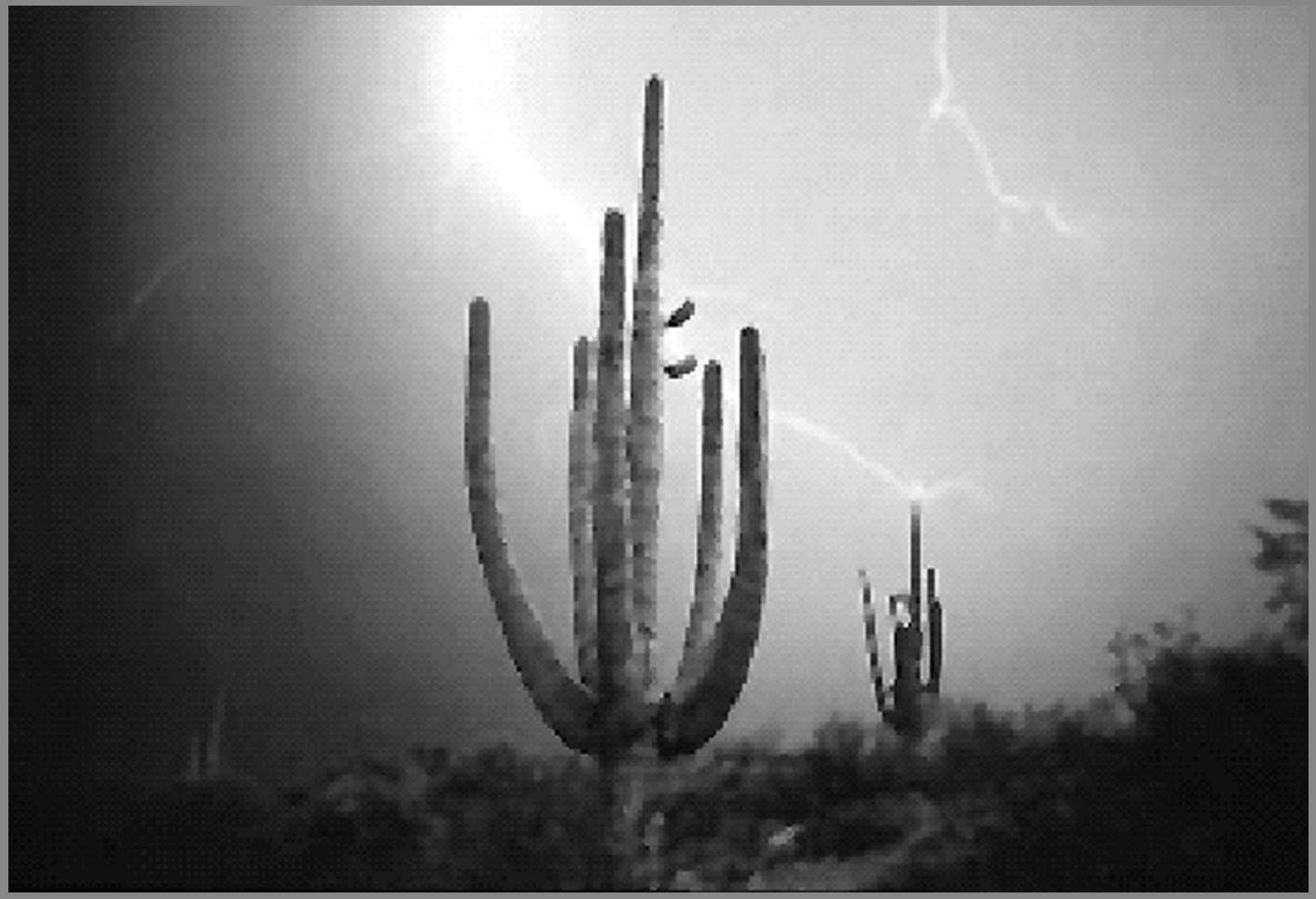
EXPRESS TEAM PROJECT

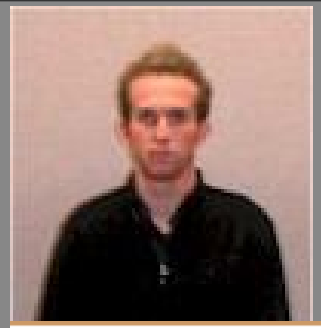
2003

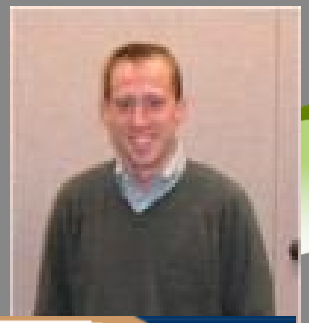
CE222/122 Stanford University

INTRODUCTION



Team members

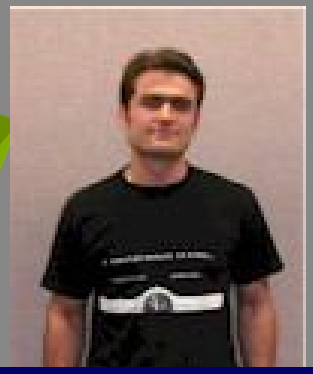




Georgia Tech College of Architecture

architect

Vincent Jaulneau-Labarre



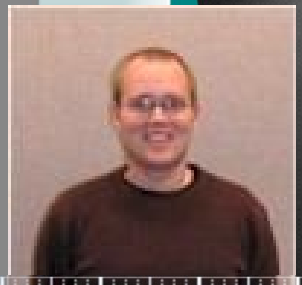
owner

Hans Verheij

engineer

Maik Brehm

Bauhaus-Universität



KUNGL TEKNISKA HÖGSKOLAN

construction manager

Jonas Biornstad

Stanford University

construction manager

Ryan Crockett

engineer

Noreen Chan

UNIVERSITY OF NEW MEXICO

Climate

average temperature 68 F

average rain 8.7"

