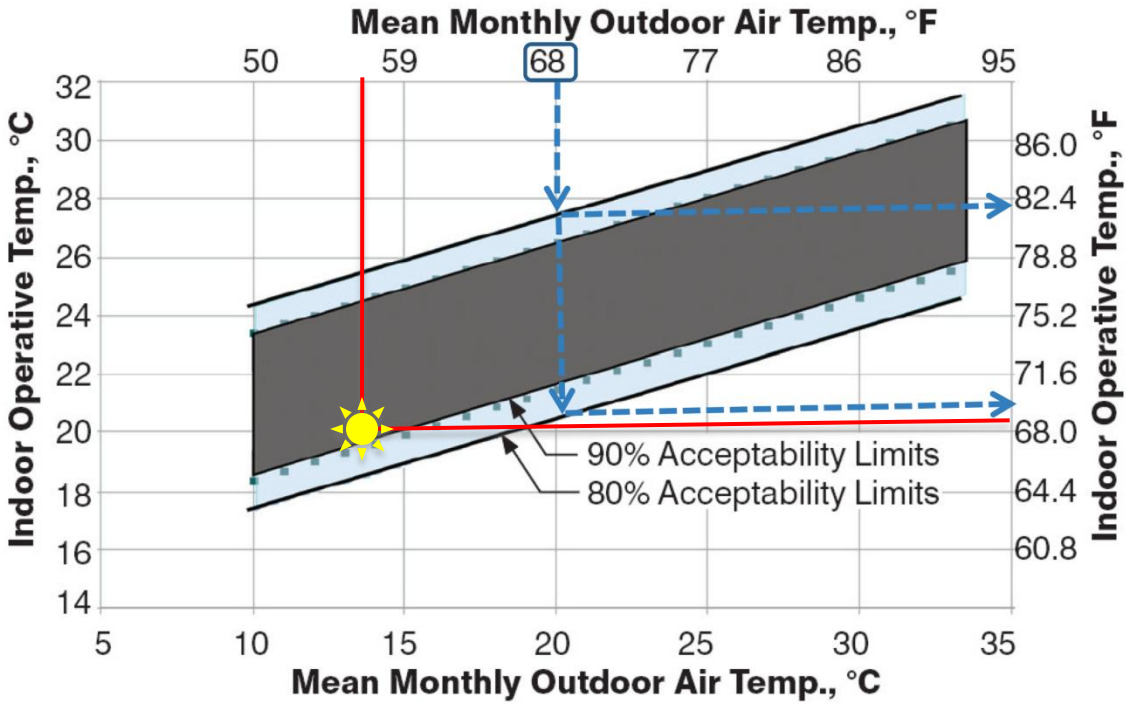
ASHRAE
Std 55-2004: Comfort Range

<u>3rd Floor Hallways:</u>

- Mean Monthly Outdoor Air Temp: 57°F
- Indoor Operative Temp: 69°F

Adaptive Comfort Model for Nat Vent Spaces

(Applies when occupants have access to operable windows)



ASHRAE
Standard 62.1

- New Requirement in 2010:
  - Mechanical ventilation in naturally ventilated spaces

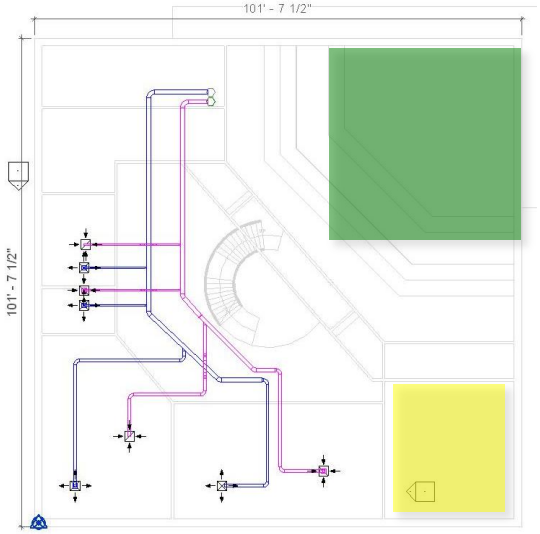
Natural Ventilation

with

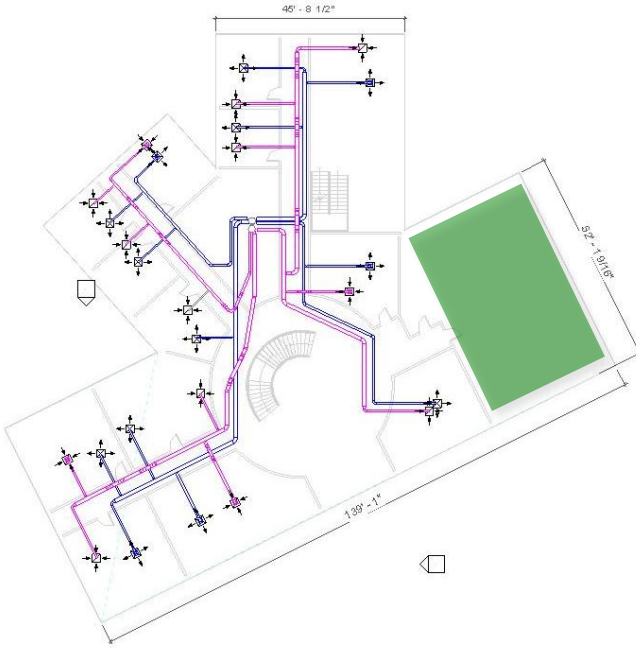
Active Multi-System Chilled Beams

Mechanical System
Distribution Tree

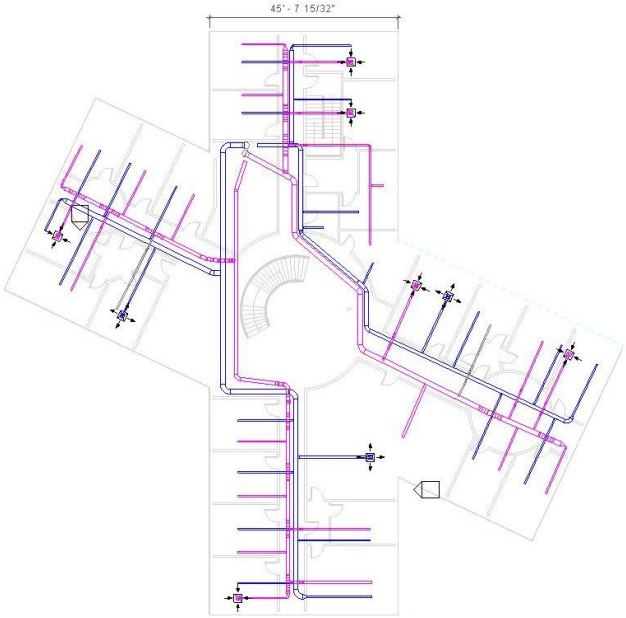
FLOOR 1



FLOOR 2



FLOOR 3



Server Room Portable A/C Unit

Displacement Ventilation

Active Multi-Service Chilled Beams

Supply

Return

A E C M L

Airflow Criteria

Baseline (40% WWR)

Space	Cfm/sf
Classroom	0.667
Hall	0.250
Lab	1.000
Lounge	0.667
Mechanical Room	0.042
Office	0.667
Server Room	1.333
Storage/Copy	0.042
Toilets	1.667
Auditorium	0.85

Mechanism (60% WWR)

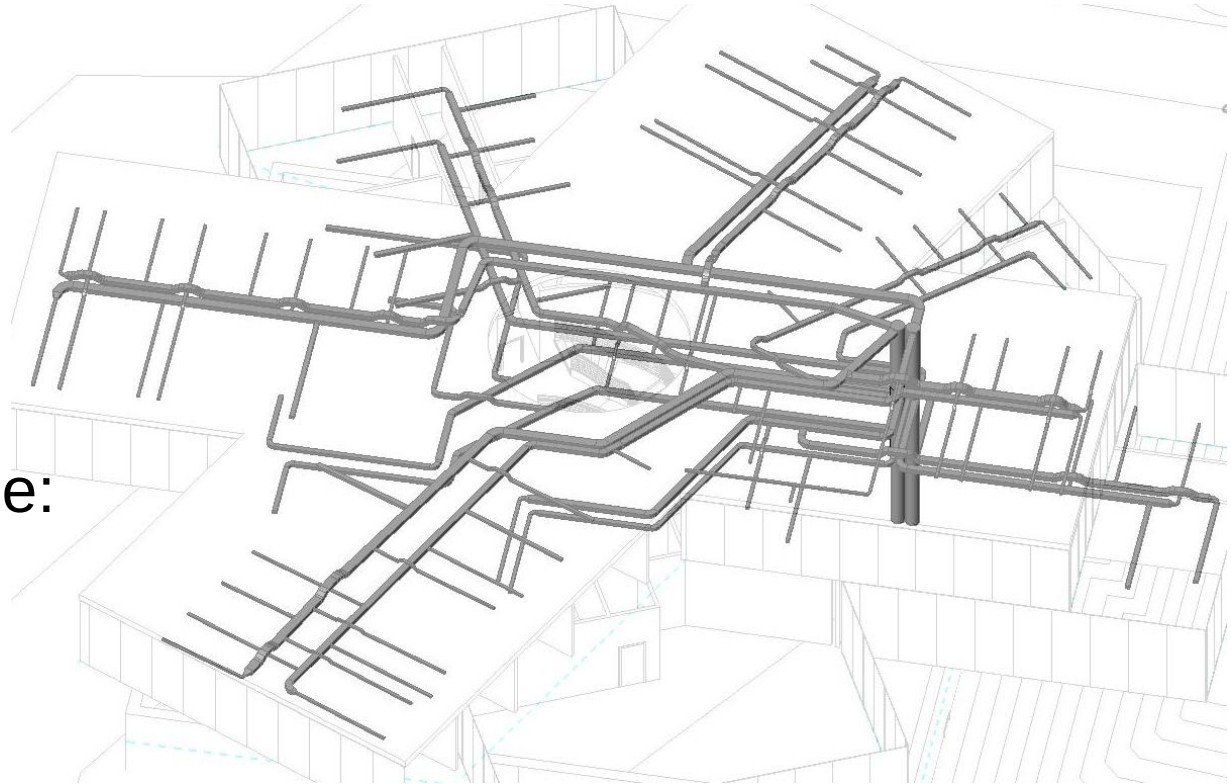
Space	Cfm/sf
Classroom	1.083
Hall	0.250
Lab	1.000
Lounge	1.083
Mechanical Room	0.042
Office	1.083
Server Room	1.333
Storage/Copy	0.042
Toilets	1.667
Auditorium	1.105

Afaan Naqvi
PE LEED AP CEM

MEP Distribution

AHU:
400 fpm face velocity

Main Vertical Supply Duct Size:
25” diameter



Energy-Saving Design: low-velocity AHU, smooth ductwork

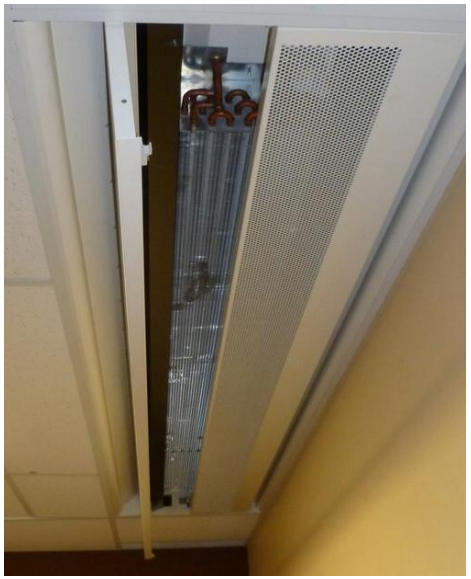
Mechanical System
Active Multi-Service Chilled Beams

- Advantages to entire team:
  - Prefabricated *(CM)*
  - Less Space in Sandwich Height *(A/E*
  - Reduced Installation Cost *(CM)*
  - Low Maintenance Cost *(LCFM)*
  - Multiple Systems in One Unit (Save Space)