high temperature in July 92 F

low temperature in January 47 F

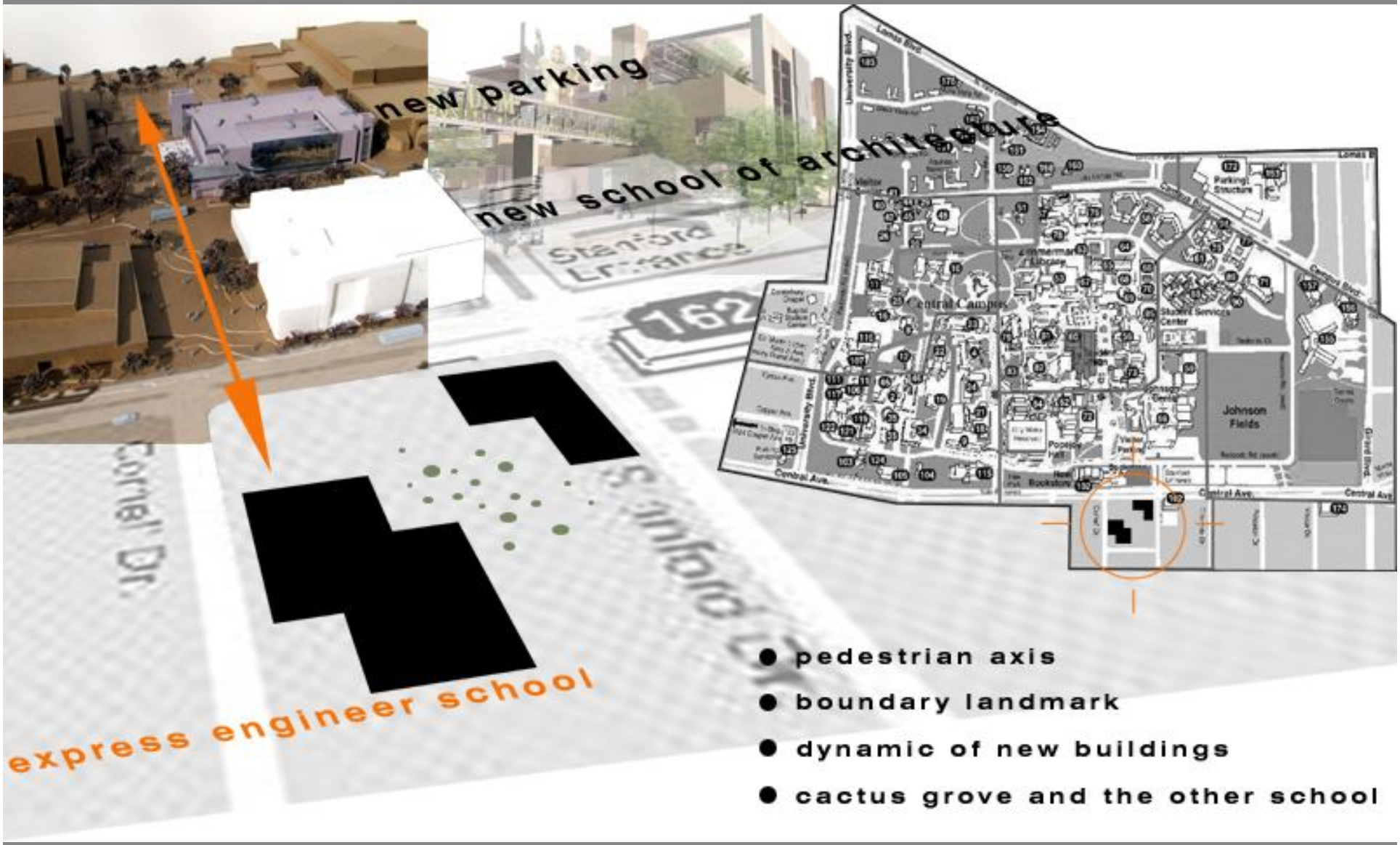
Soil conditions

bearing capacity 4 ksf

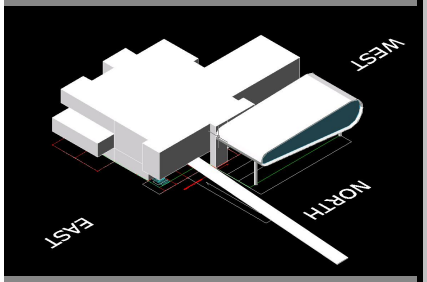
medium compact sands
inorganic silts

Zone 2B earthquake zone

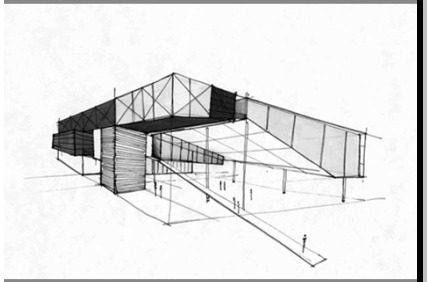
Site layout with building



CONCEPT 1

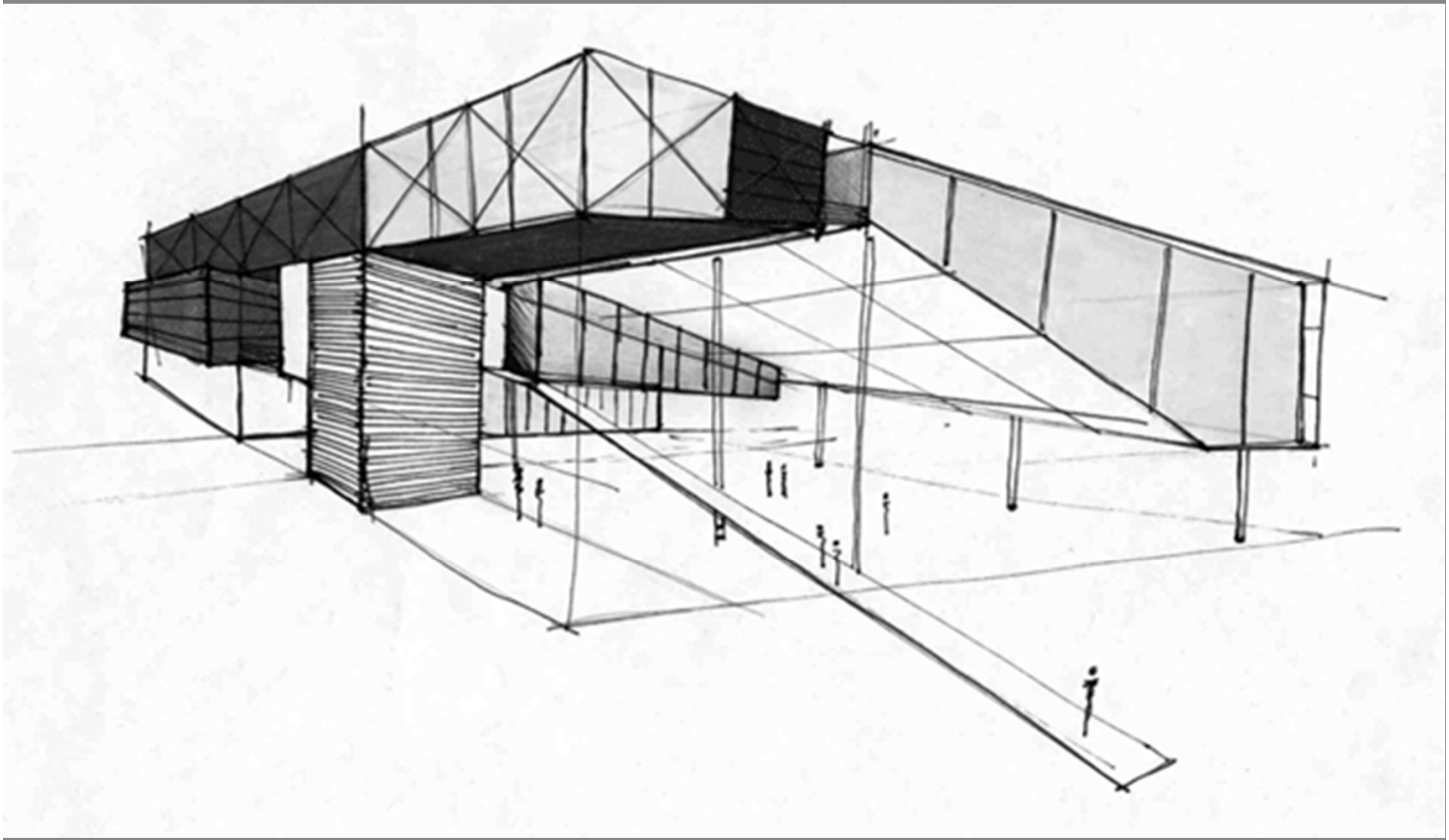


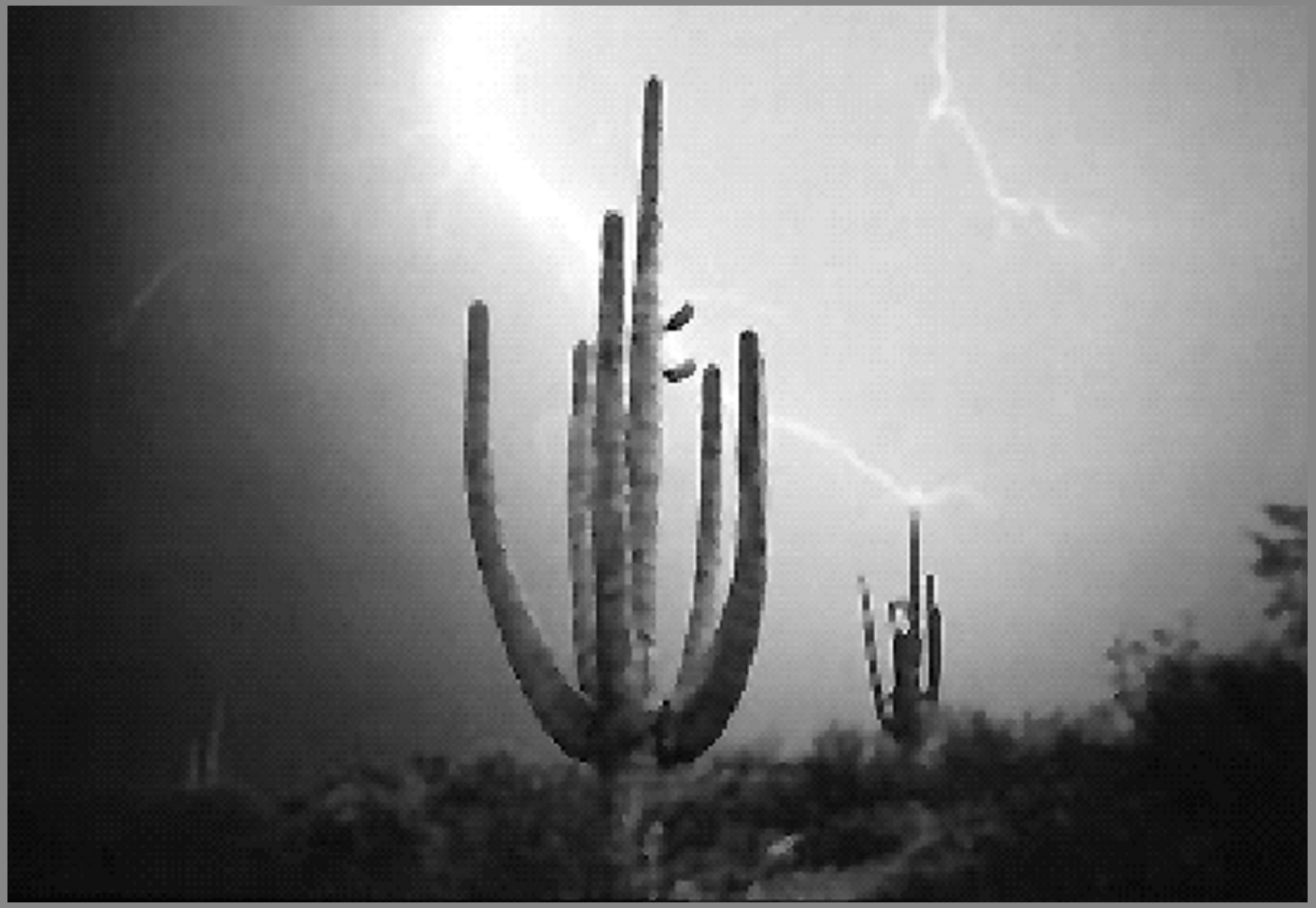
CONCEPT 2



CONCEPT 1 CONCEPT 2

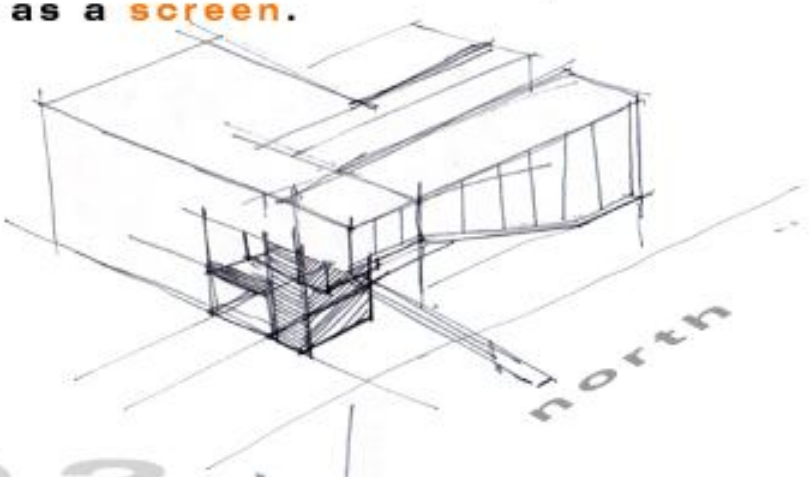
	Steel	CIP	ICF	PHMRF	Steel	CIP	ICF	PHMRF
Architect's								
Program Layout (well defined)								
Exterior Façade								
Egress								
Light and Comfort of Building								
Predicted Life Cycle cost								
Owner Requirments:								
Energy Efficiency								
100 year Lifespan								
Security Needs								
Privacy Needs								
Acoustics								
Daylight								
View								
Environmental requirements								
Structure:								
Clear Load Path								
Homogenous System								
Vibration/Deflections								
Efficient Use of Material								
Flexibility of Structure								
CM								
Time								
Cost								
Constructability								





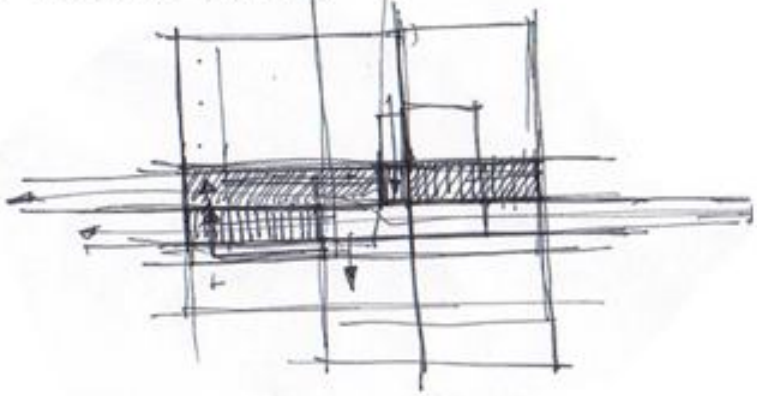
01

open the auditorium to the pedestrian axis as a screen.



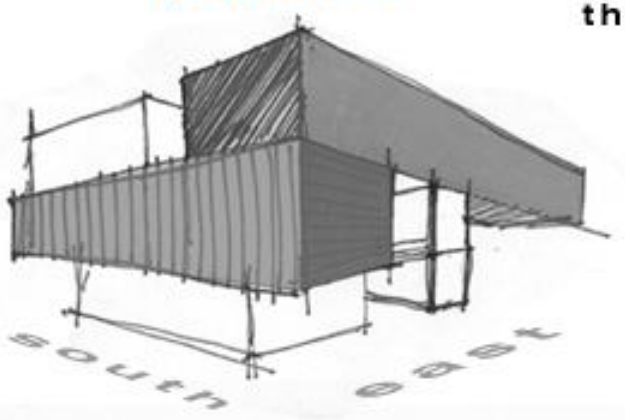
02

use the "passage" idea as a link to the cactus grove



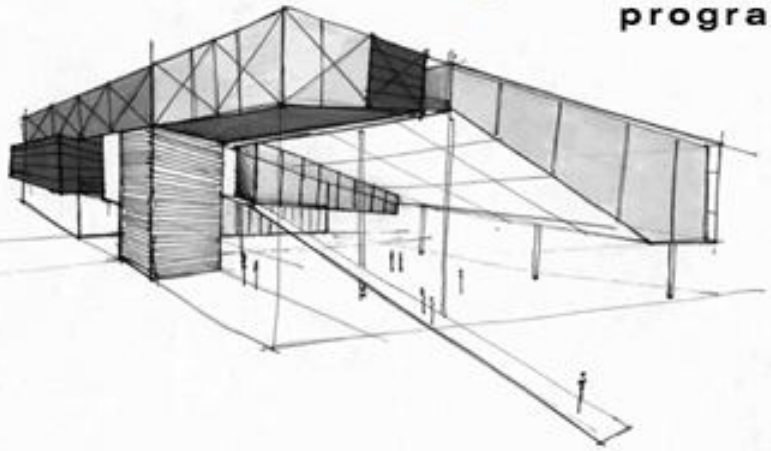
03

create a protection from the sun on the south



04

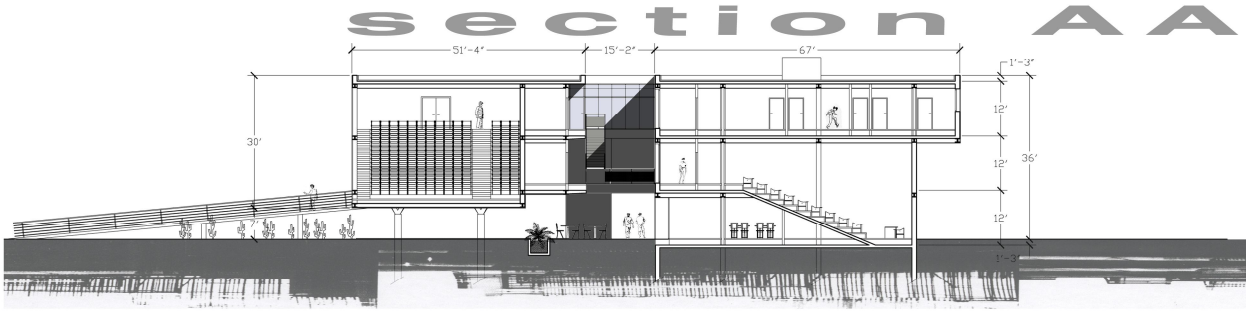
create a roof building for additional programs

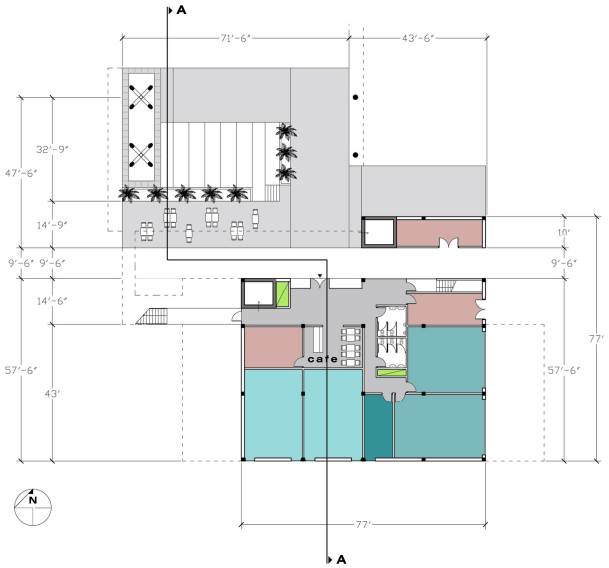


Plans and section

- Faculty offices
- Chairs' office
- Senior admin.
- Secretaries
- Auditorium
- Storage
- MEP
- Students offices
- Large Classrooms
- Small Classrooms
- Seminar Rooms
- Instruction Lab.
- Computer Lab.
- Technical Support

section AA





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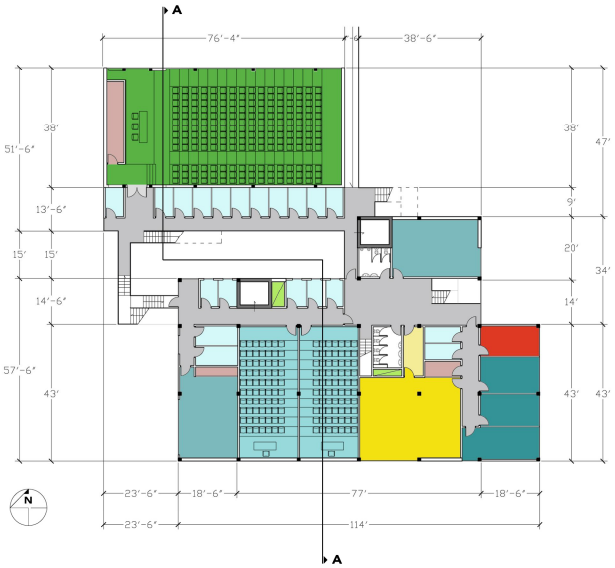

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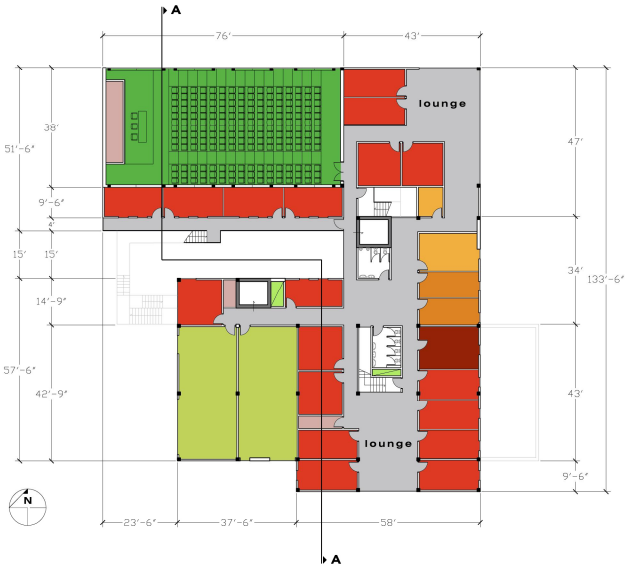
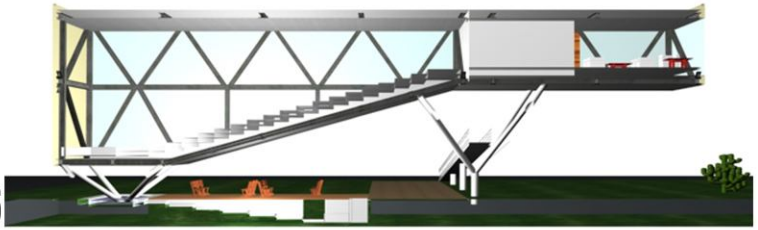
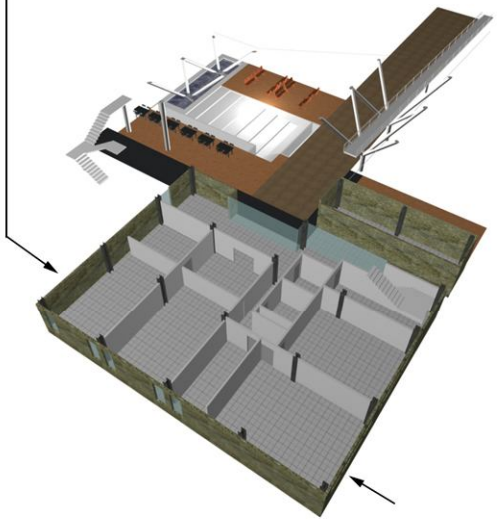
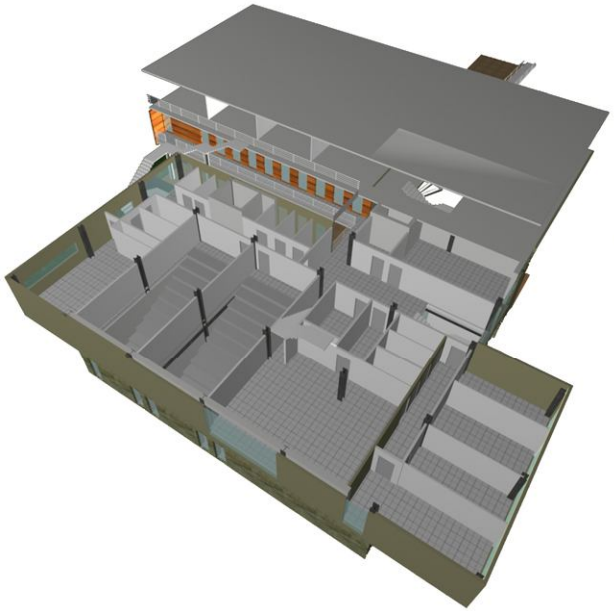


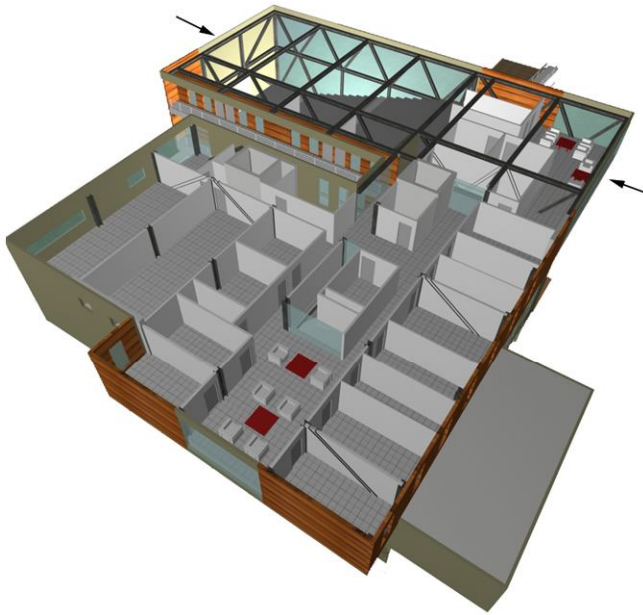
03

sections



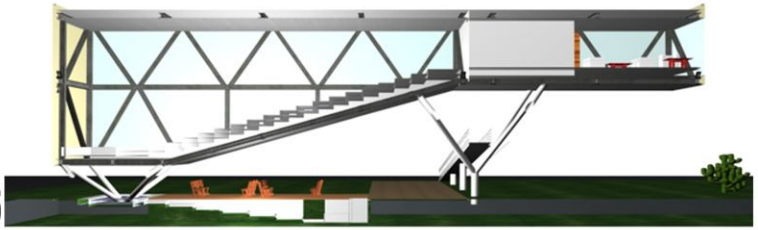




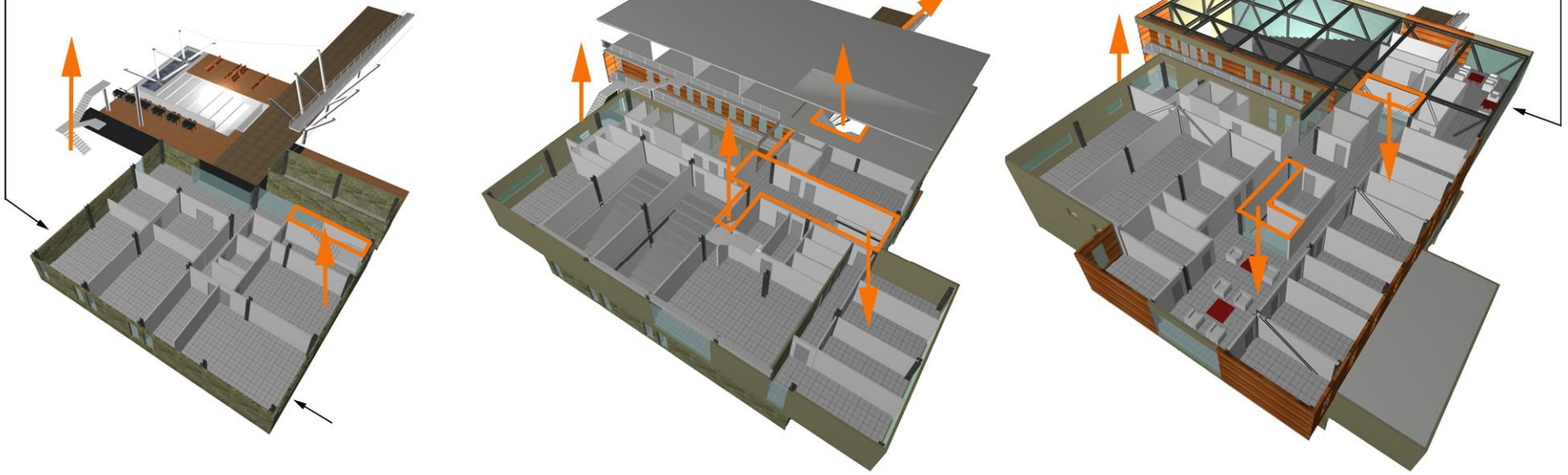


01 02 03

sections



circulations - dynamic dilation



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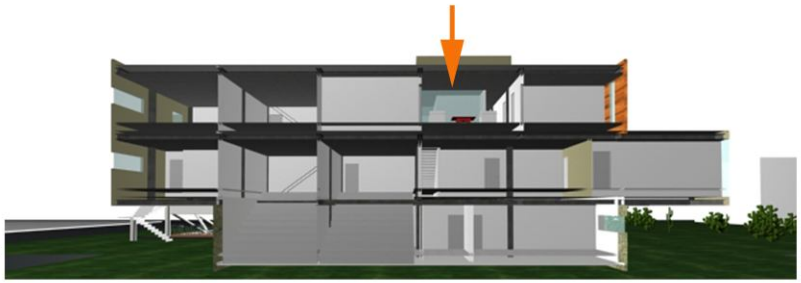
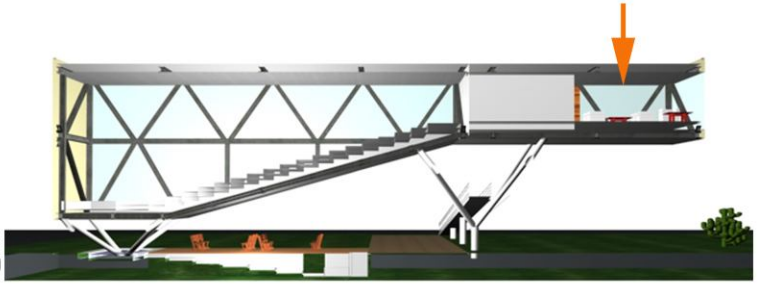
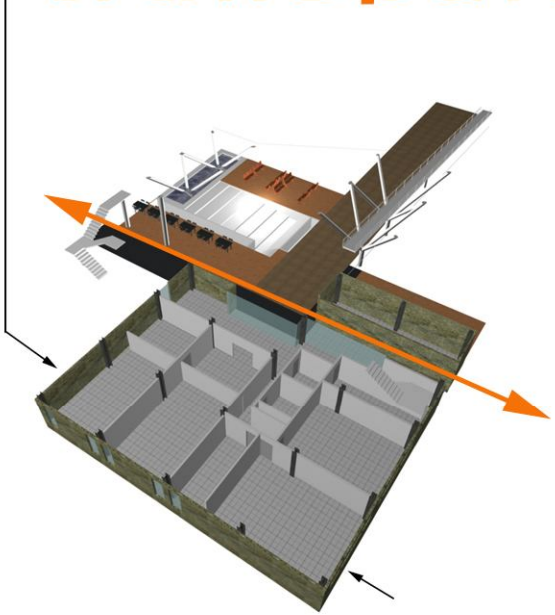


sections

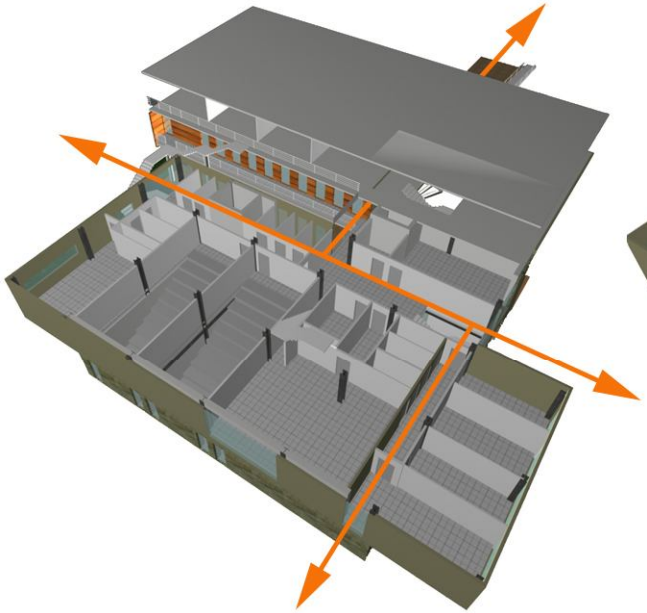


transparency



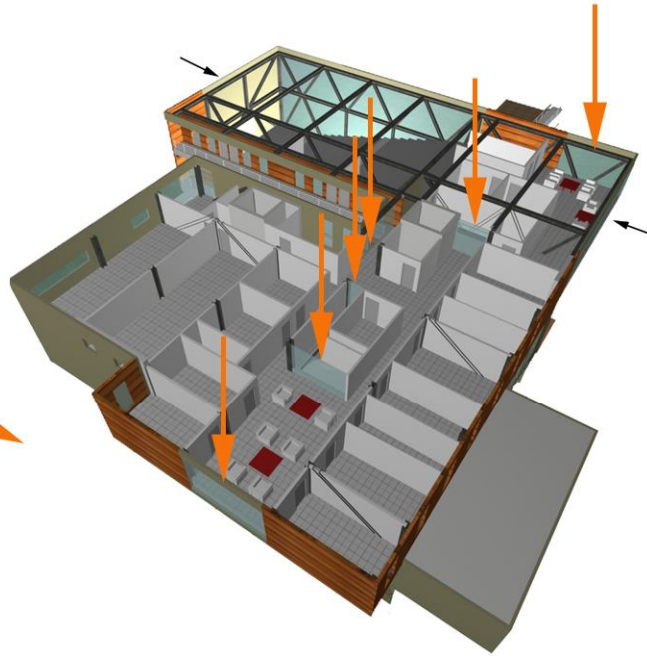
marking the entrance

01



circulation + outside

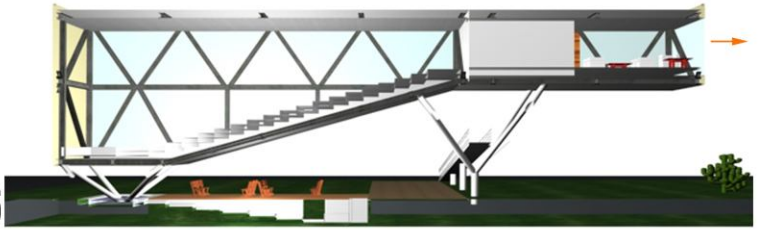
02



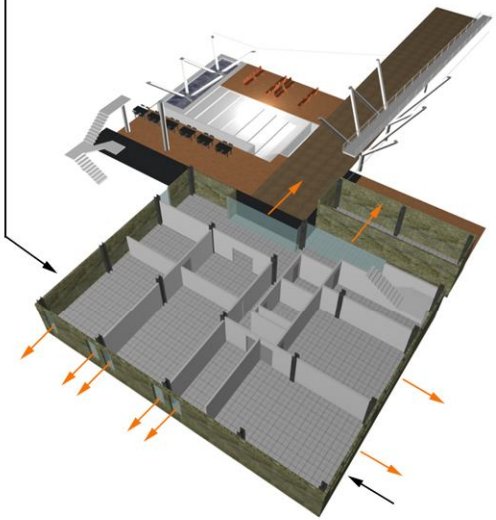
creating one fluid plan

03

sections



openings



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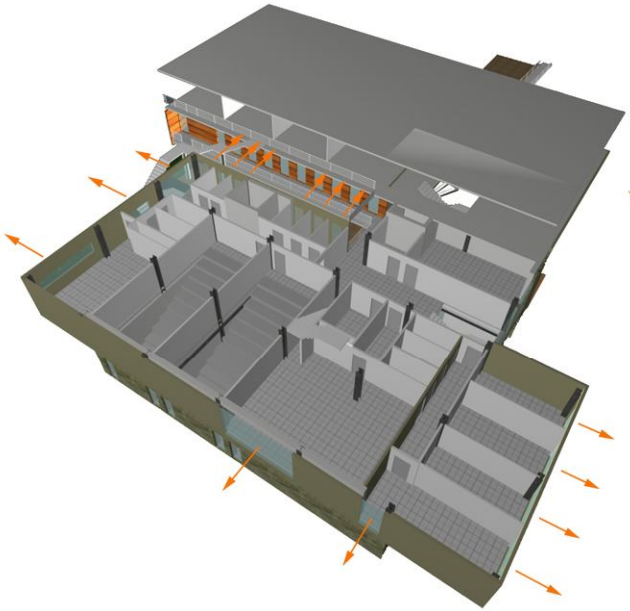

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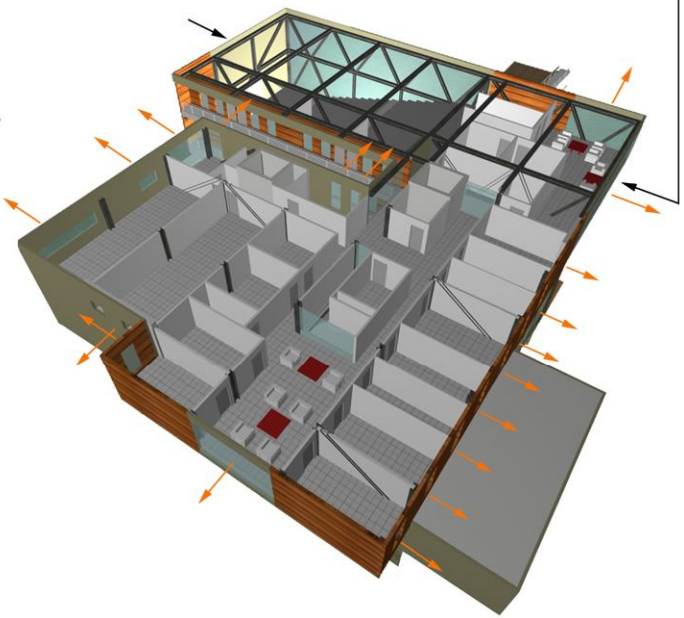