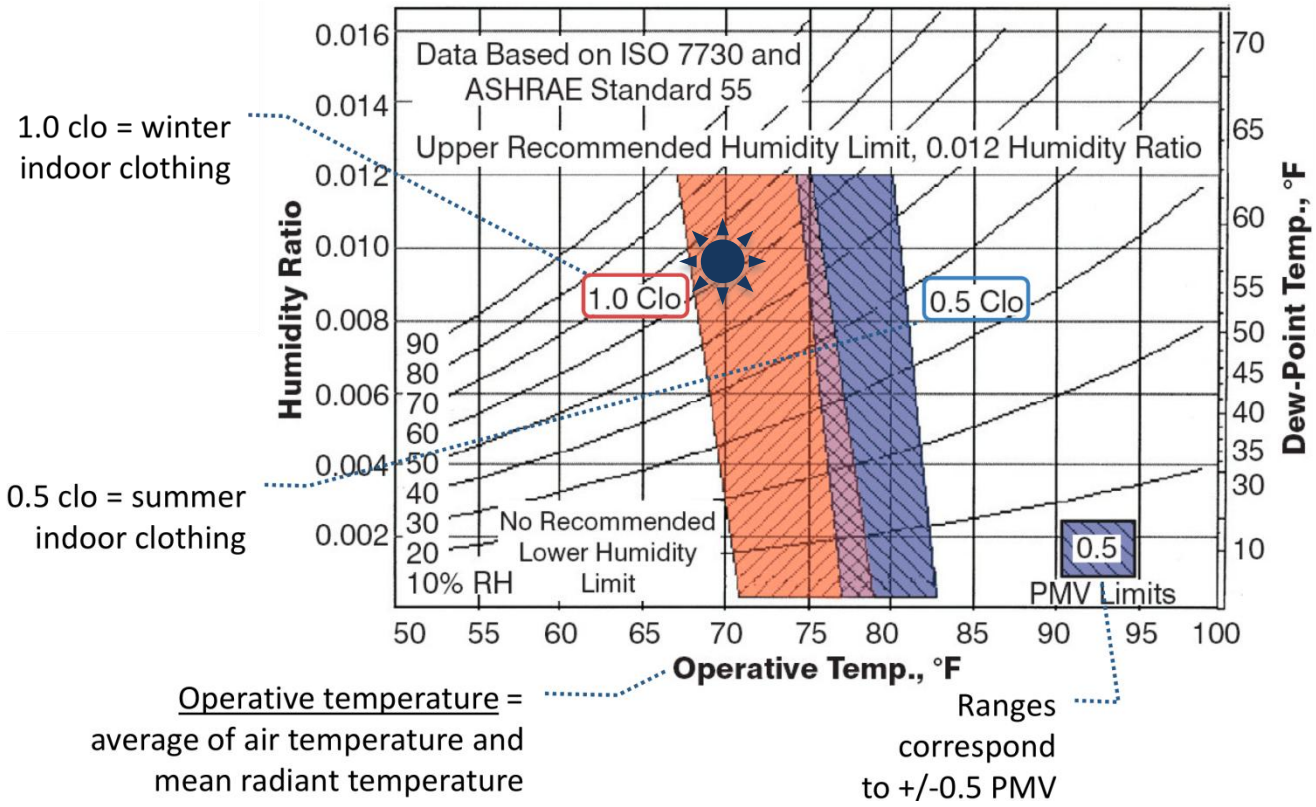
Mechanical System
Active Multi-Service Chilled Beams

- Thermostats (individual Control)

- Sensor on each Chilled Beam
  - Provide only the required Heating/Cooling
  - Linked to Thermostats
  - Dewpoint Temperature Control



ASHRAE
Std 55-2004: Comfort Range



~0.96 clo

Trousers, Long-Sleeve Shirt, Suit Jacket

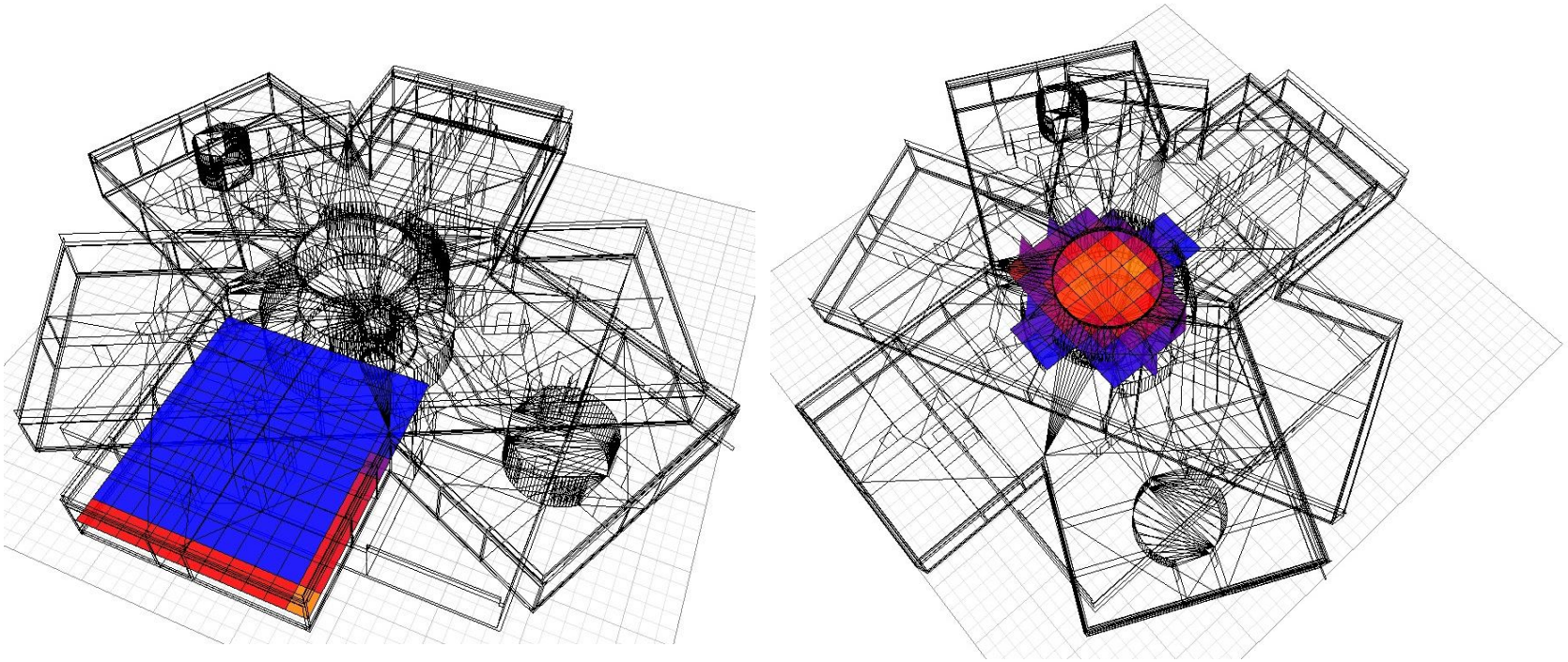
Lighting Design

ASHRAE Standard 90.1-2007

Space Type	LPD (W/sf)	Mechanism (# lamps)
Office-Open Plan	1.1	683
Conference/Multi-Purpose	1.3	107
Corridor/Transition	0.5	142
Restroom	0.9	47

32-W T-8’s in the multiservice chilled beams

Lighting Strategies
Dimming Controls

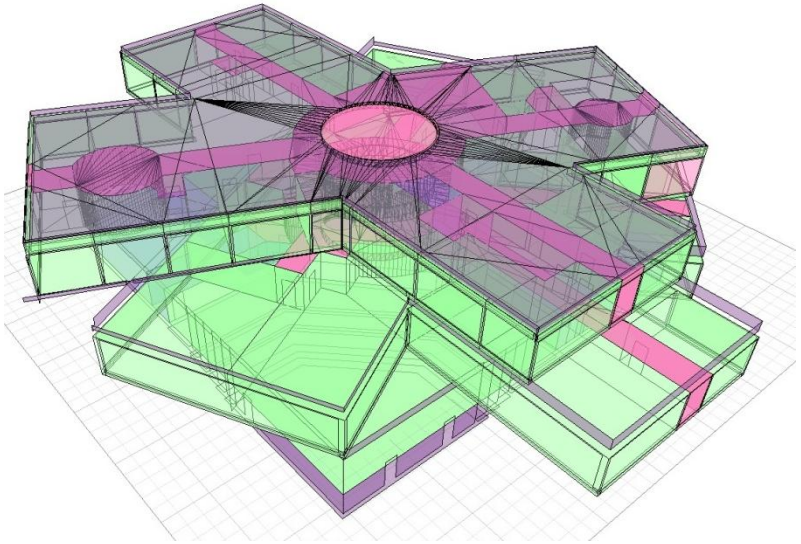


- More daylighting around perimeter and below atrium
- Dimming controls in these areas
  - 9% energy savings

Lighting Strategies
Programmed Schedule

- Building Operation Schedule: 6 am – 11 pm
- Timers in Systems to Shut Down Beyond Schedule
  - Everything must be manually controlled after hours

Ecotect Model



- Compare:
  - Baseline
    - fully air-conditioned spaces
  - Natural Ventilation
    - stack effect in corridors
    - mixed mode in rooms
  - Natural Ventilation + Timers
    - fully operable 6 am – 11 pm

Thermal Zone Settings:

Pink: Hallways

Green: Functional Rooms (Offices, Classrooms)

Purple: Server Room, Storage Rooms

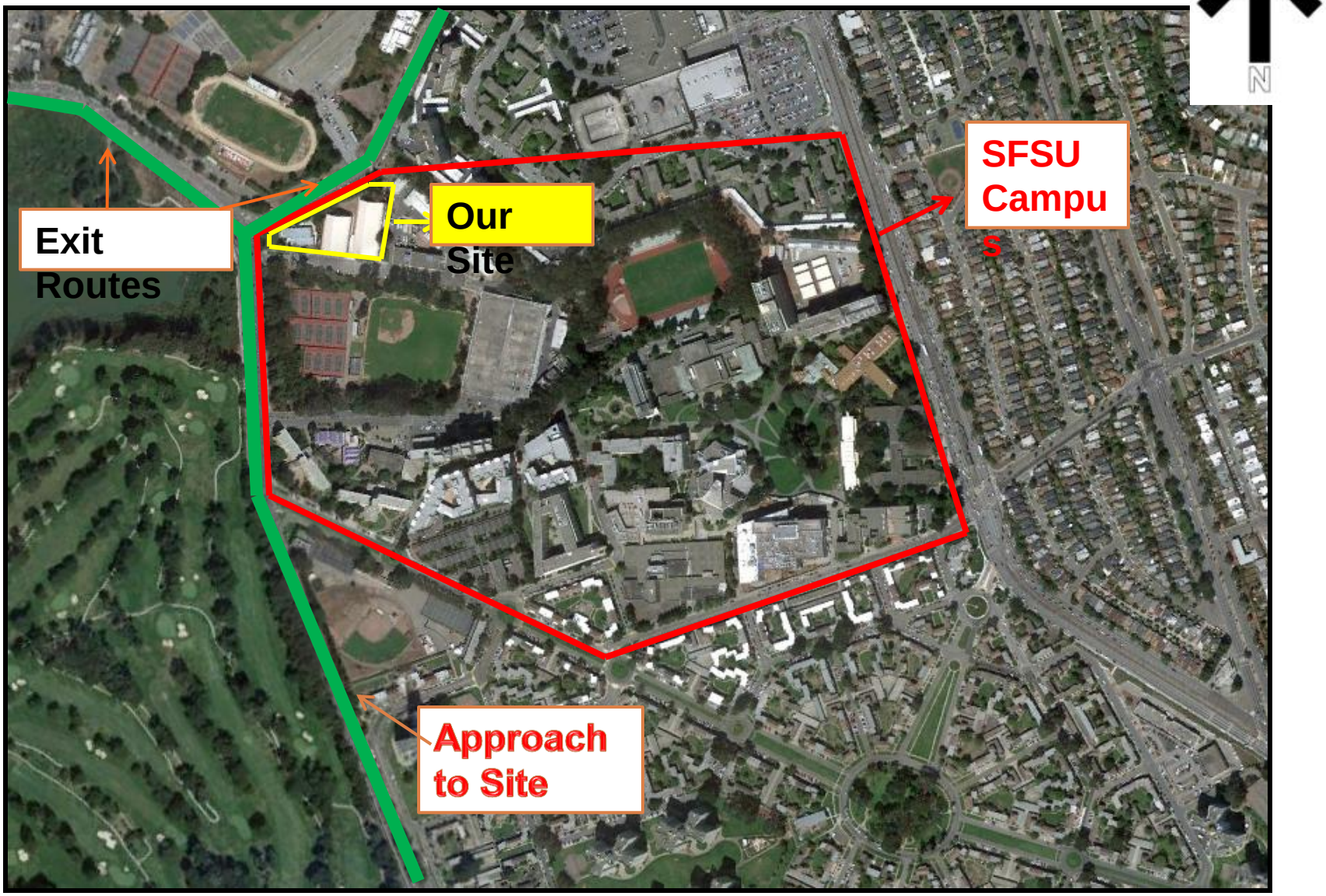
Red (unseen on

Energy Consumption

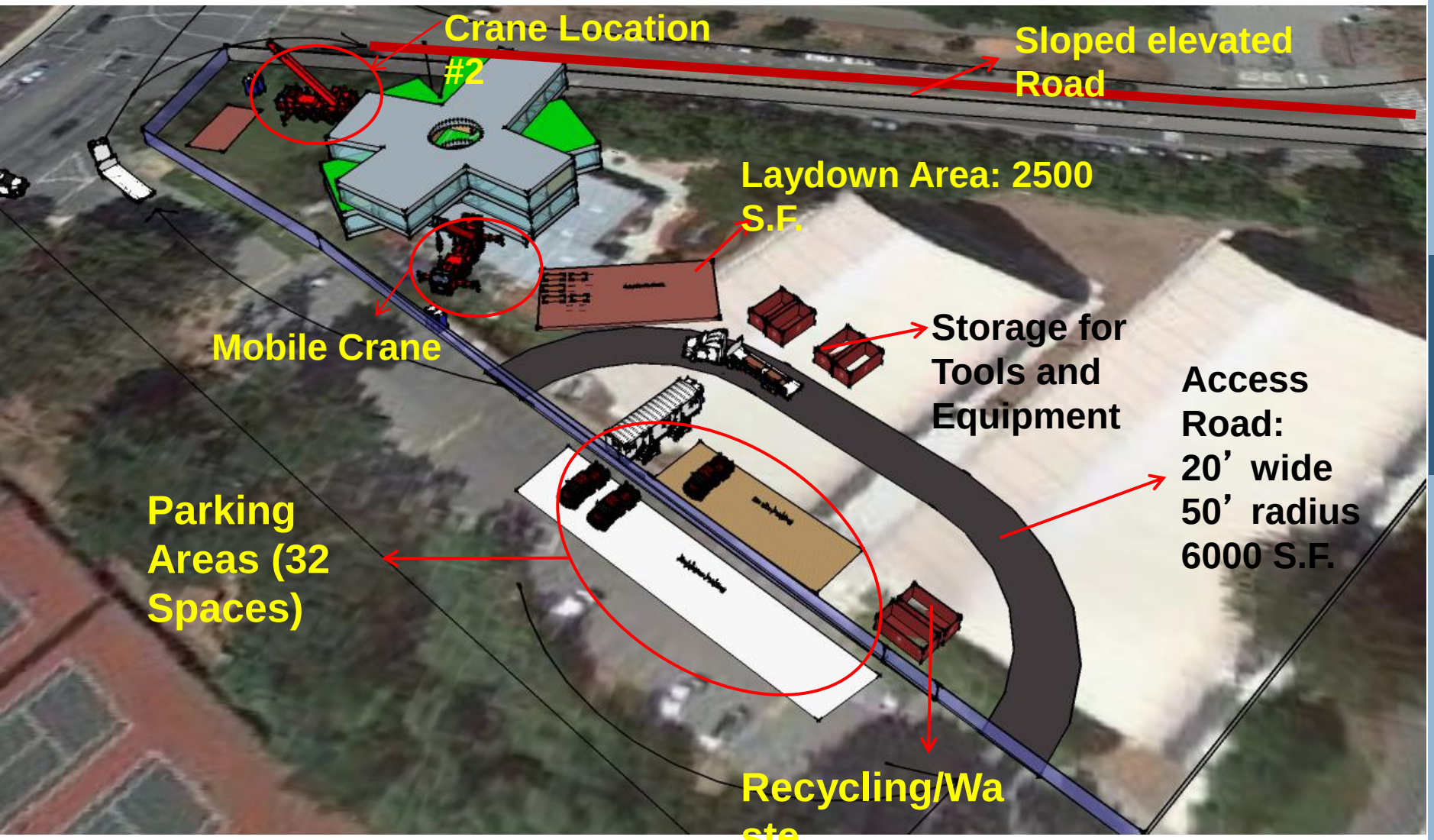
	Max Heating (kW) Max Cooling (kW)	Total Heating/Cooling Load (kWh/m^2/yr)
Baseline	496 kW January 2nd 588 kW July 2nd	289 kWh/m^2/yr
Natural Ventilation	550 kW January 2nd 680 kW July 2nd	245 kWh/m^2/yr
Natural Ventilation + Dimming + Timers	556 kW January 2nd 715 kW July 2nd	190 kWh/m^2/yr

34% Saved

Site Access



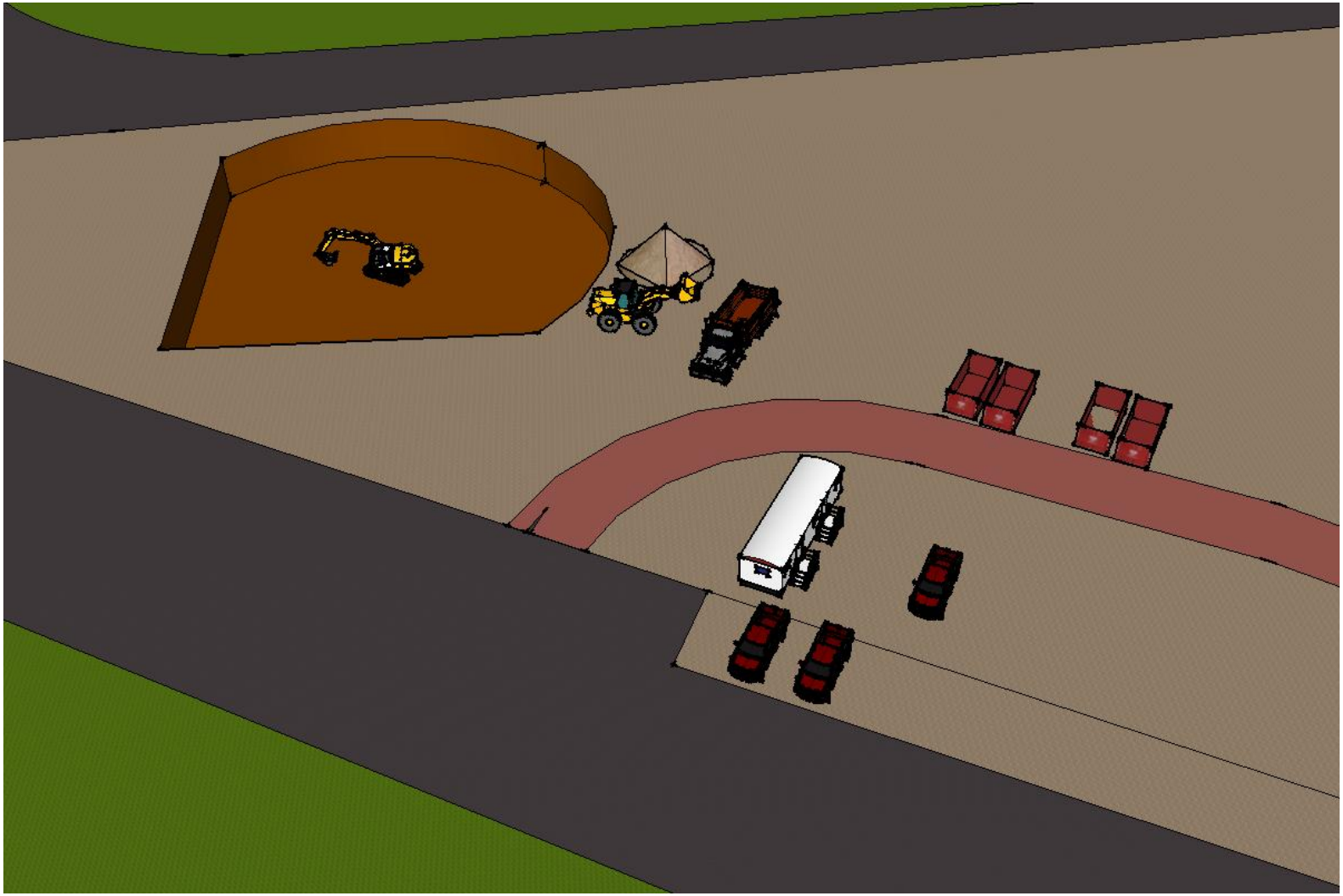
Site Layout



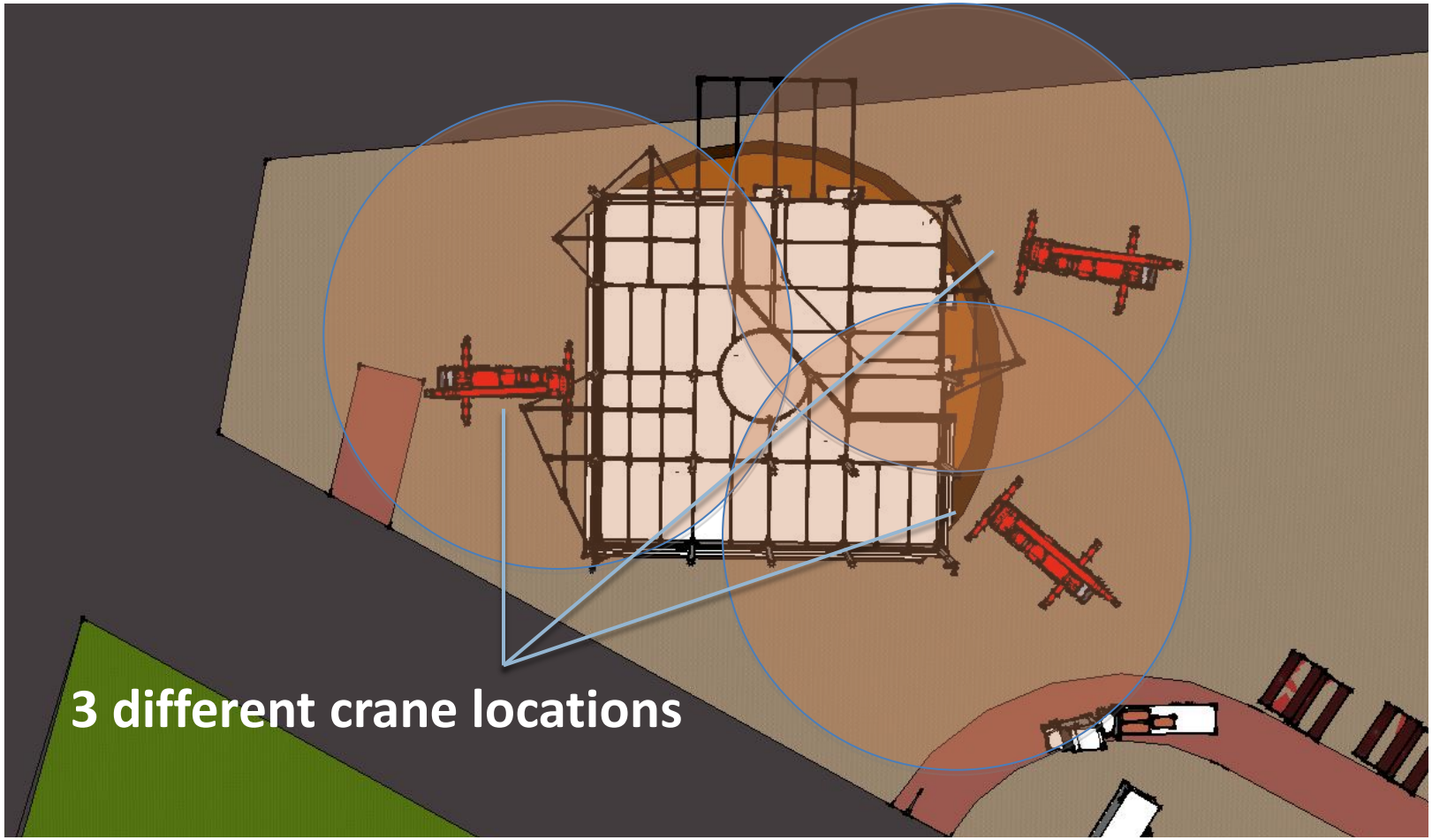
A
E
C
M
L

Site Layout

Excavation



Site Layout
Steel Erection



Equipment

Wheel Loader:
JCB 426 HT
2.5 CY Bucket

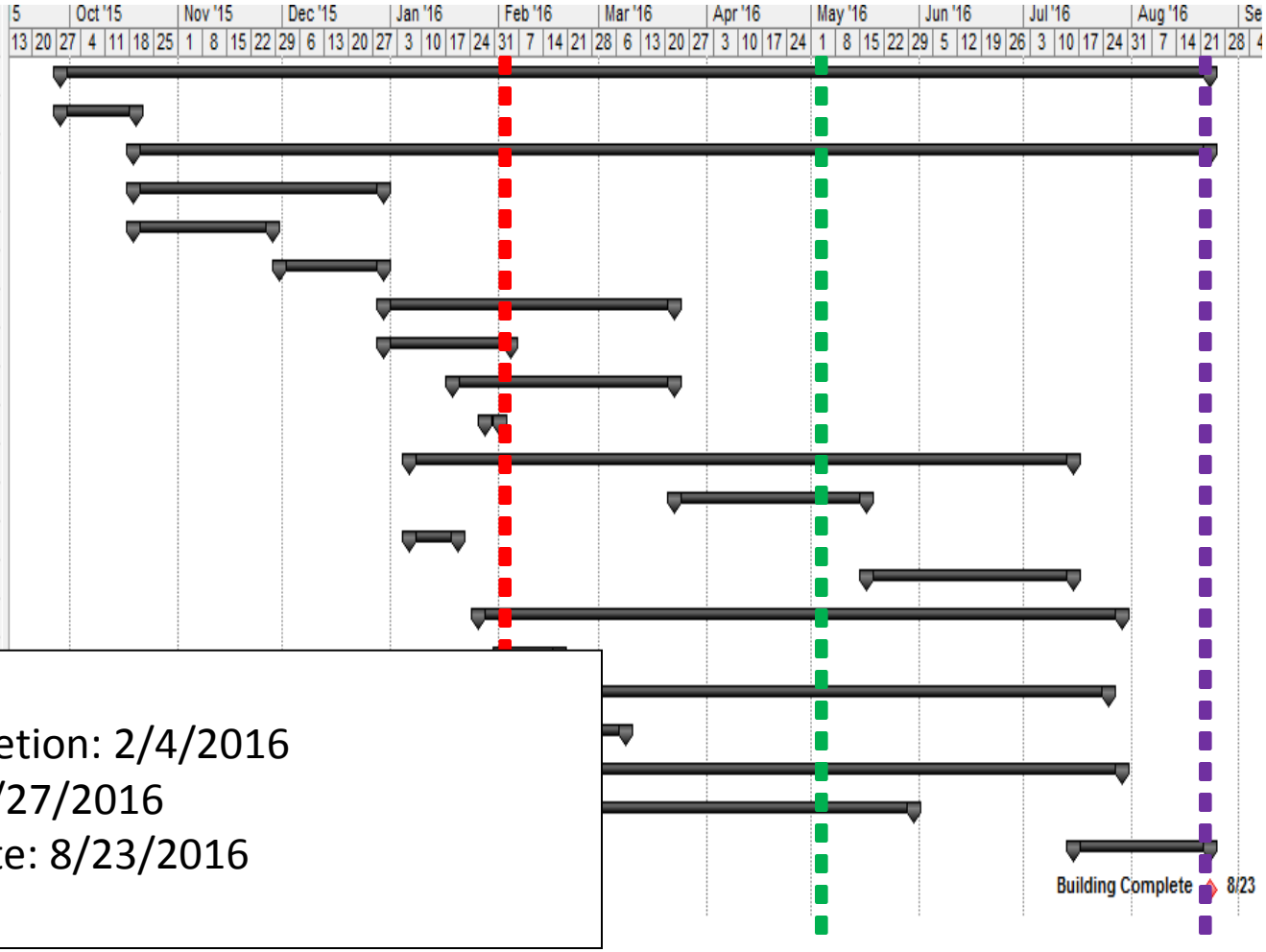
Excavator:
JCB JS 260
1.5 CY Bucket

Mobile Crane:
Grove TM 8690

<u>Other Equipment</u>
Aerial Lifts
Forklift
Trucks

Construction Schedule

	Task Name	Start	Finish
1	Team Pacific SFSU Building Proje	Mon 9/28/15	Tue 8/23/16
2	Sitework	Mon 9/28/15	Mon 10/19/15
9	SFSU Building	Mon 10/19/15	Tue 8/23/16
10	Substructure	Mon 10/19/15	Tue 12/29/15
11	Basement Constructio	Mon 10/19/15	Fri 11/27/15
21	Foundations	Mon 11/30/15	Tue 12/29/15
29	Shell	Wed 12/30/15	Tue 3/22/16
30	Superstructure	Wed 12/30/15	Thu 2/4/16
67	Exterior Enclosure	Tue 1/19/16	Tue 3/22/16
96	Roof	Thu 1/28/16	Mon 2/1/16
99	Interior	Wed 1/6/16	Fri 7/15/16
100	Interior Construction	Tue 3/22/16	Mon 5/16/16
115	Stairs	Wed 1/6/16	Wed 1/20/16
121	Interior Finishes	Tue 5/17/16	Fri 7/15/16
152	Services	Tue 1/26/16	Fri 7/29/16