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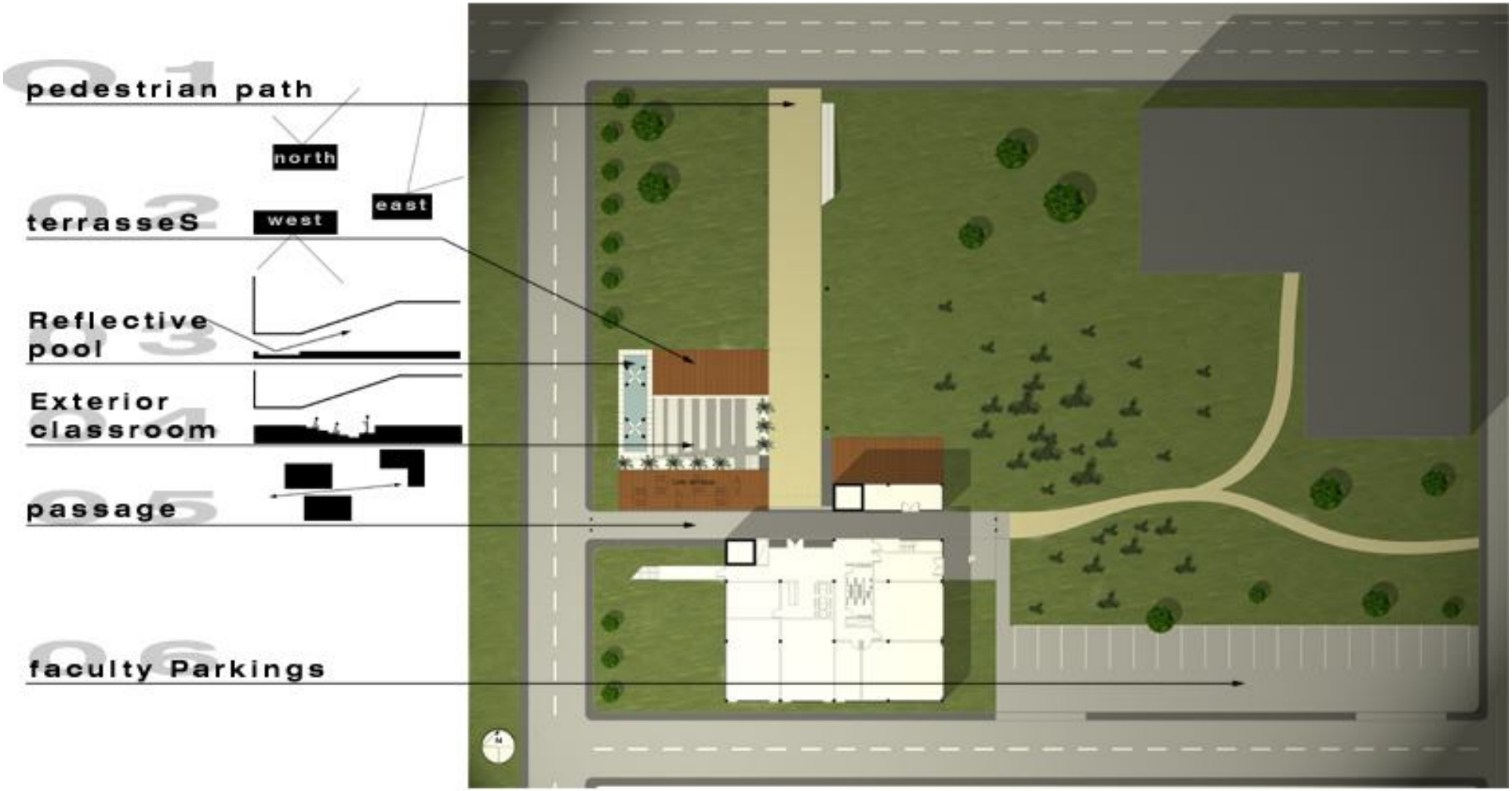
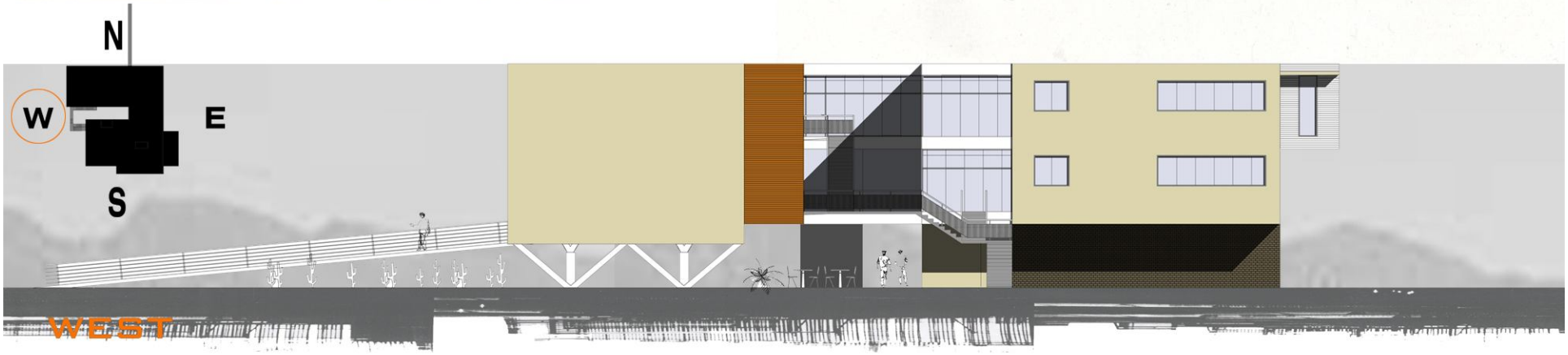
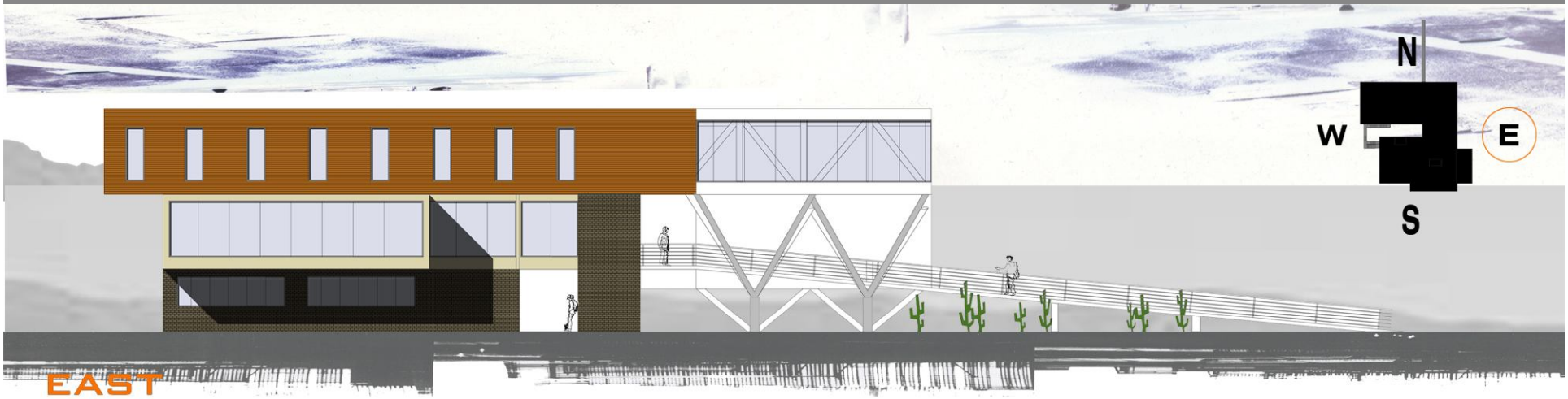
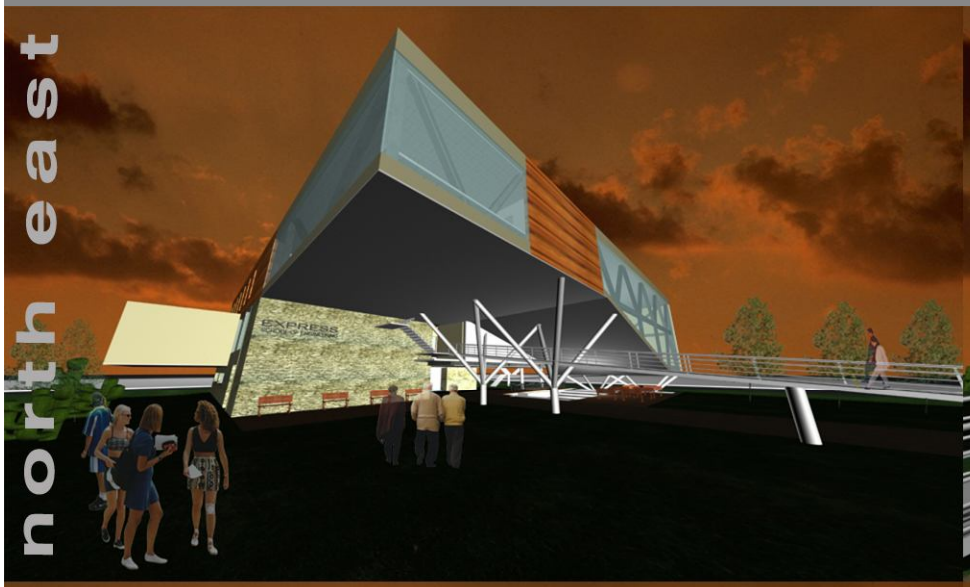

01
pedestrian path
north
east
03
terrasseS
west
Reflective
pool
04
Exterior
classroom
05
passage
06
faculty Parkings