Project Duration: 237 Days

- ConXtech Completion: 2/4/2016
- Early Move-in: 4/27/2016
- Building Complete: 8/23/2016

ConXtech Complete

Early Move-in

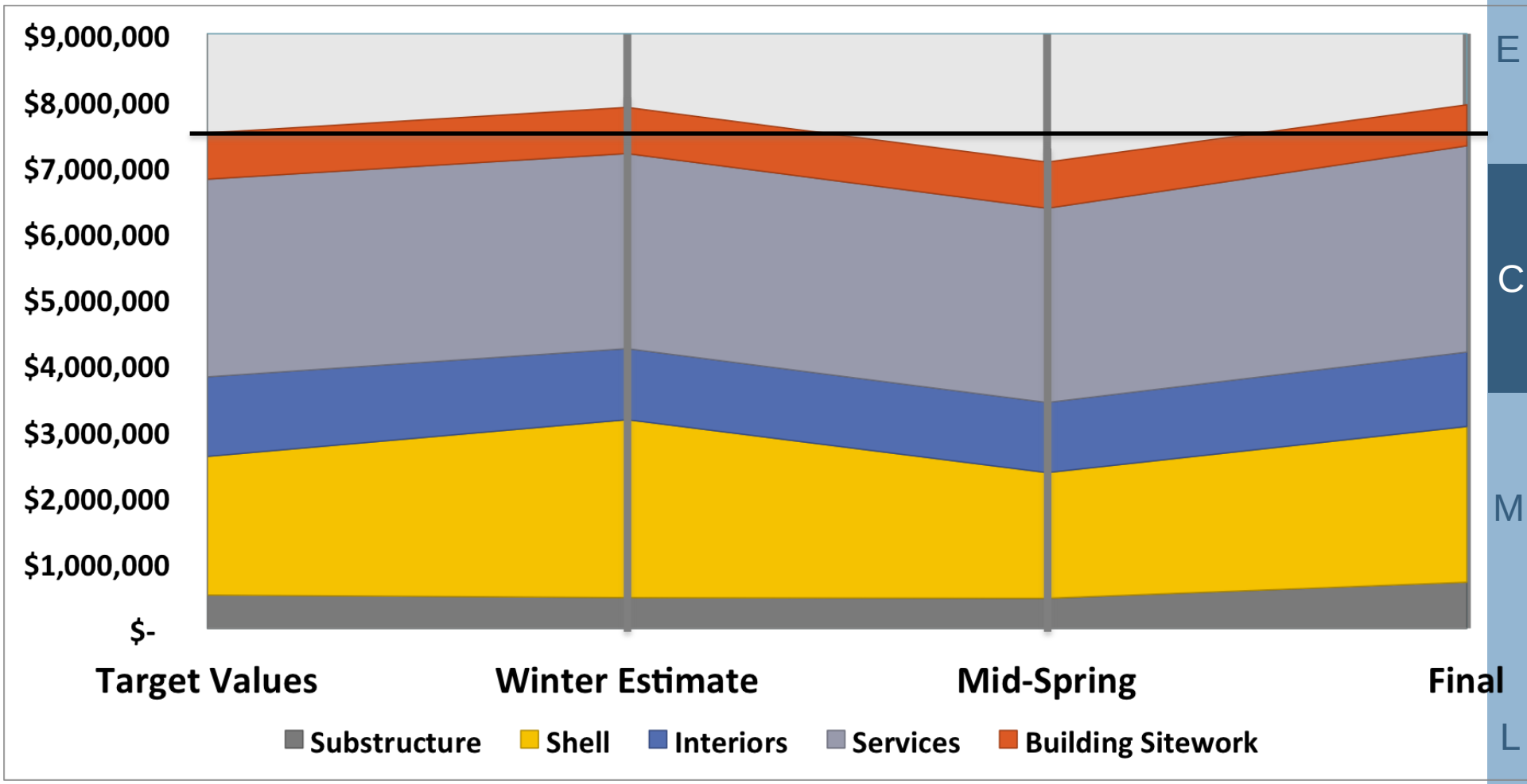
Building Complet

Construction Model

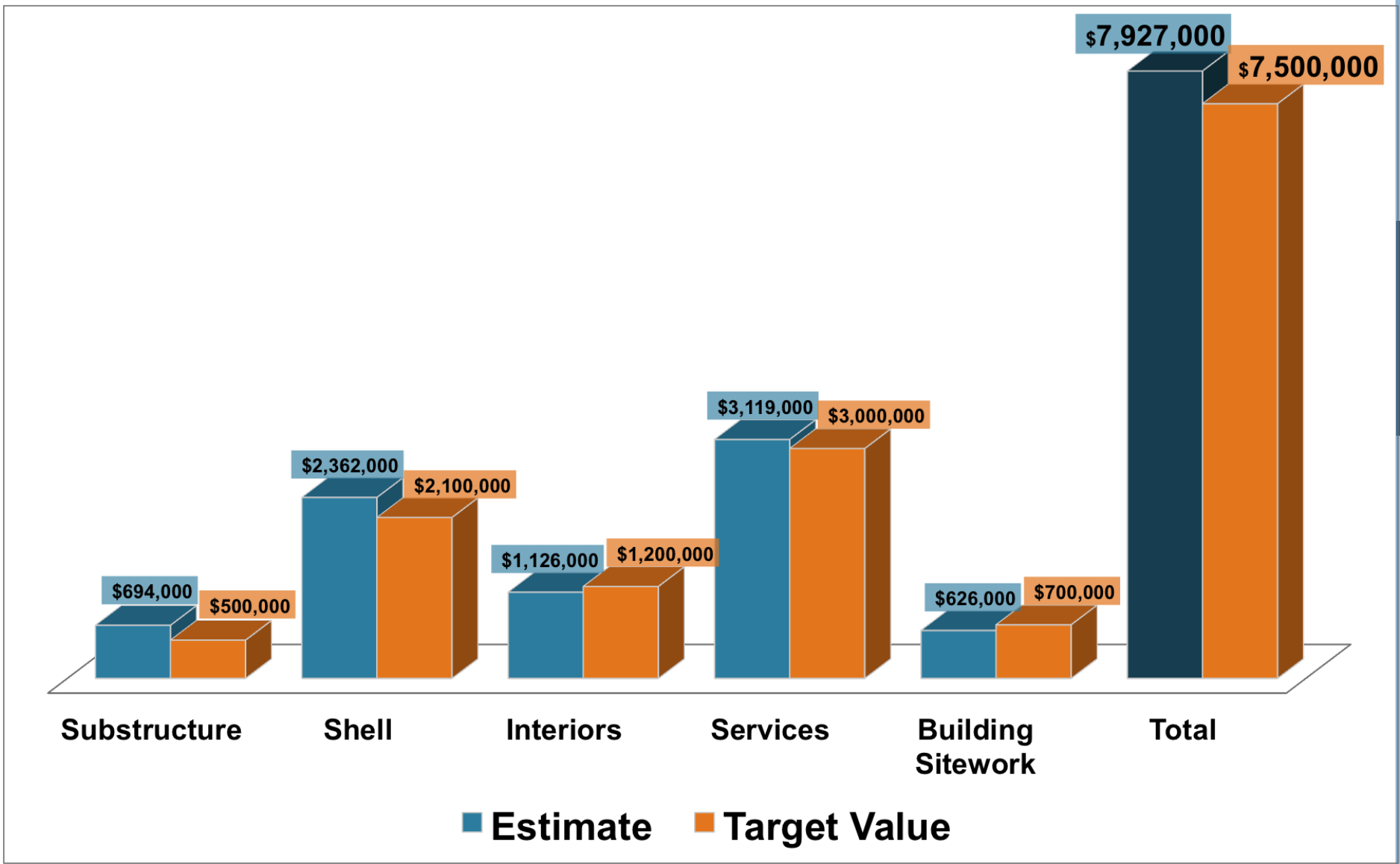
Target Value Design: Tracking

		Target Values	Winter Estimate	Mid-Spring	Final
A	Substructure	$ 500,000	$ 460,000	$ 455,054	$ 694,000
B	Shell	$ 2,100,000	$ 2,700,000	$ 1,901,067	$2,362,000
C	Interiors	$ 1,200,000	$ 1,070,000	$ 1,056,082	$1,126,000
D	Services	$ 3,000,000	$ 2,950,000	$ 2,944,000	$3,119,000
G	Building Sitework	$ 700,000	$ 700,000	$ 700,000	$ 626,000
	Total Project Estimate	**$ 7,500,000**	**$ 7,880,000**	**$ 7,056,203**	**$7,927,000**