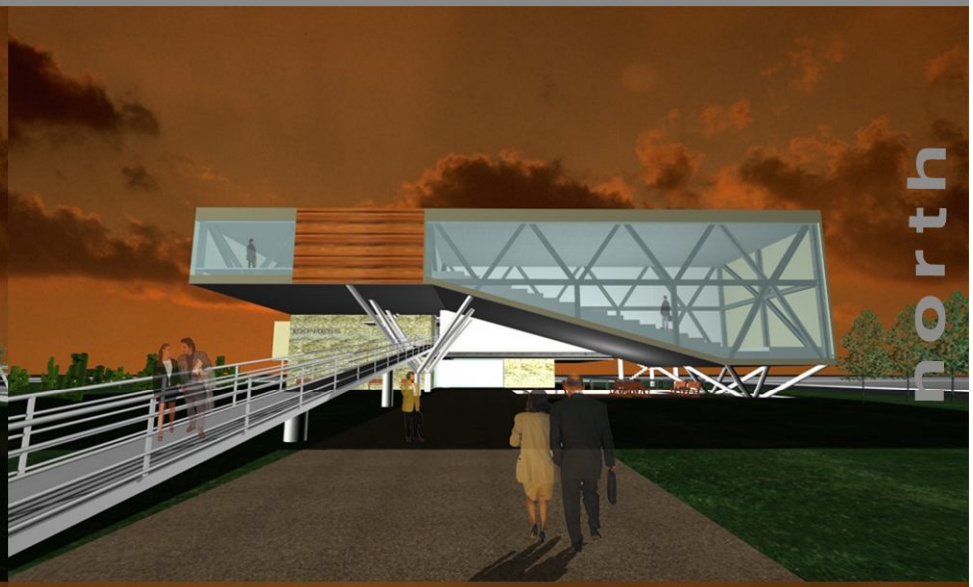

N
W
E
S
EXPRESS
ENGINEERING SCHOOL
NORTH

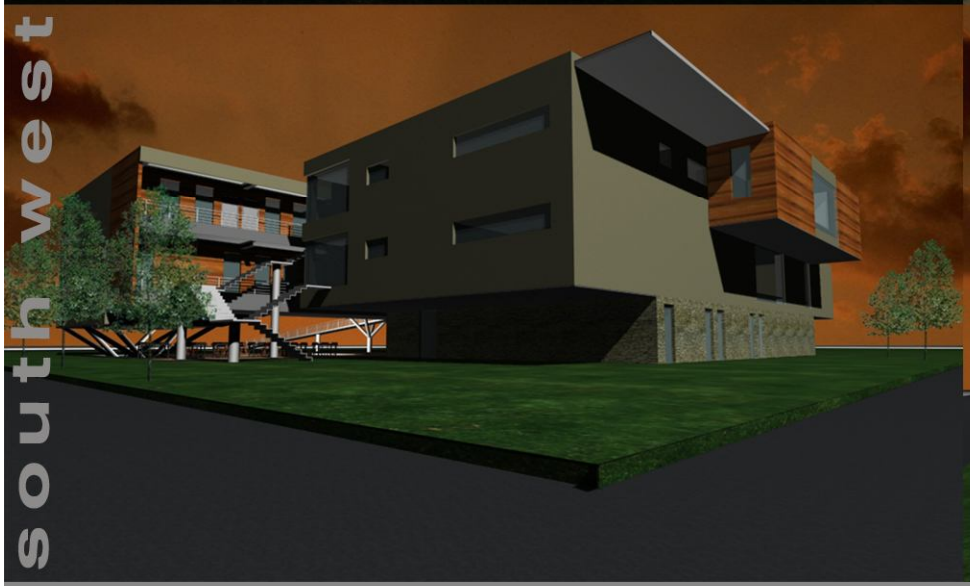

N
W
E
S
WEST

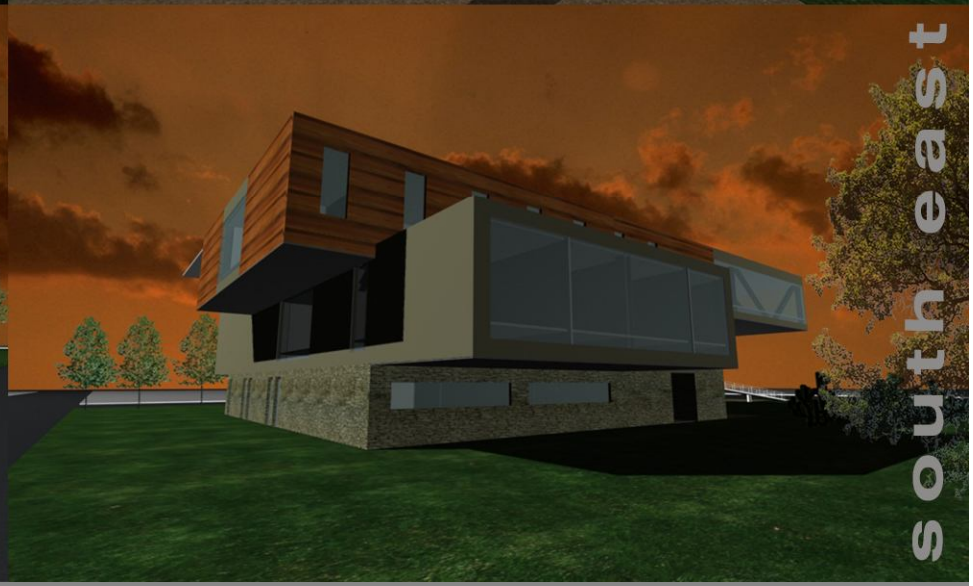

N
W
E
S
EAST


N
W
E
S
SOUTH

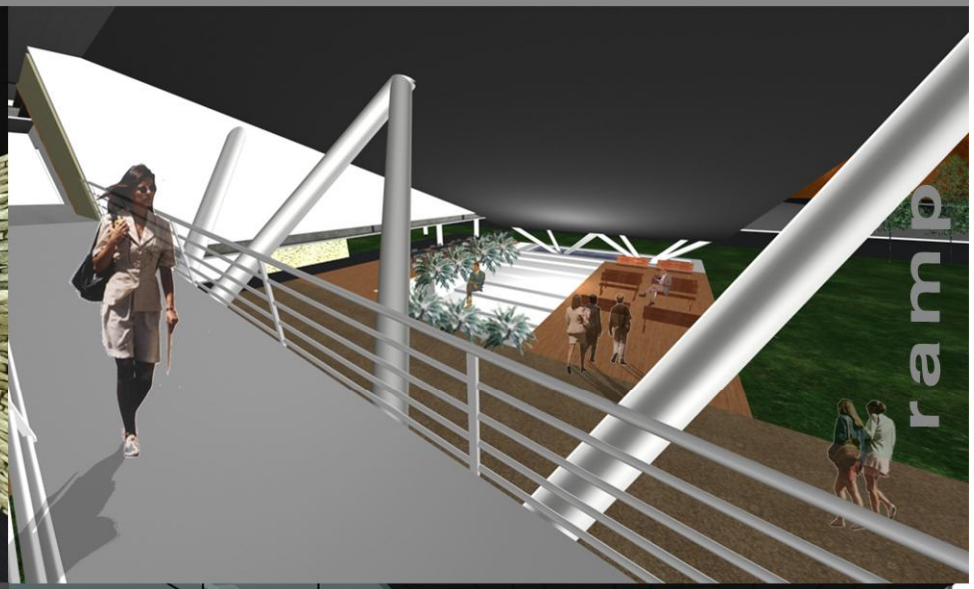

north east

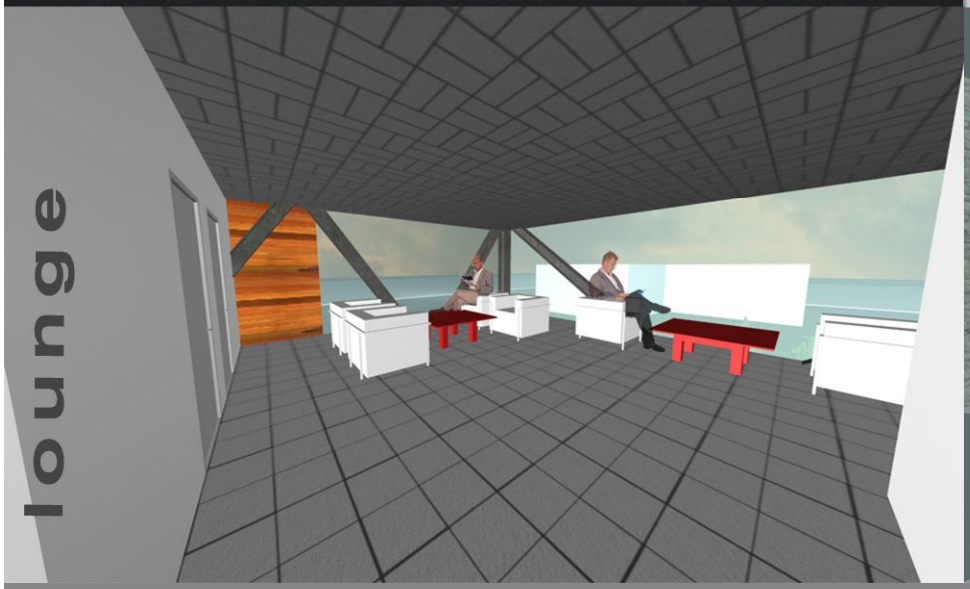

north


south west

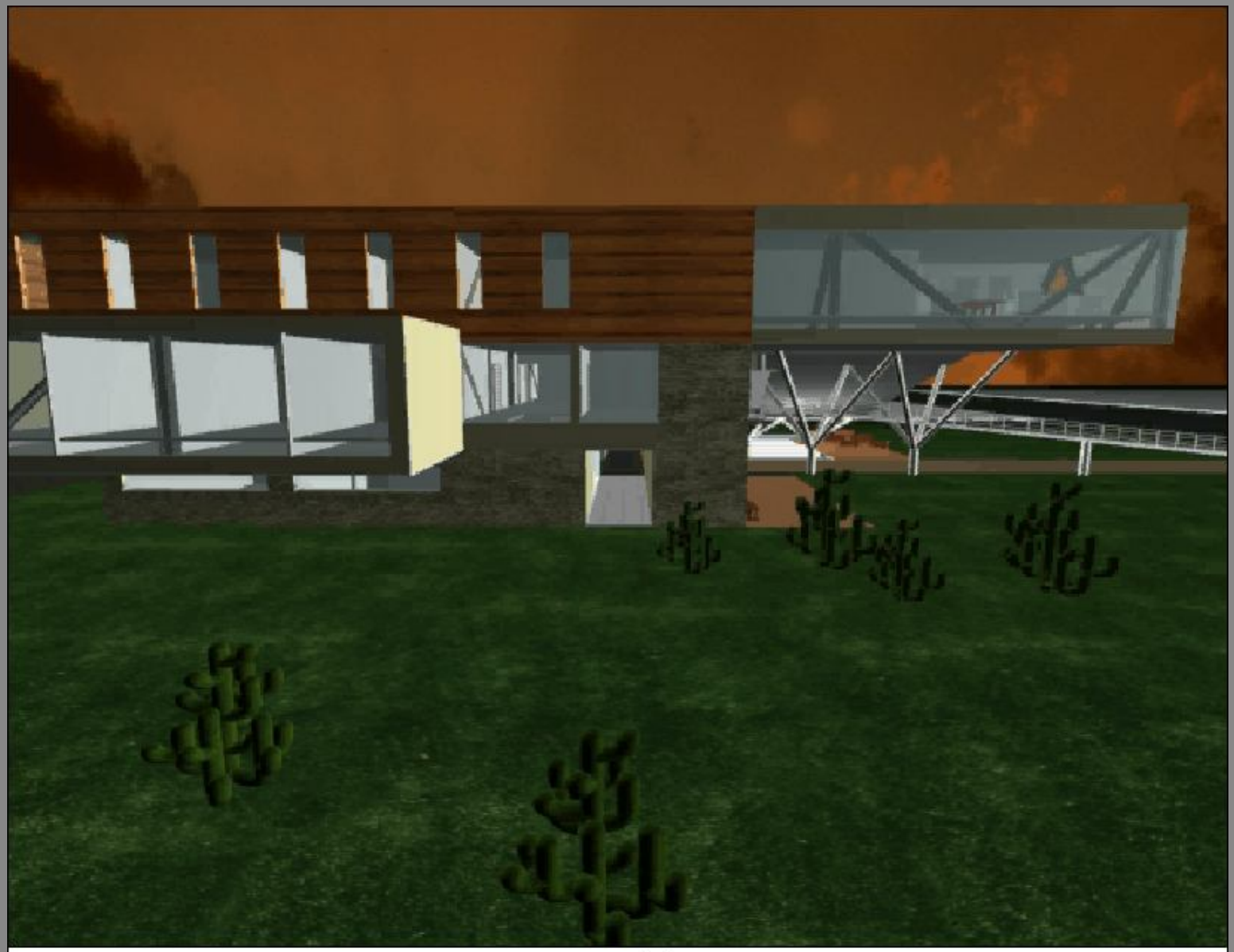

south east


passage


ramp


lounge


entrance



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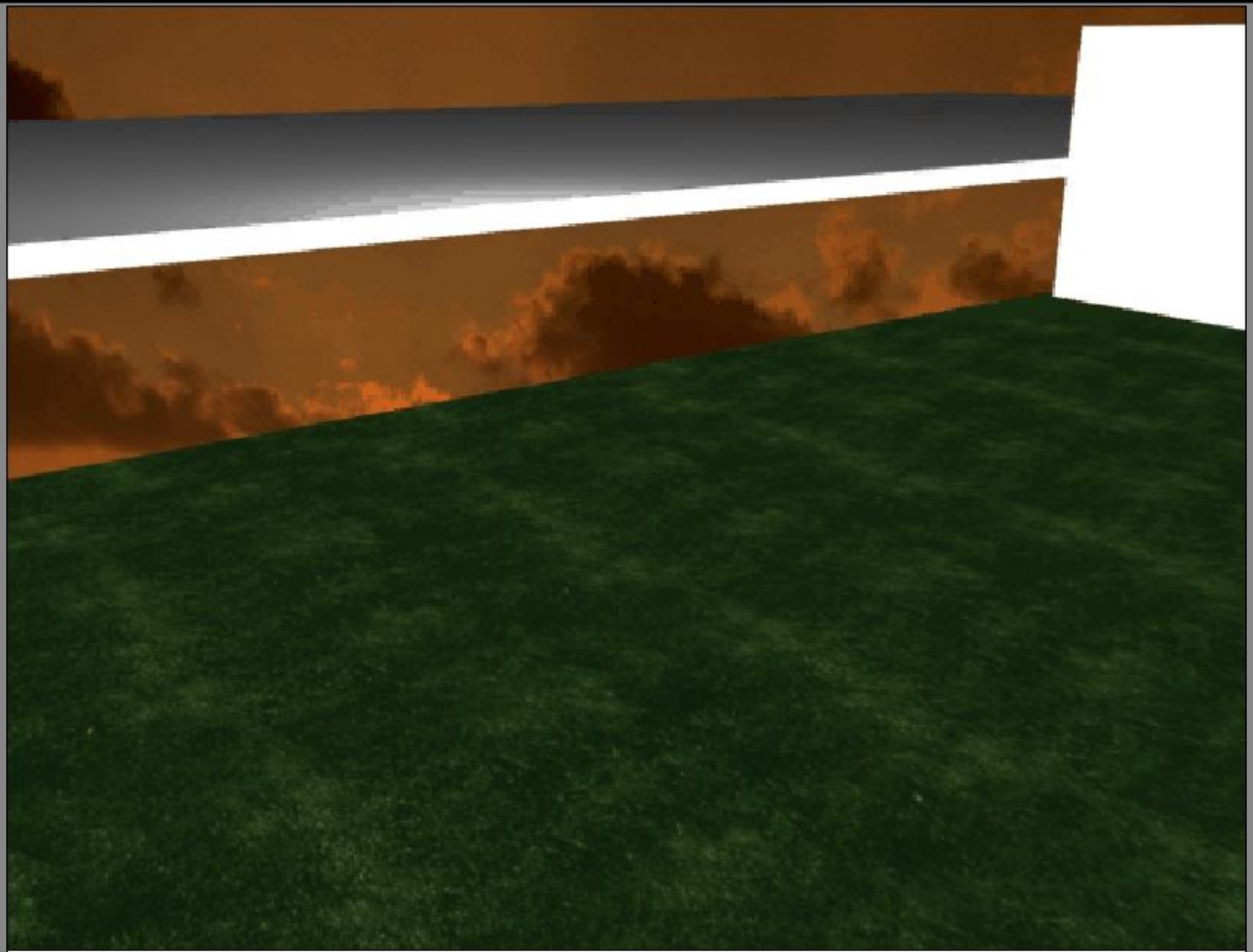

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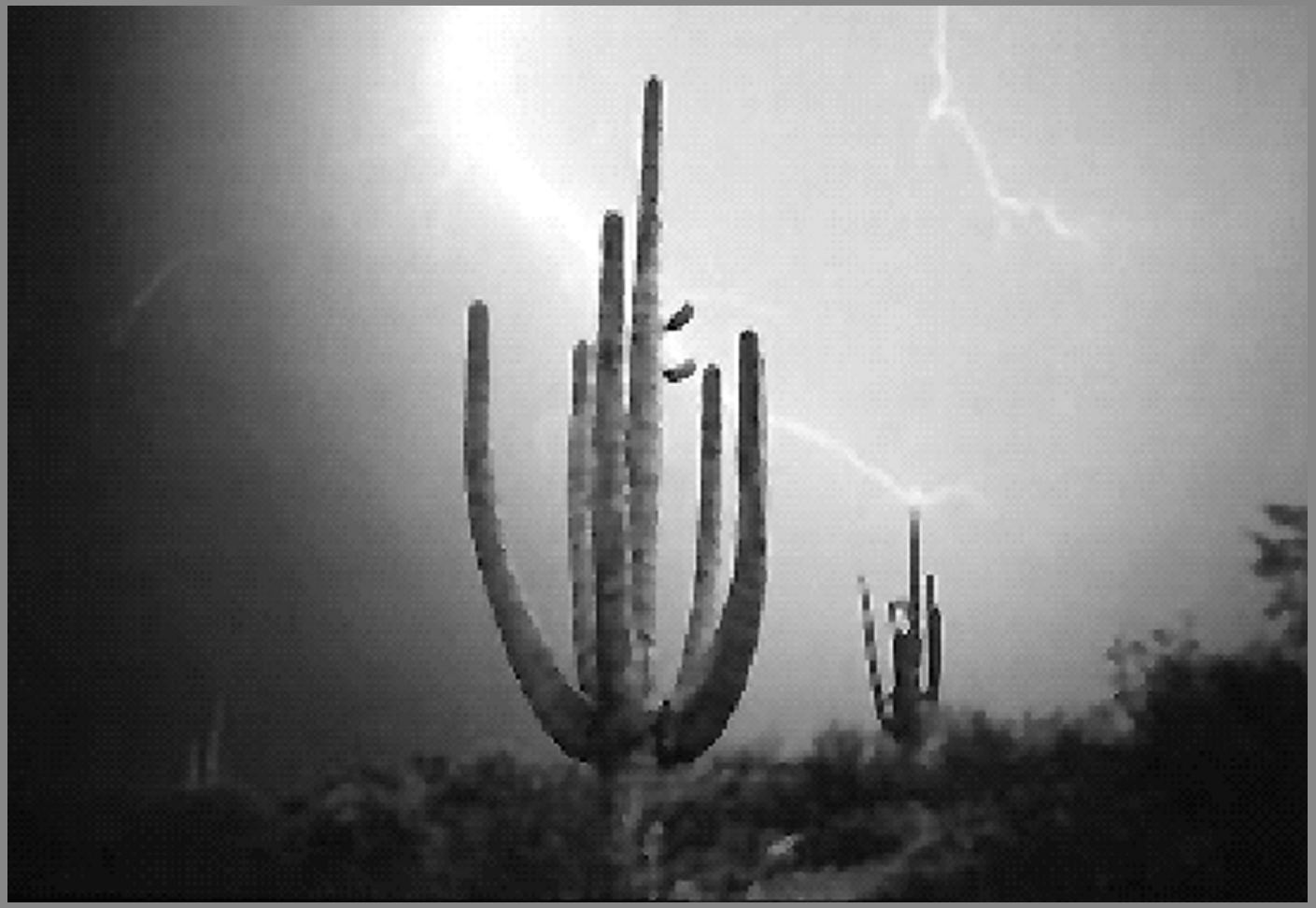
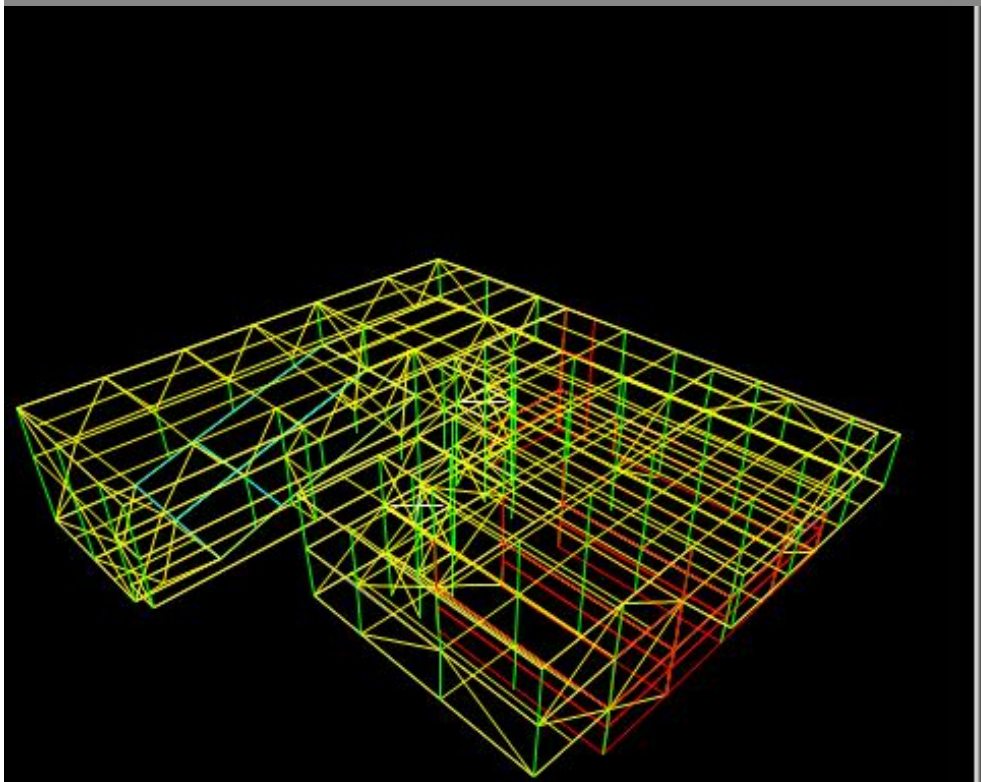
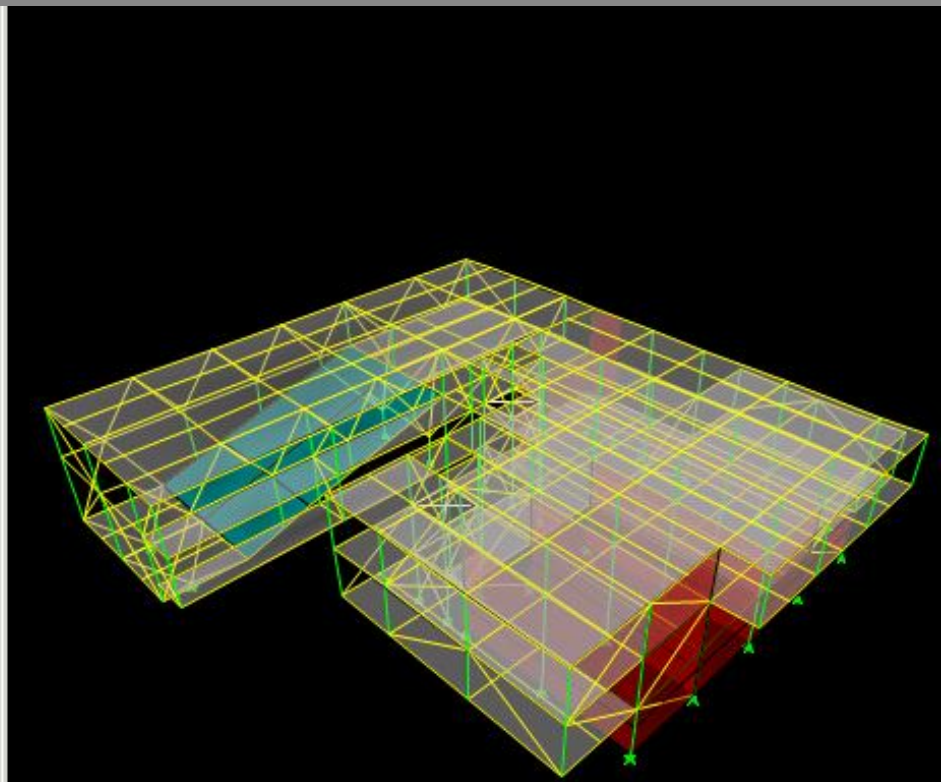
ENGINEER





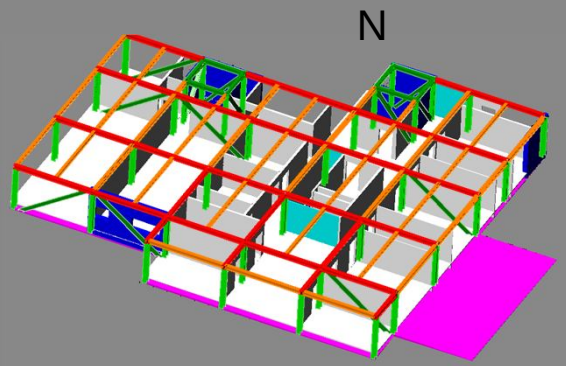


KEY ISSUES:

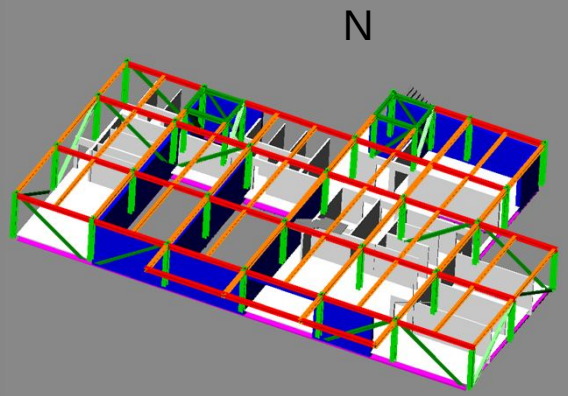
CANTILEVERS ON EVERY FACE OF THE BUILDING

AUDITORIUM

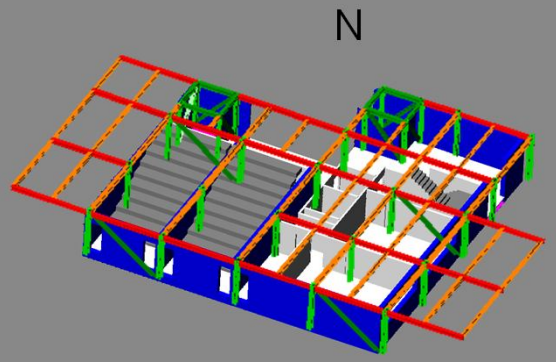
3rd

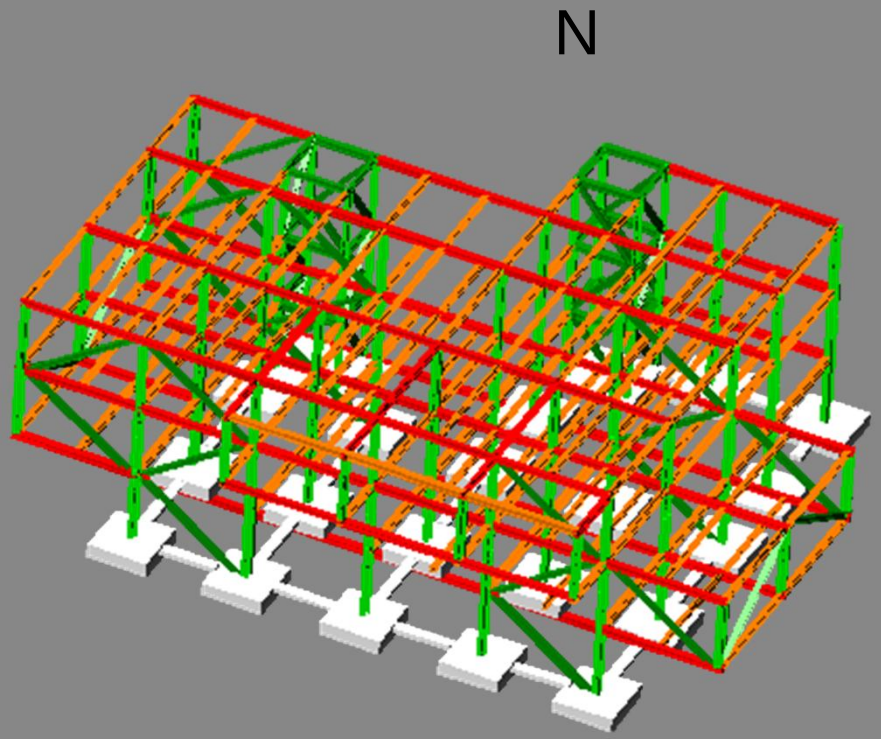


2nd



1st





Dead Loads

- Steel Framing: 15 psf
- Concrete Deck: 50 psf

Additional Dead Loads:

- MEP/Ceiling 15 psf
- Partitions: 20 psf
- Façade (glass): 15 psf

Live Loads

- Auditorium: 60 psf
- Office: 50 psf
- Class Rooms: 40 psf
- Computer Labs: 100 psf
- Corridors: 100 psf
- MEP Rooms: 200 psf
- Roof: 20 psf

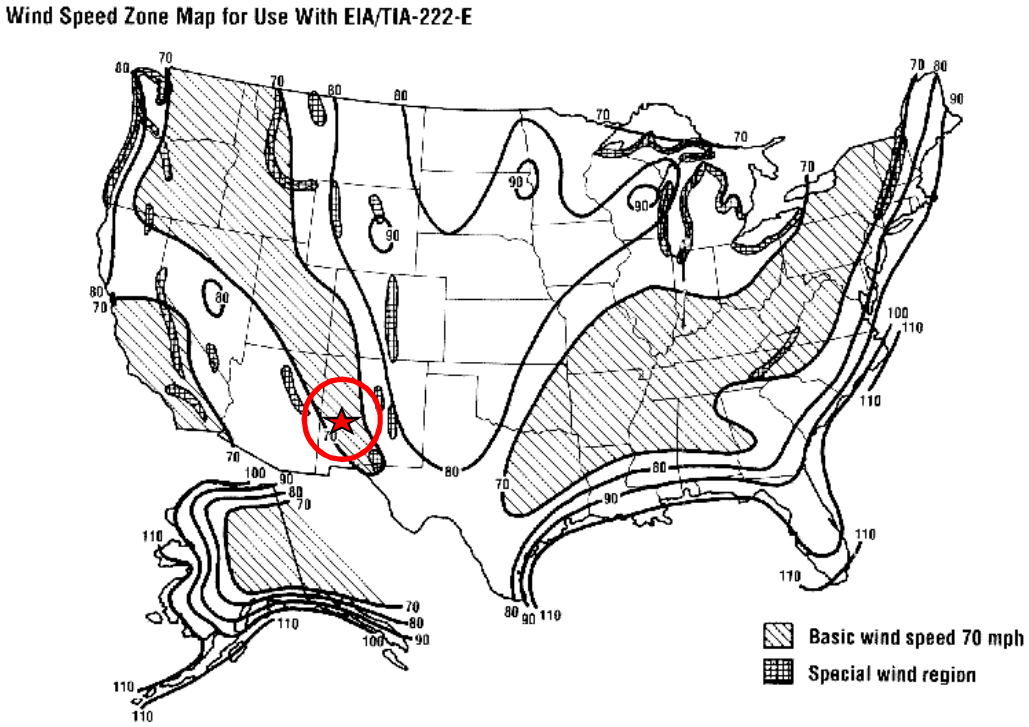
Lateral Loads

- Seismic – Zone 2B
- Wind

Wind Load Calculation: (UBC code, Method 1)

BASE SHEAR=~60 kips

$p = C_e C_q q_s I$



Height	Ce:
0-15'	0.62
20'	0.67
25'	0.72
30'	0.76
40'	0.84

(Exposure B)

Cq=	0.8	(inward)
	0.7	(roof)
	0.5	(outward)
I=	1	
q_s=12.6 psf		(V_{33}=70mph)