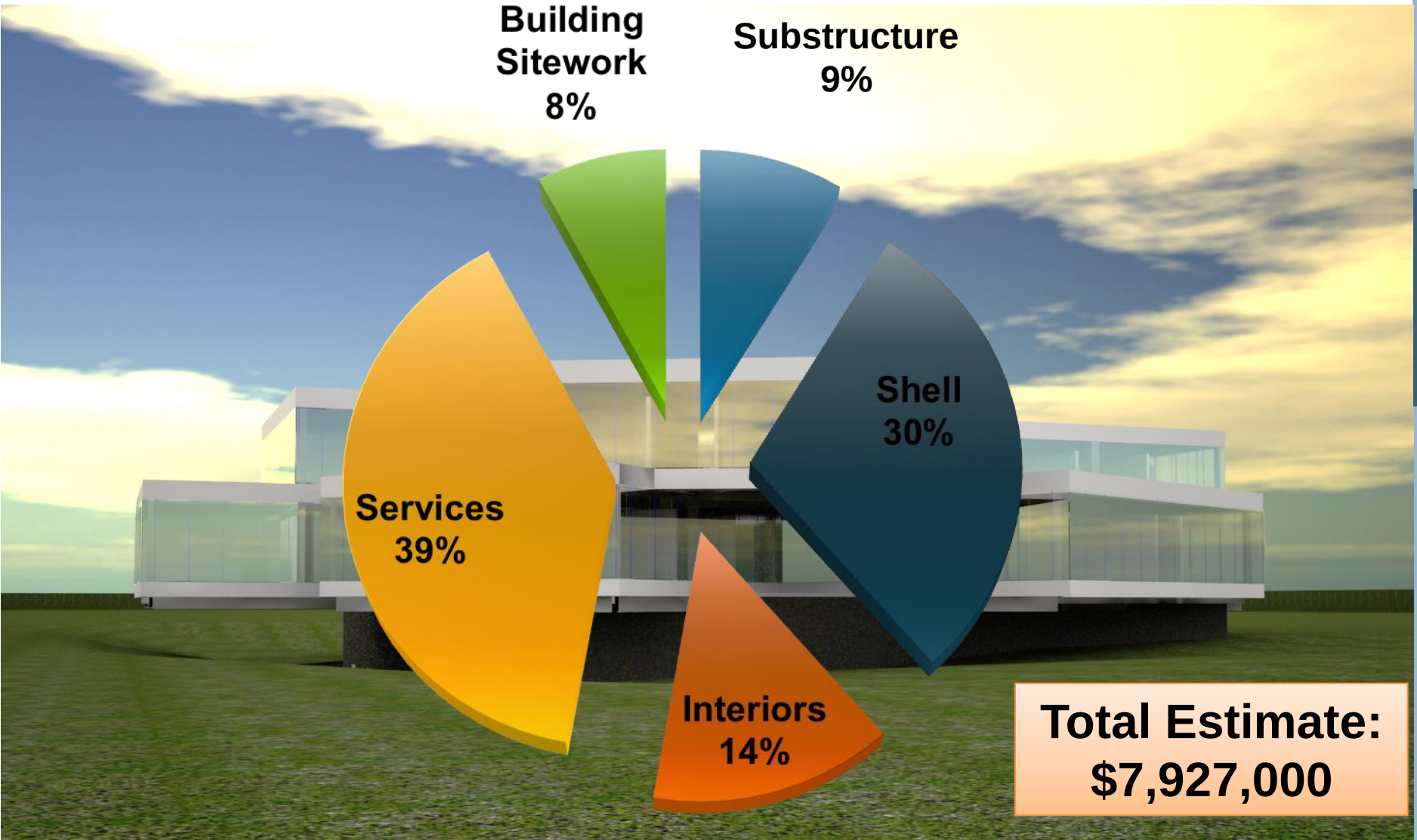
Target Value Design: Tracking



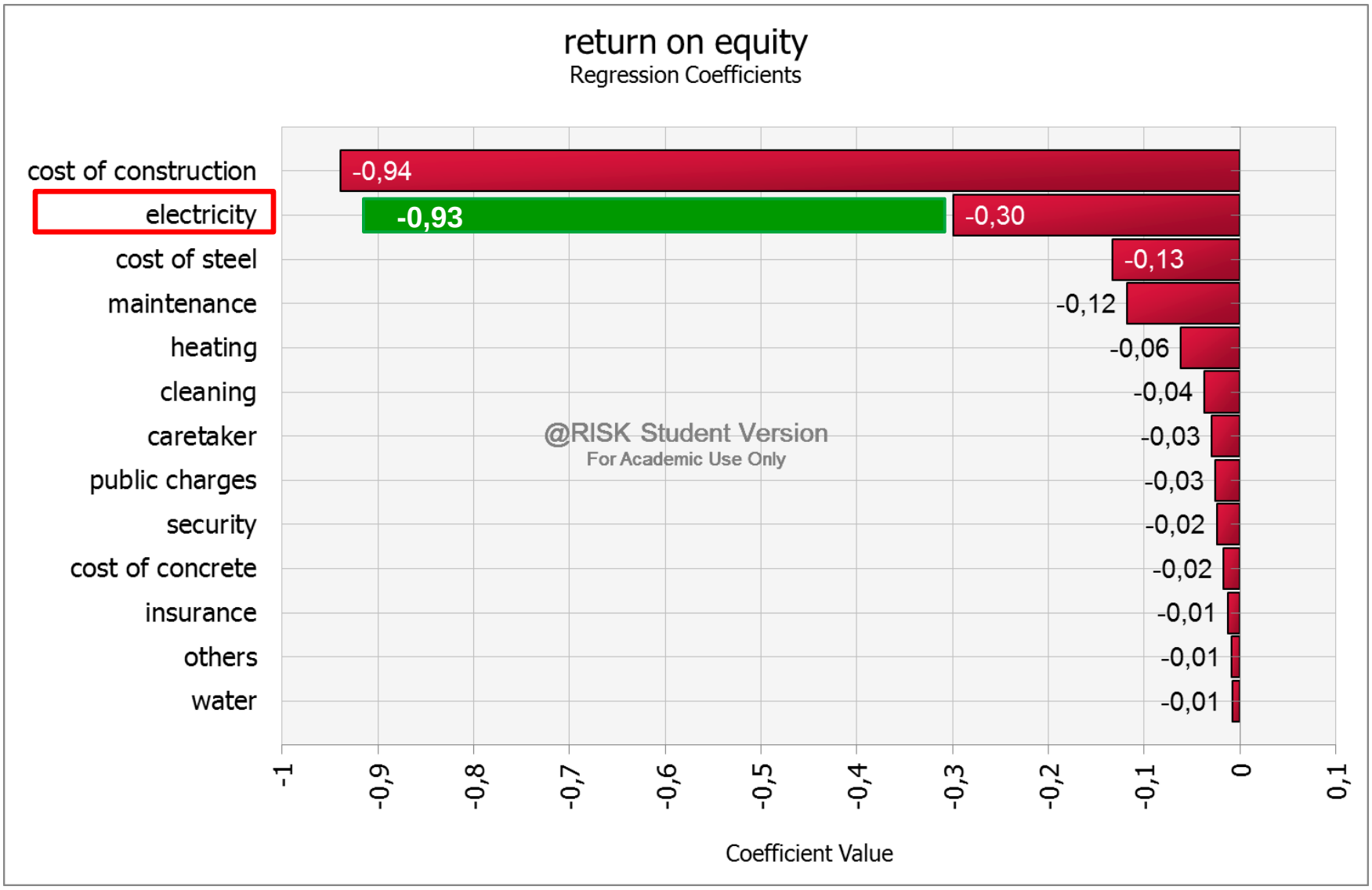
Estimate vs. Target Values



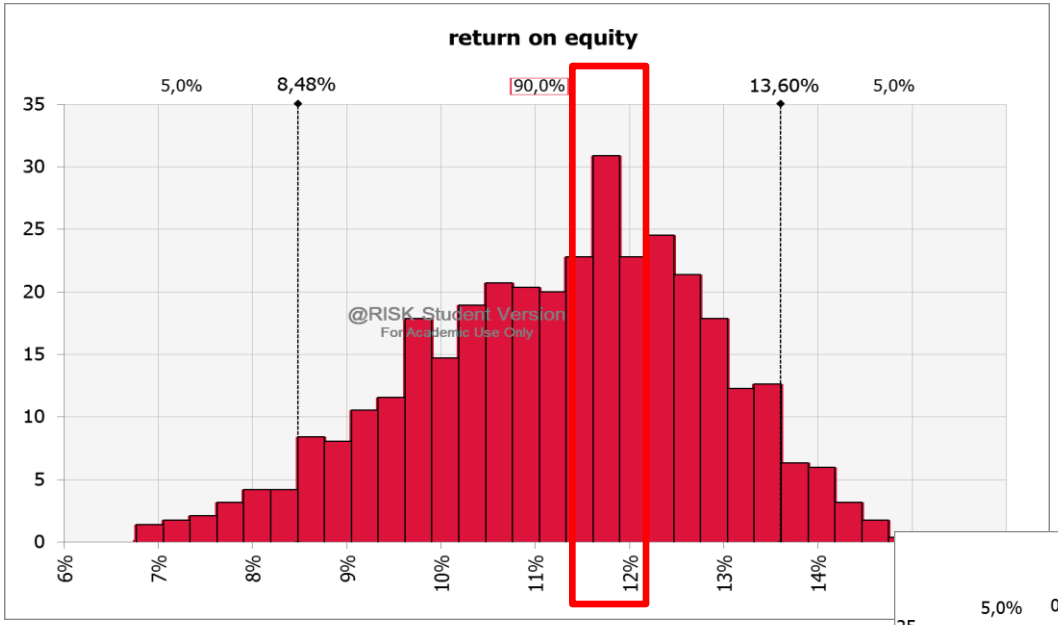
Construction Costs



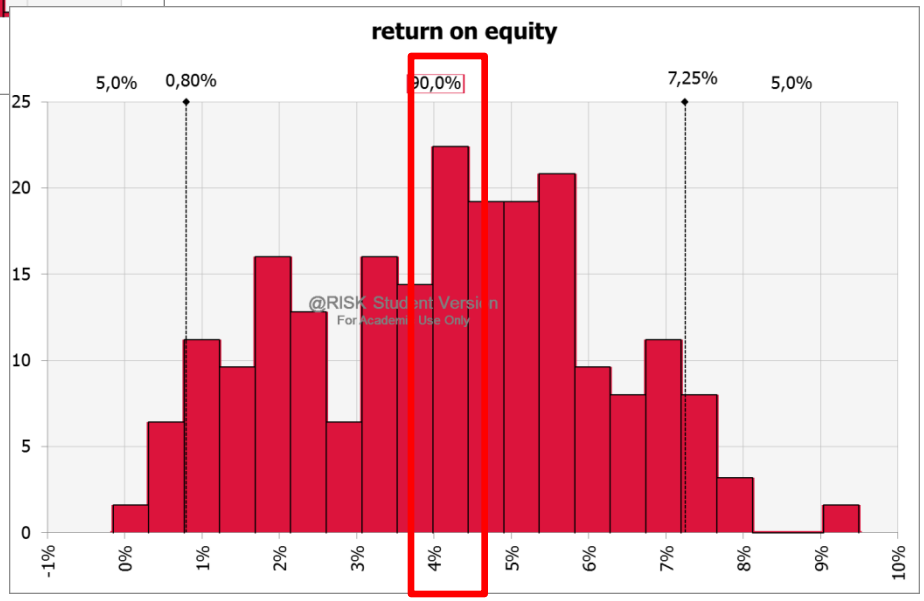
Natural Ventilation vs. HVAC



Return on Equity

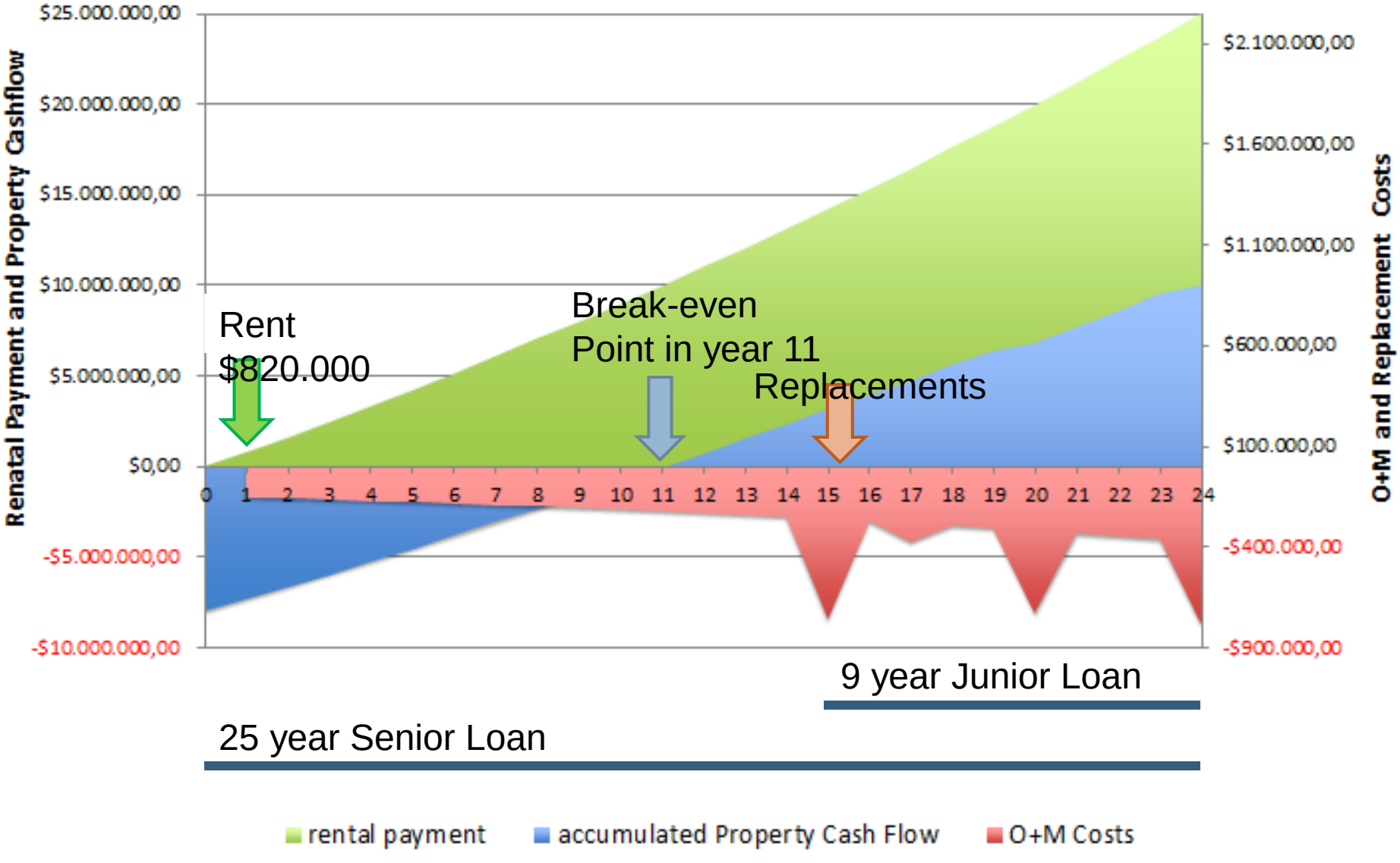


Return on Equity with Natural Ventilation ⇒ **11%**



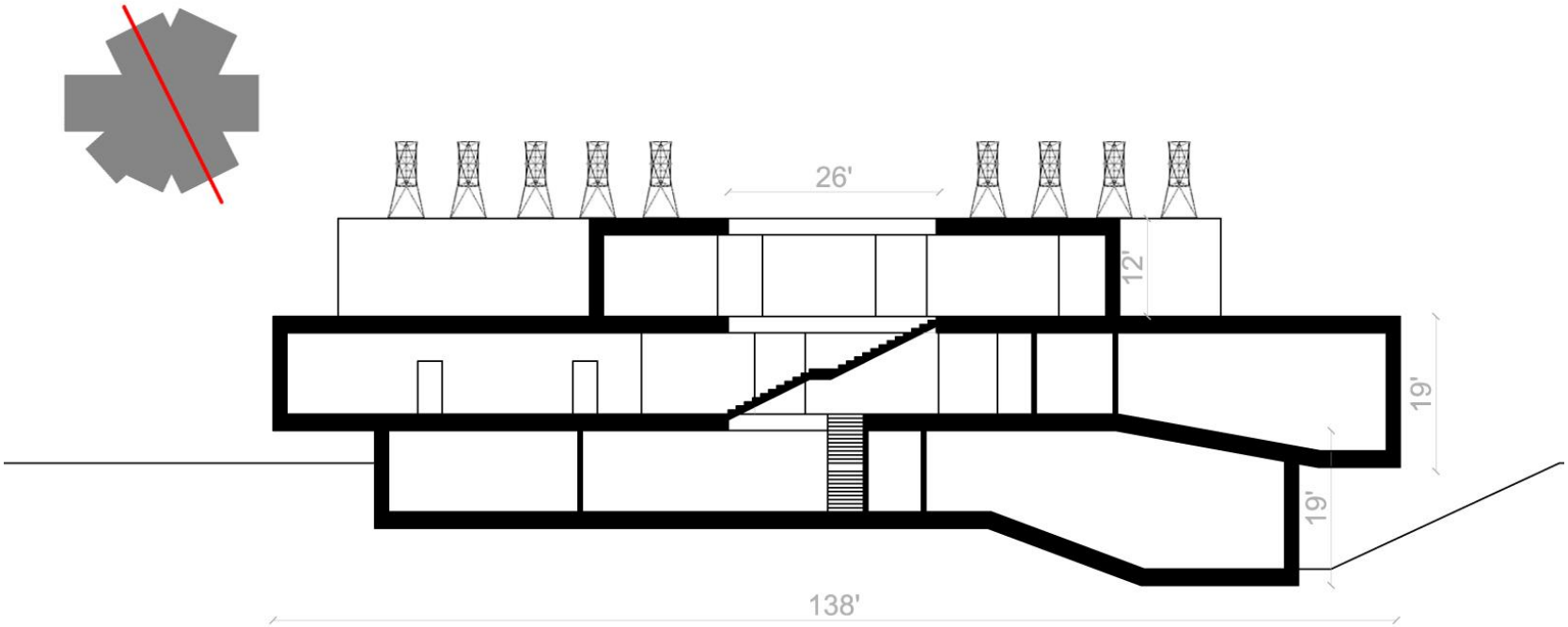
Return on Equity without Natural Ventilation with HVAC ⇒ **4%**