Floor	Height	p(psf)
roof	36	14
3	24	12
2	12	10
1	0	0

Steel Deck 3VLI

↓

Composite Beam
W12x22

↓

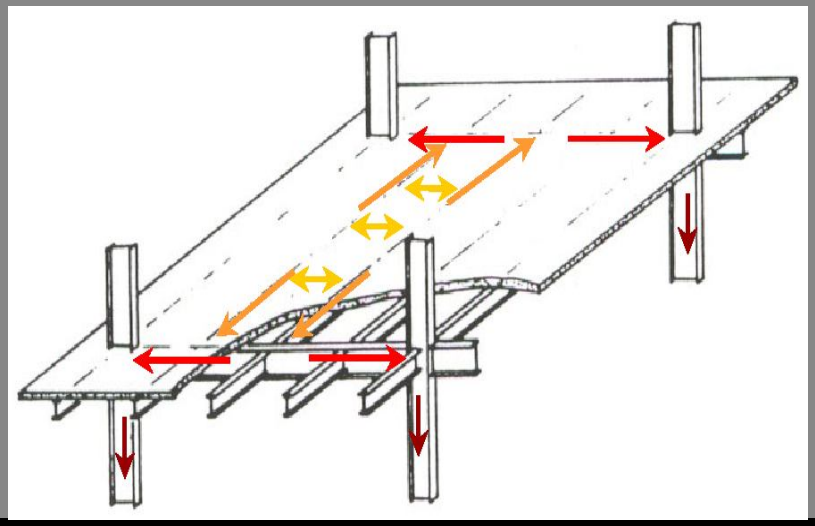
Composite Girder
W14x30

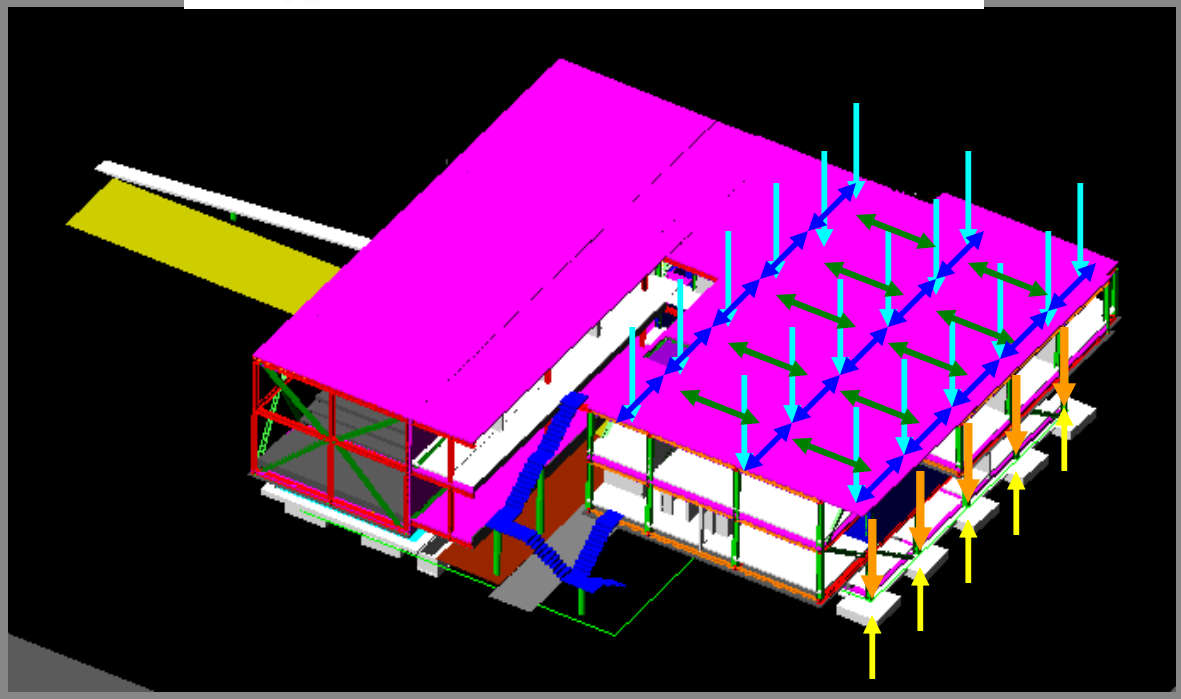
↓

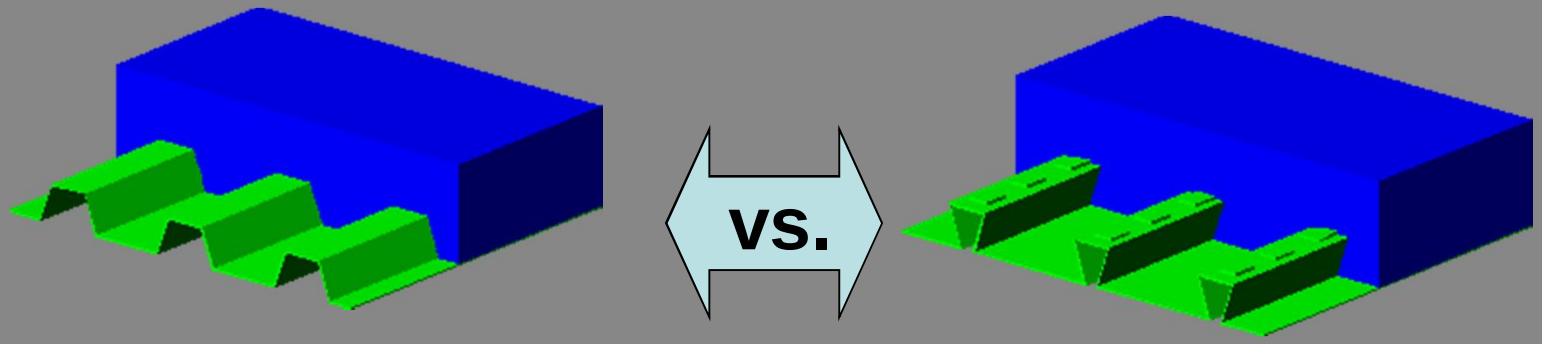
Column
W14x61

↓

Spread Footing
9‘6“x9‘6“x30“





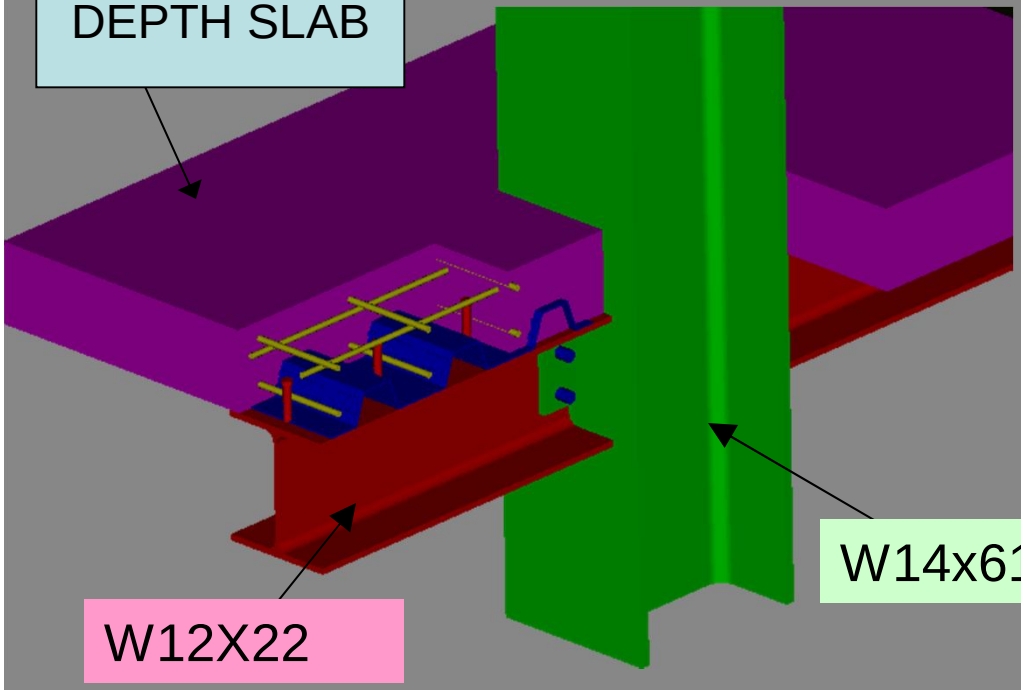


American Way

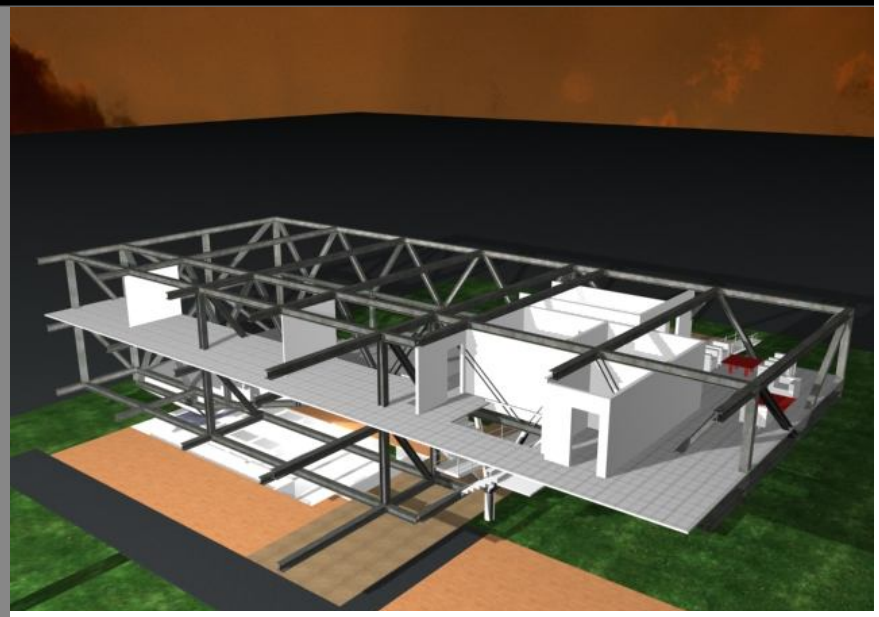
Without composite
Max. Span 11ft
Filler Beam
Available

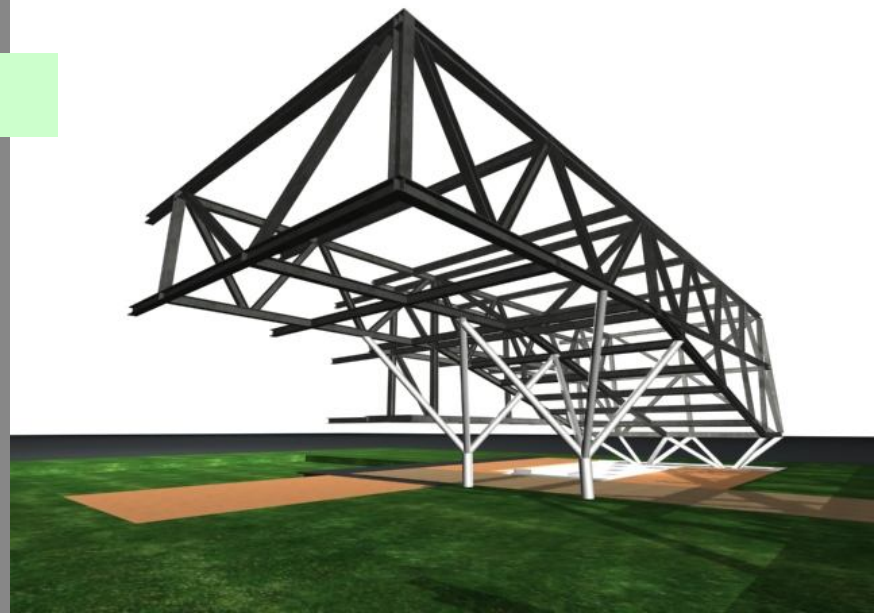
German Way

With composite
Max. Span 20ft
No filler Beam
Not available



SLAB – BEAM - COLUMN





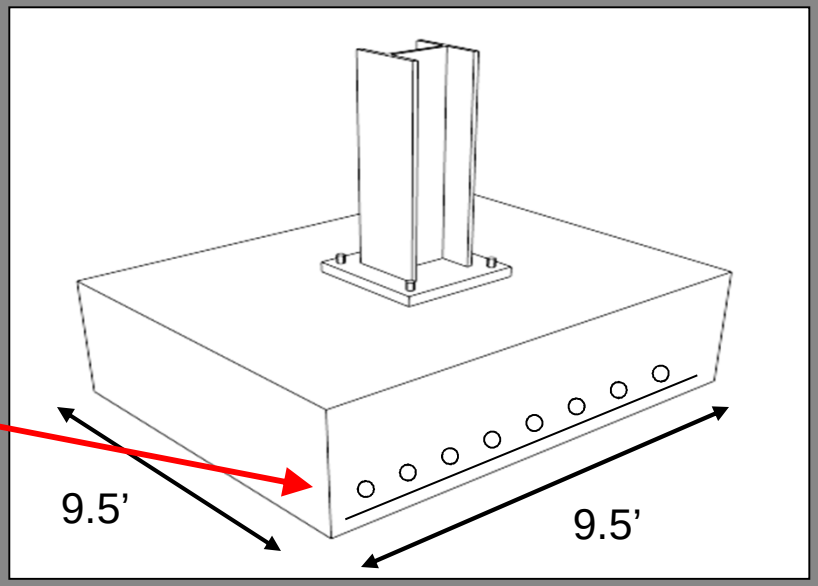
Foundation Design

Spread Footing

9.5‘x9.5‘x30“

w/ 8 #8 @15“ o.c.

both directions



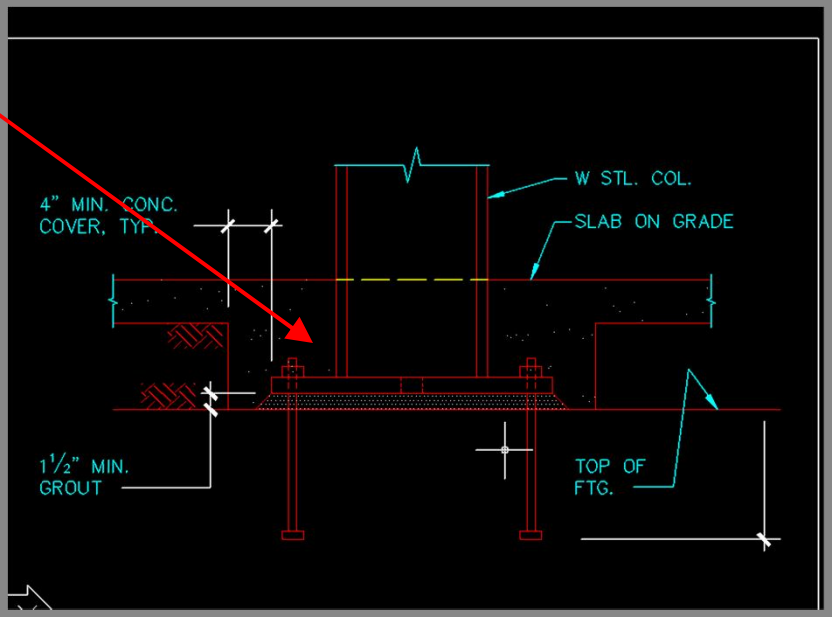
1” BASE PLATE

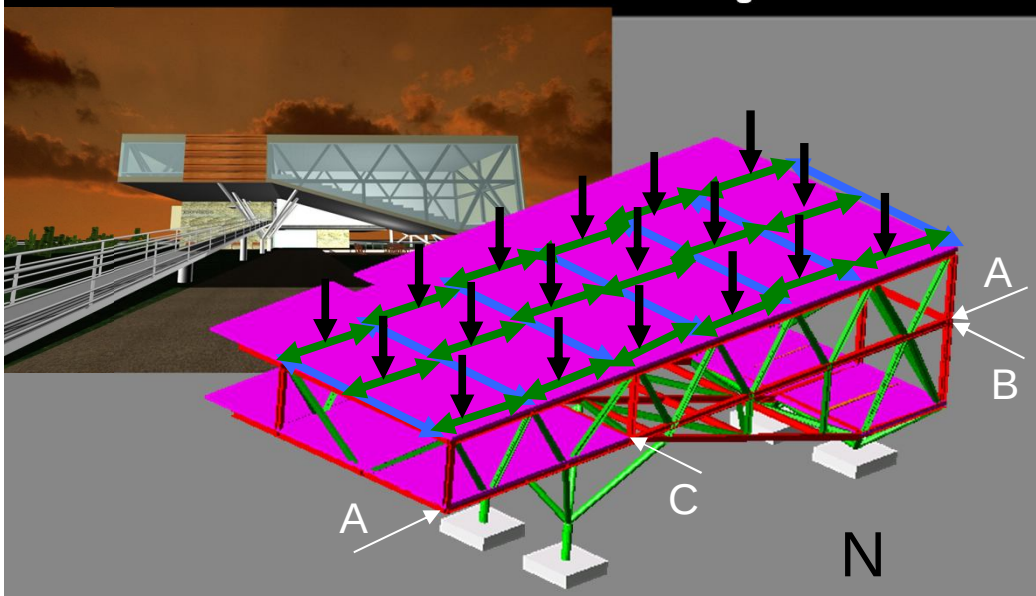
Wall Footing

14“ thick, 5‘5“ wide

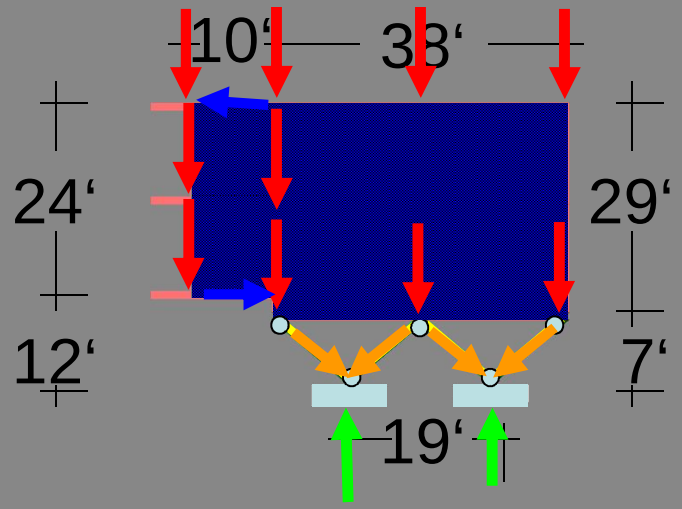
w/ #4 @6“ o.c.