Life Cycle Financial Structure



A E C M L

Vertical Axis Wind Turbines



VAWT – Vertical Axis Wind Turbine

- Savings:
  - 10% of total Energy Costs
- Payback:
  - After 12 years

LEED Certification

Sustainable Site	23 / 26
Water Efficiency	0 / 10
Energy and Atmosphere	21 / 35
Materials and Resources	7 / 14
Indoor Environmental Quality	13 / 15
Innovation in Design	6 bonus
Regional Priority	4 bonus
Total	**64**

A
E
C
M
L

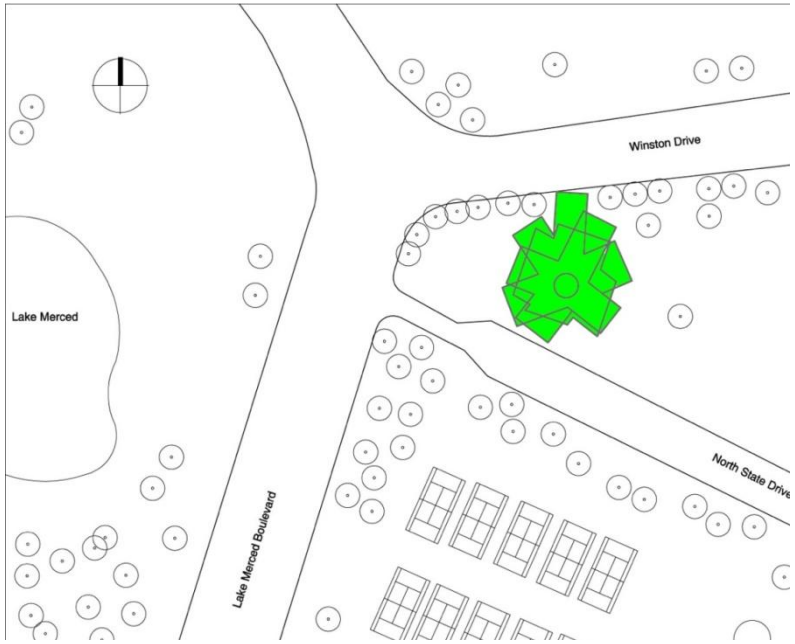
Swinerton Challenge: Native

- Site Plan:
  - “Adapting to and Integrating with the Site.”
- ConXtech
  - “Supporting Local Suppliers and Innovators”
- Bridged Entrance
  - “Embracing the City and its Public Transit”
- Vertical Axis Wind Turbines
  - “Integrating with Nature
- Natural Ventilation
  - “Adapting to and Blending to Our Environment”

A E C M L

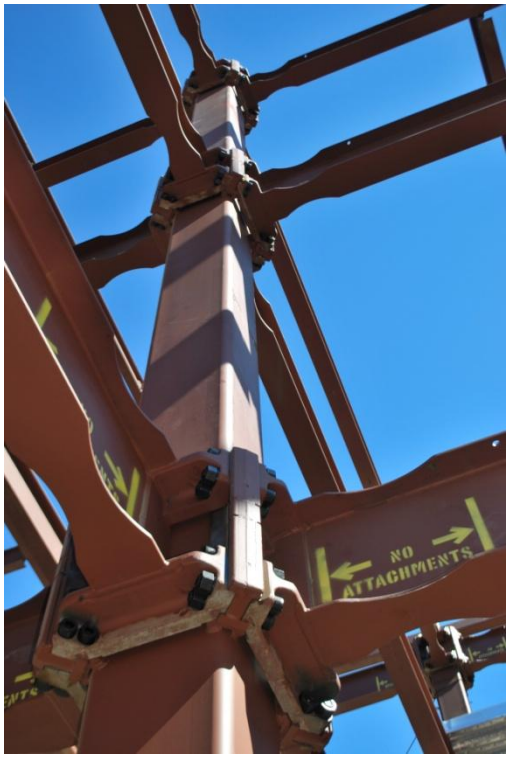
Swinerton Challenge: Native

- Site Plan:
  - “Adapting to and Integrating with the Site.”



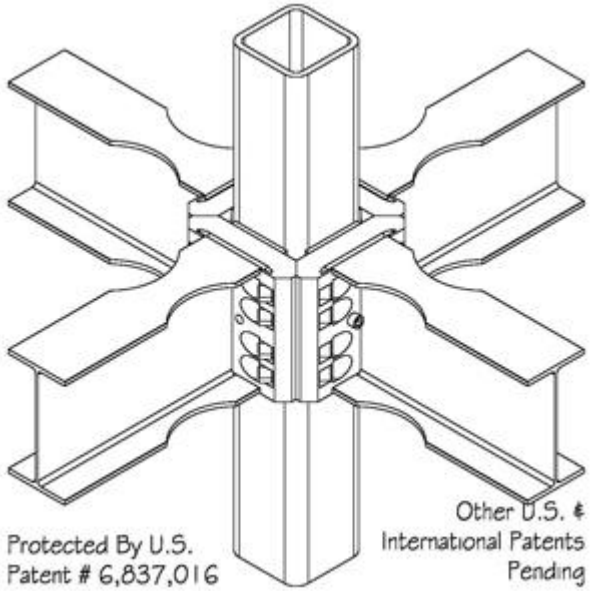
Swinerton Challenge: Native

- ConXtech
  - “Supporting Local Suppliers and Innovators”



CONXTECH

SPACE FRAME SYSTEMS



Swinerton Challenge: Native

- Bridged Entrance
  - “Embracing the City and its Public Transit”

A E C M L

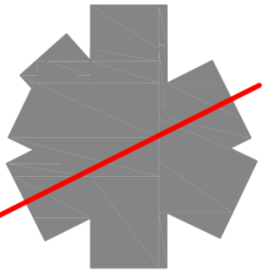
Swinerton Challenge: Native

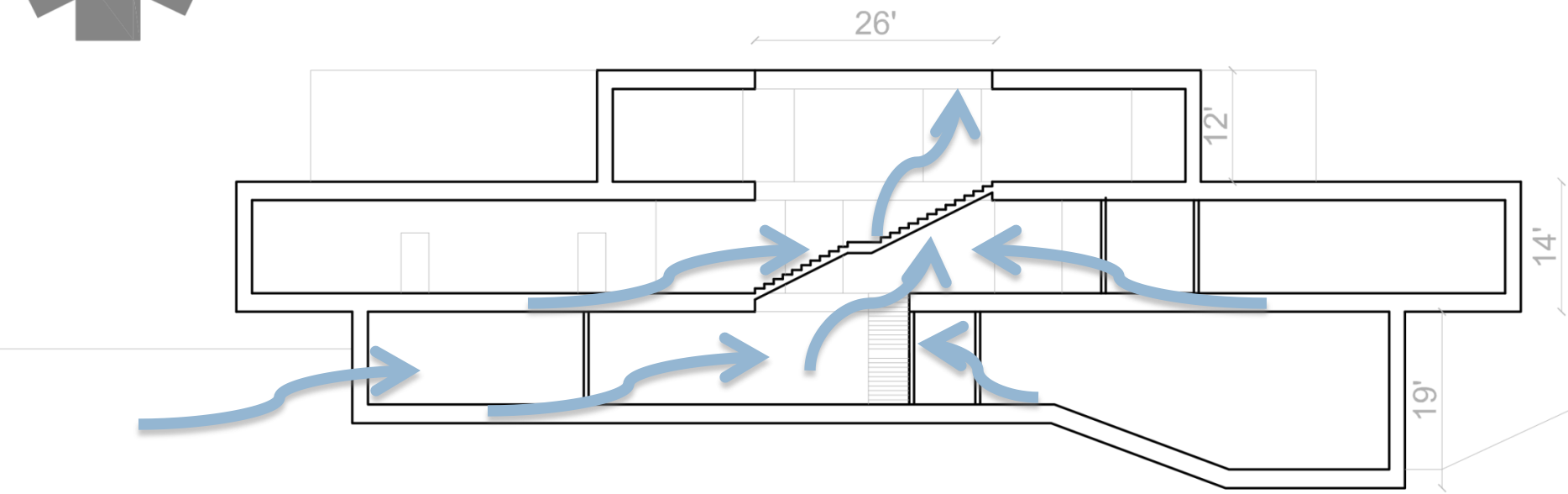
- Vertical Axis Wind Turbines
  - “Integrating with Nature

A E C M L

Swinerton Challenge: Native

- Natural Ventilation
  - “Adapting to and Blending to Our Environment”





A E C M L

Swinerton Challenge: Native

A

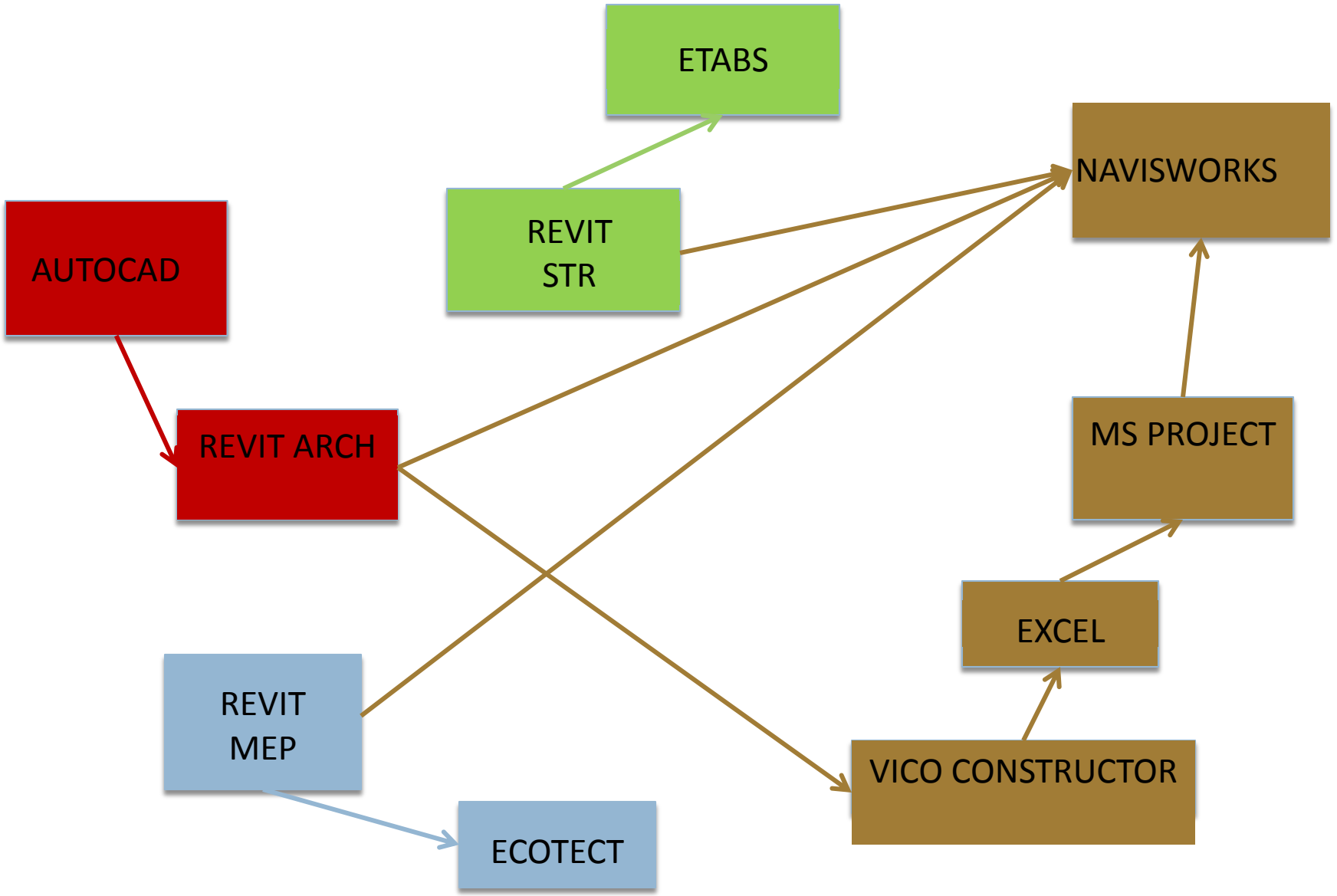
E

C

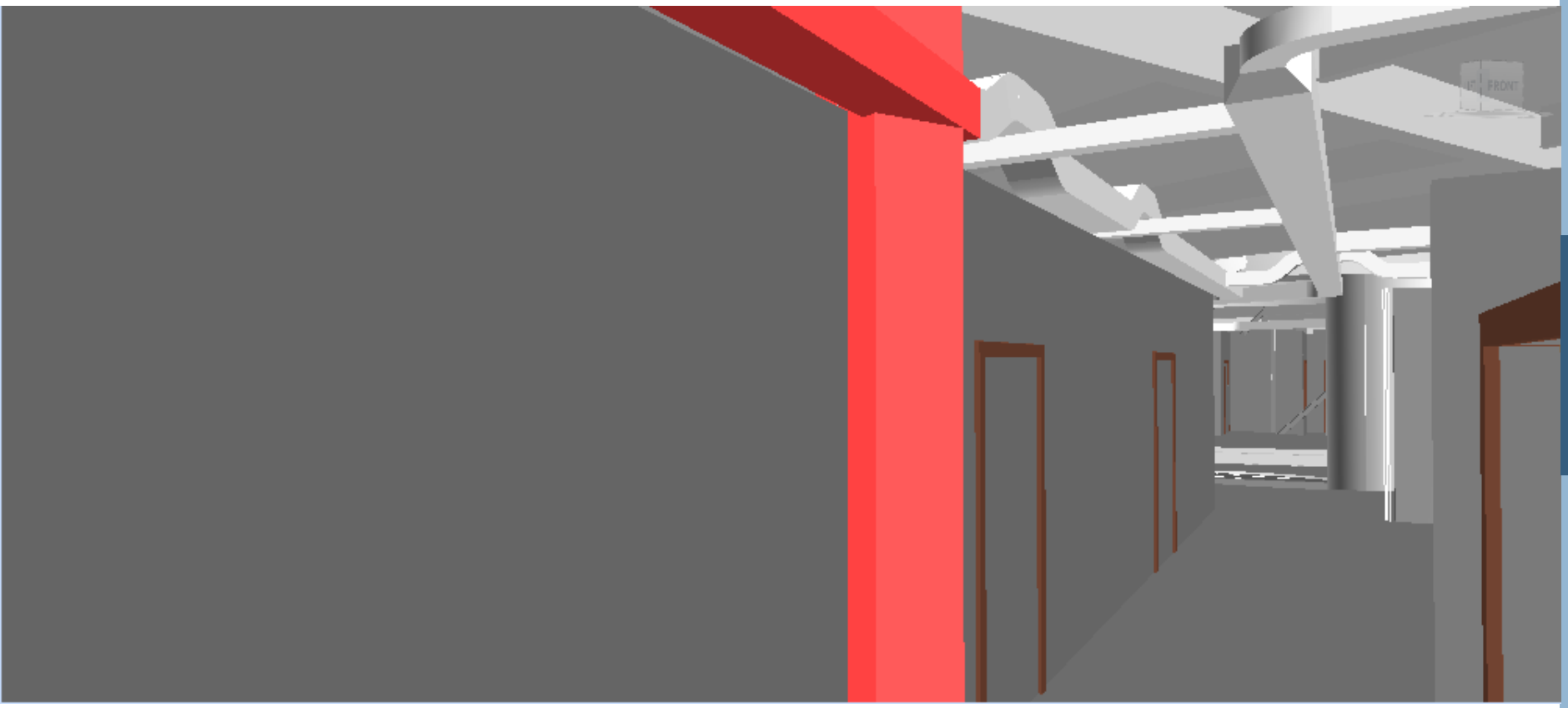
M

L

BIM Coordination

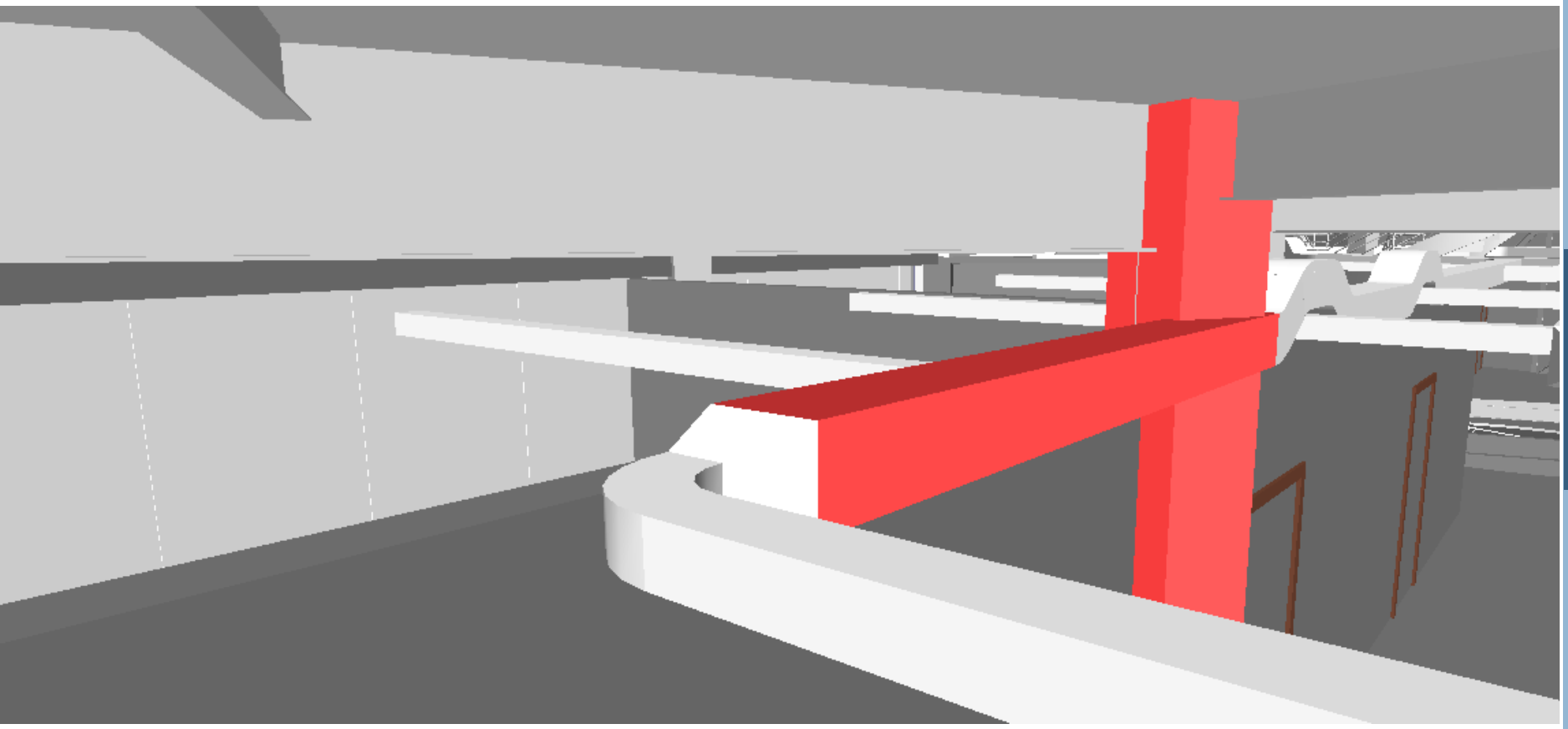


Model Integration



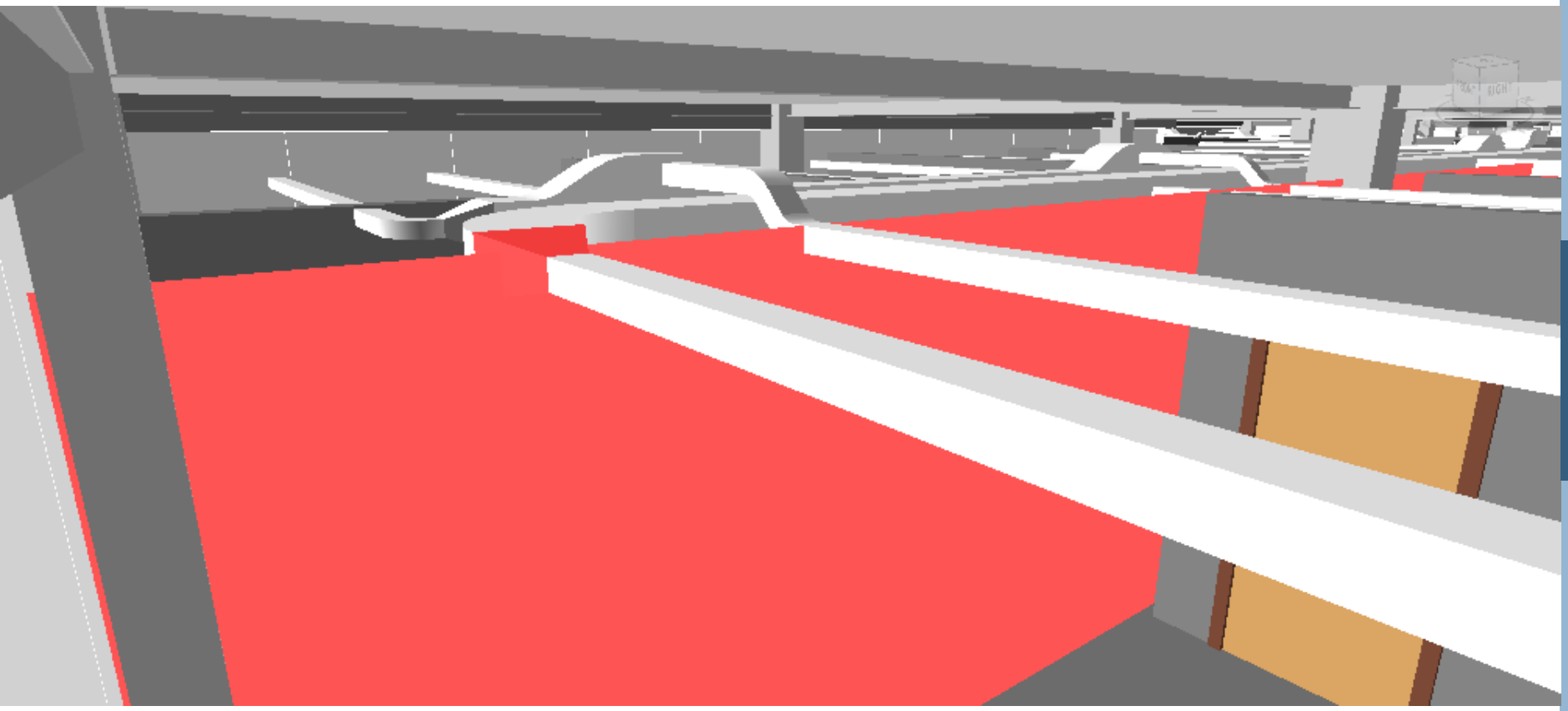
Architecture – Structure clashes

Model Integration



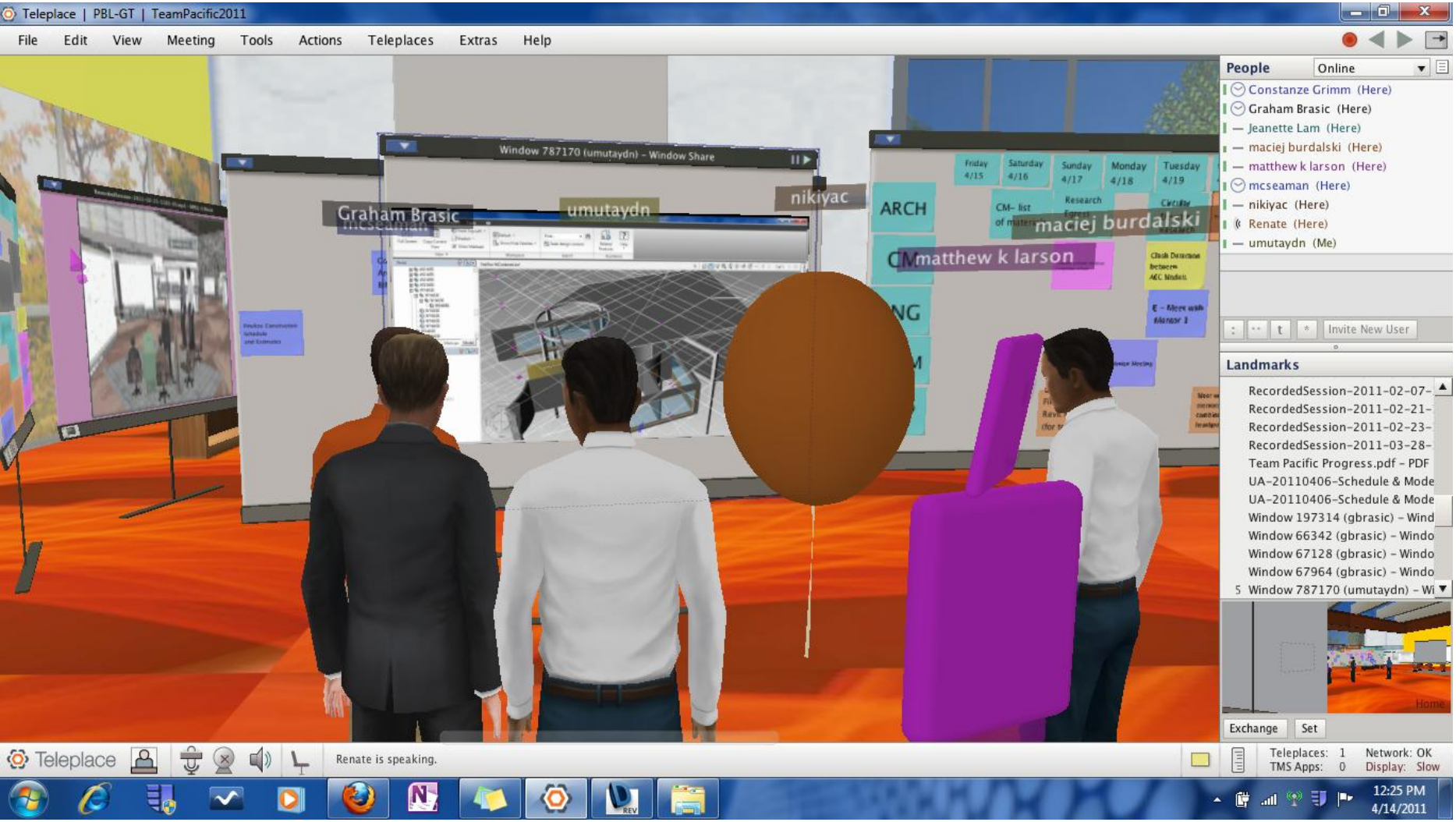
Structure– MEP clashes

Model Integration



Architecture – MEP clashes

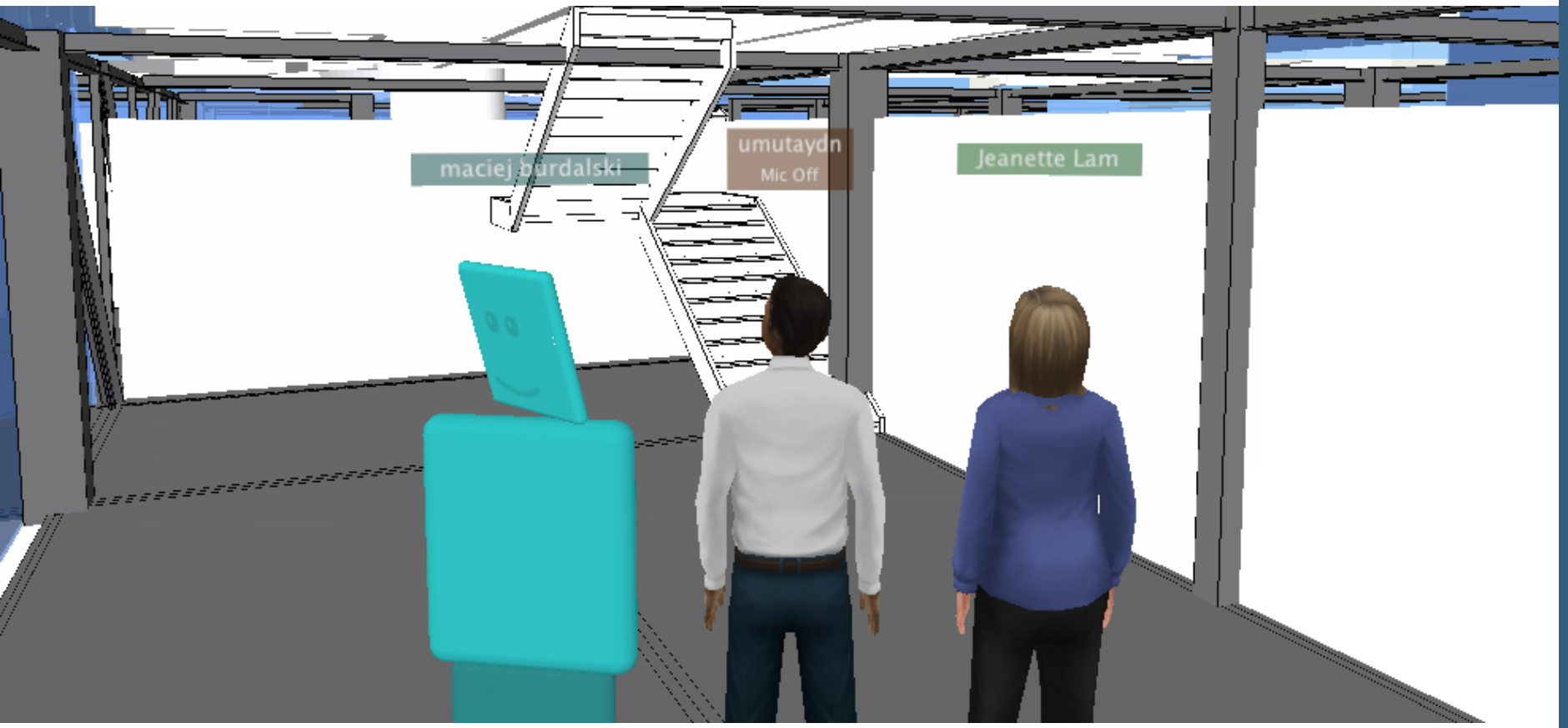
Team Communication



A E C M L

Team Communication

Team Communication



A

E

C

M

L

Team Communication

A

E

C

M

L

It is sort of fun to do the impossible – it just requires communication, communication and communication.

I hear what you are saying but I don’t understand what you are saying.

A

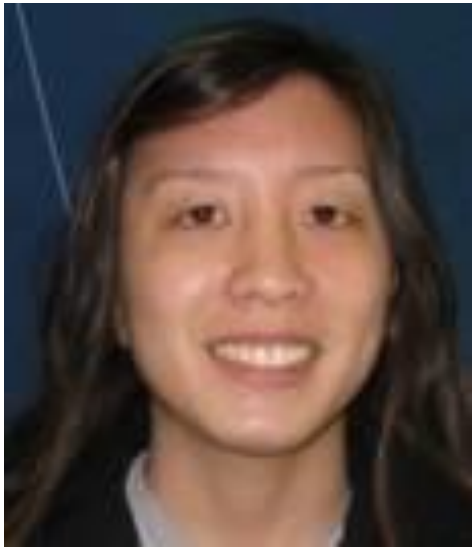
E

C

M

L

Final Reflections



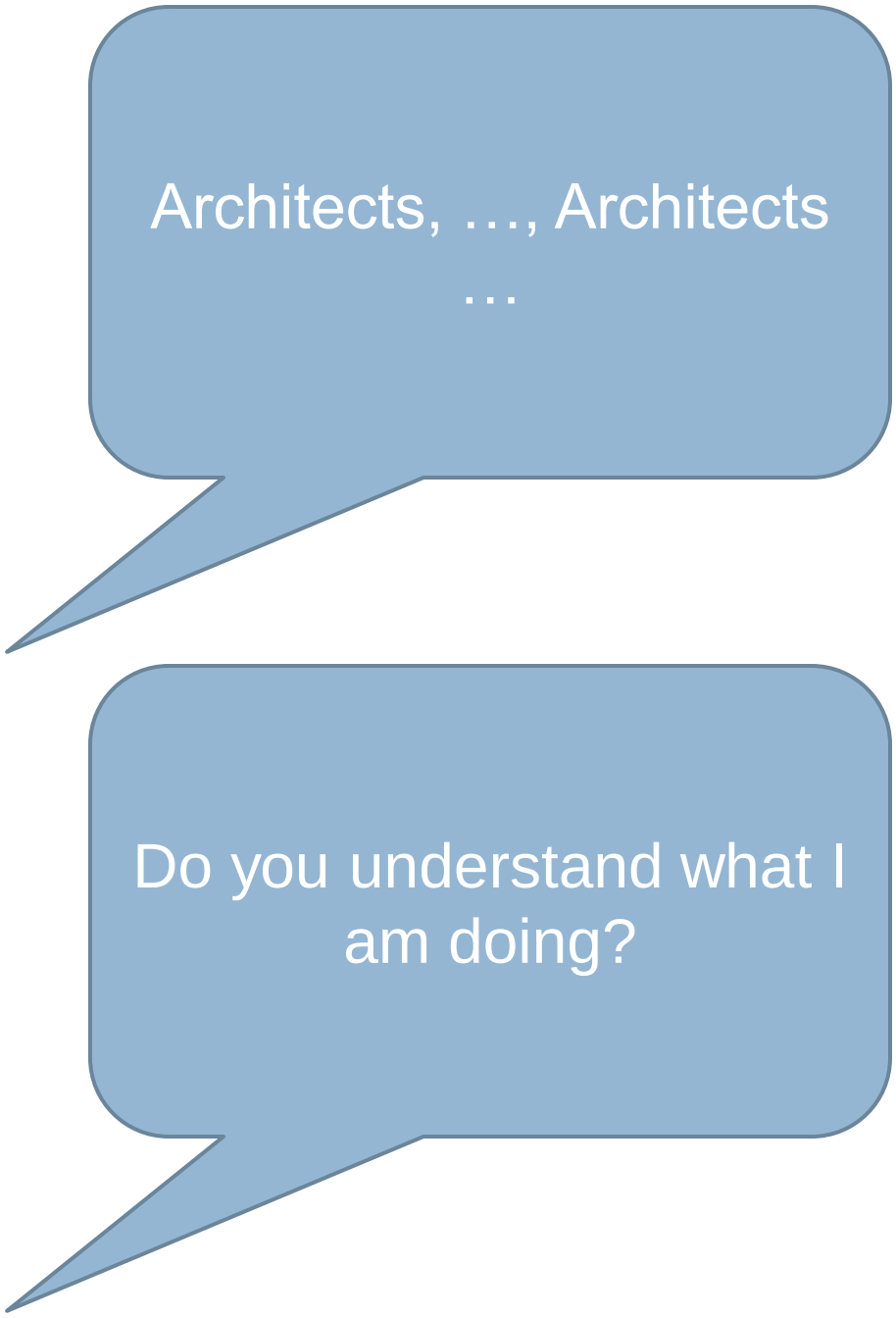
A

E

C

M

L



A

E

C

M

L

Nothing is delivered on time unless you push for it.

Learn to trust all your teammates. Work to gain their trust as well.

A

E

C

M

L

Final Reflections

A

E

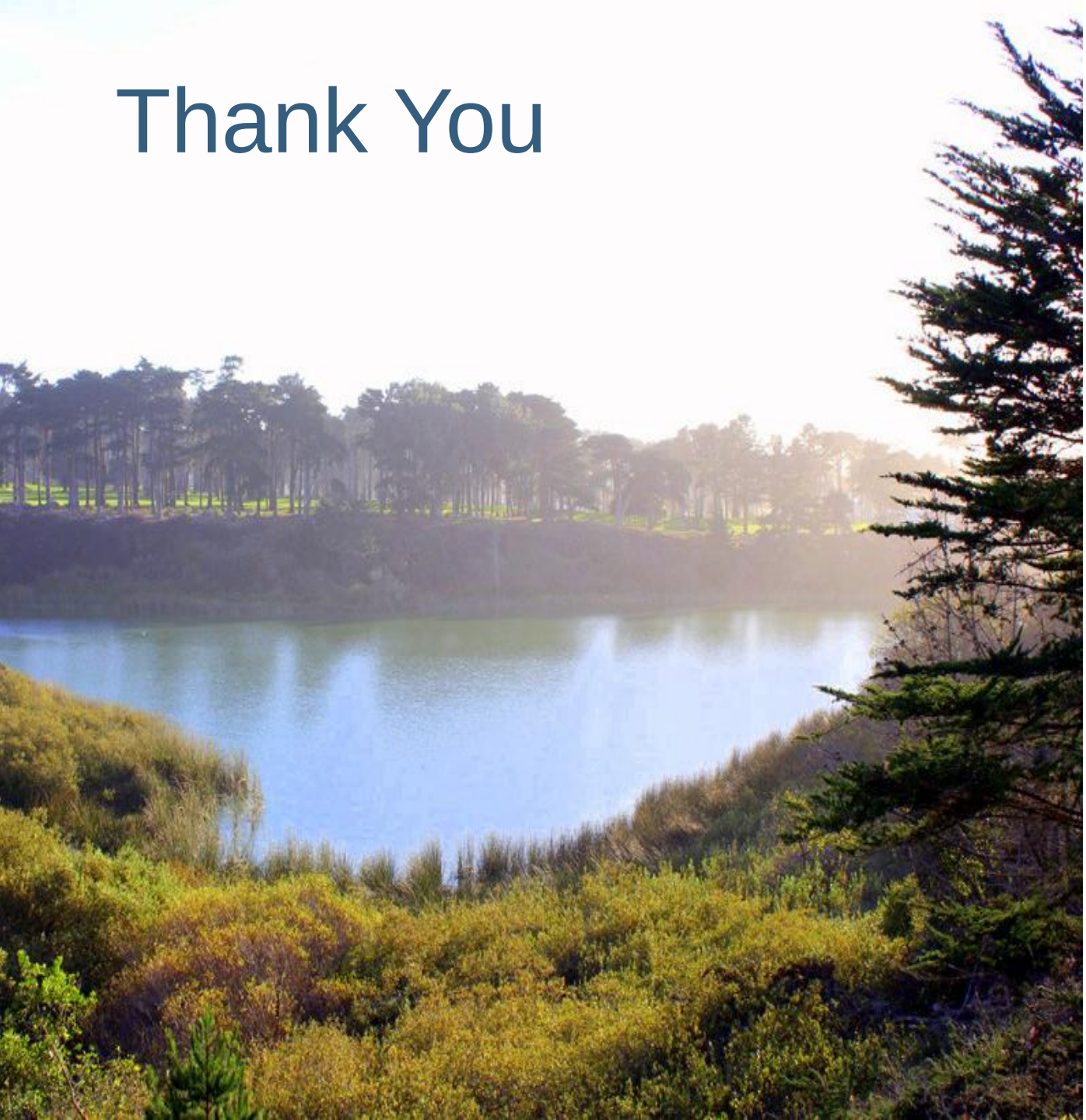
C

M

L

A
E
C
M
L

Thank You



Renate Fruchter
Björn Wündsch
Anirudh Rao
Greg Luth
Helmut Krawinkler
Eric Borchers
Henry Tooryani
Professor Kolderup
Dennis Kwan
Dustin Rothwell
Matthias Ehrlich
John Nelson
Afaan Naqvi

A
E
C
M
L