and 3 #6 T&S

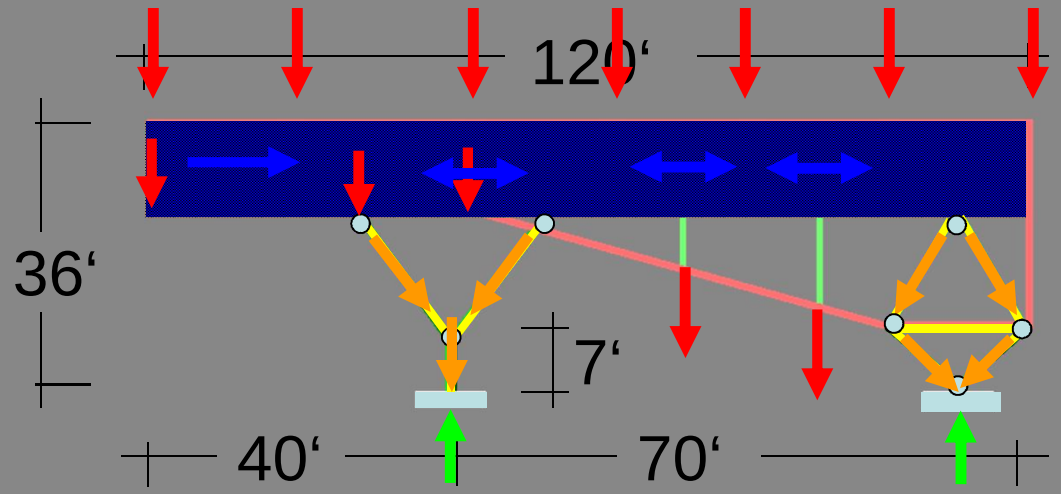




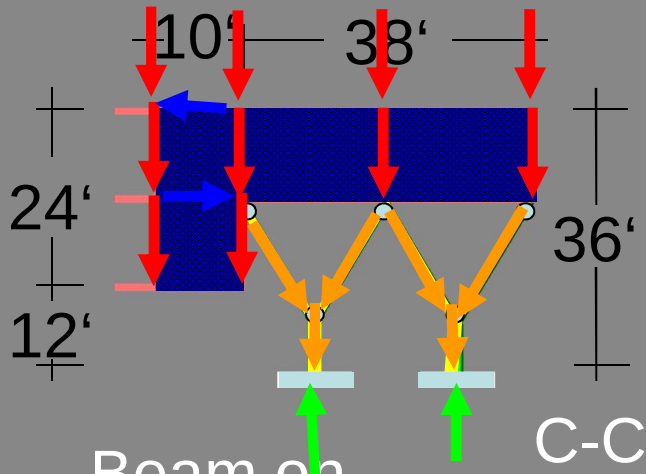
N



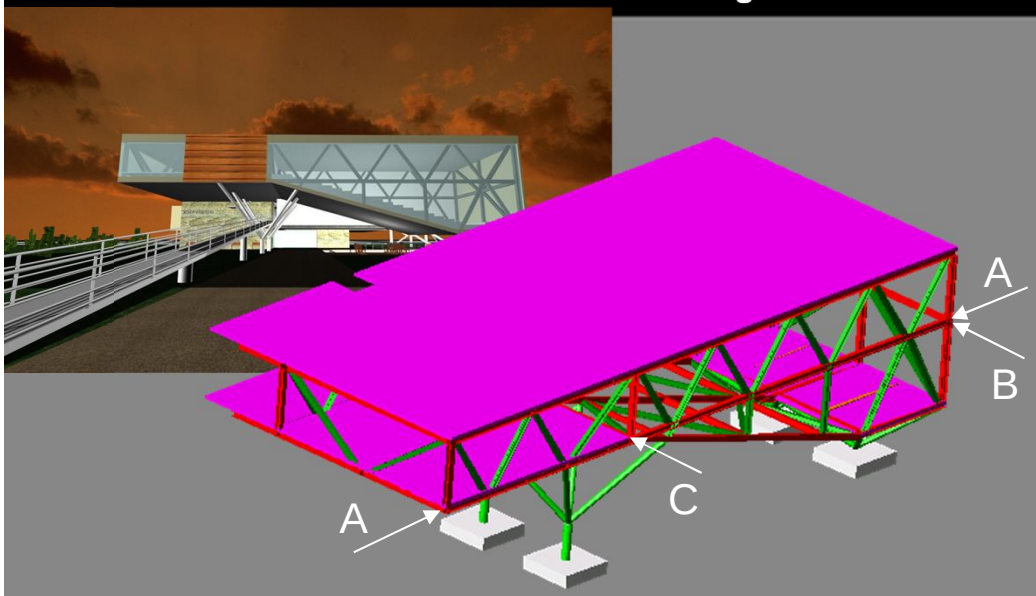
Beam B-B

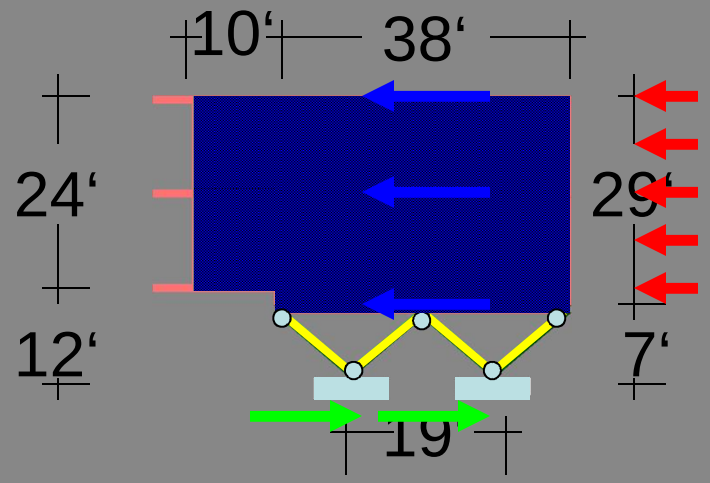


3-Pinned Frame A-A

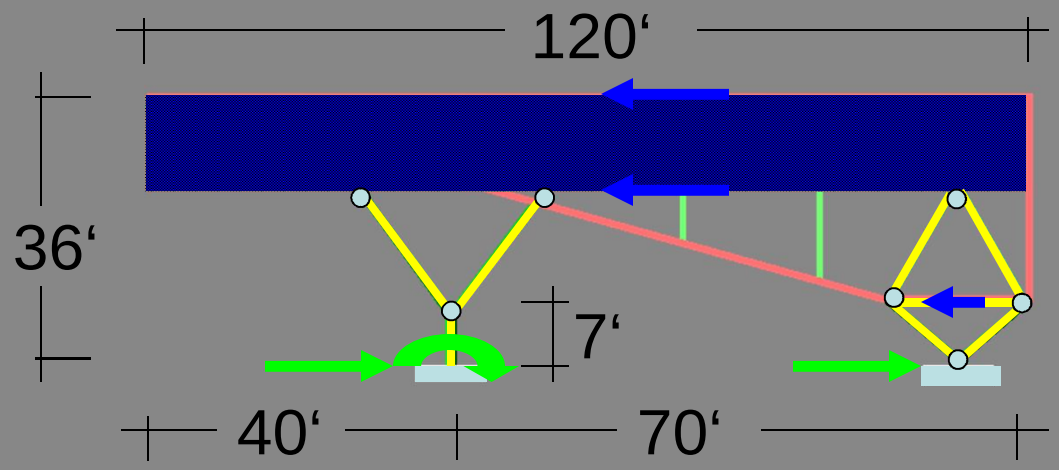


Beam on fixed columns C-C

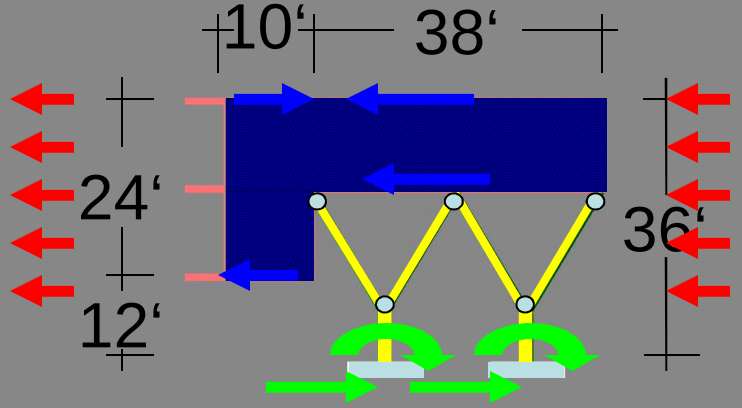




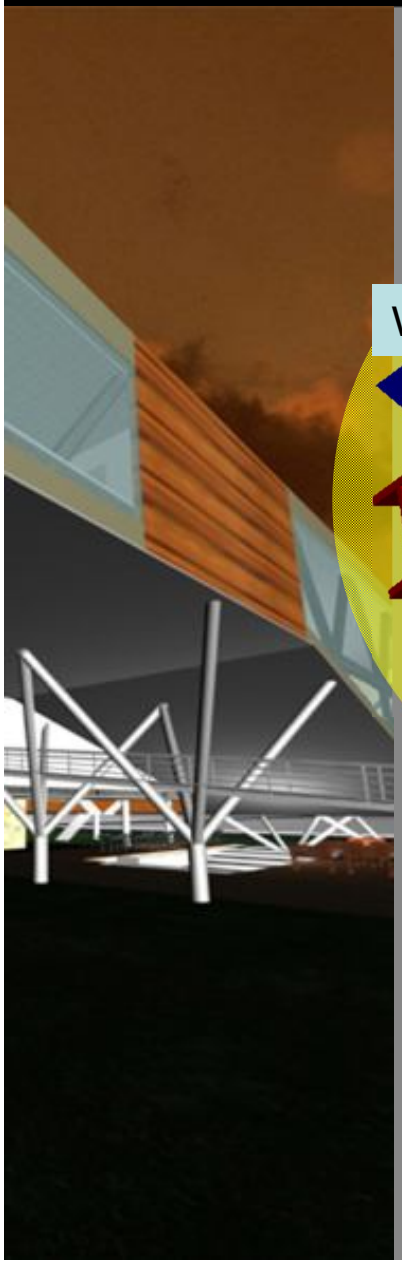
Beam B-B

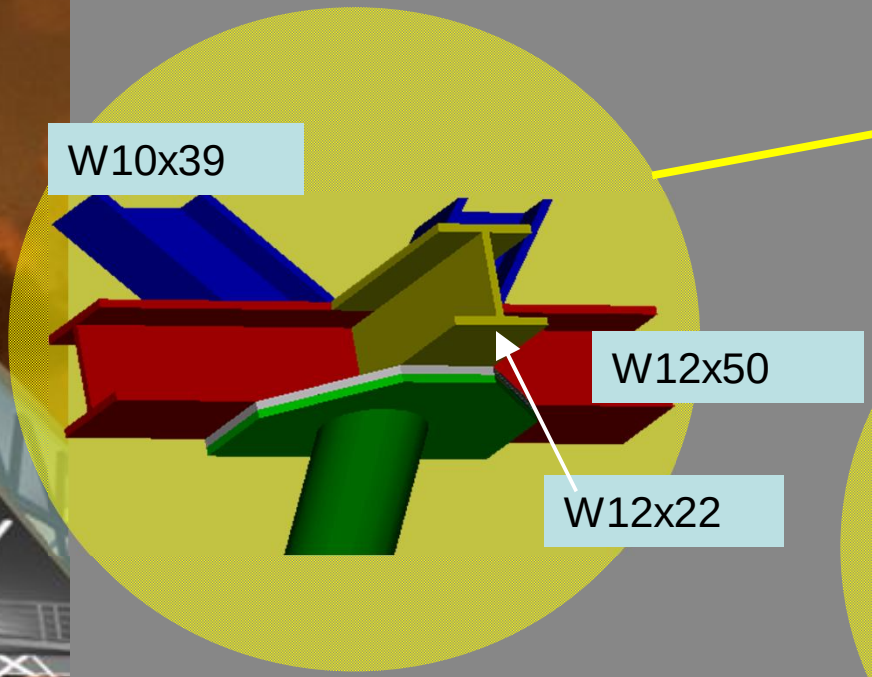


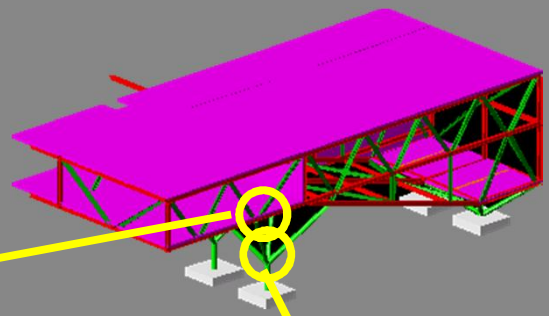
3-Pinned Frame A-A

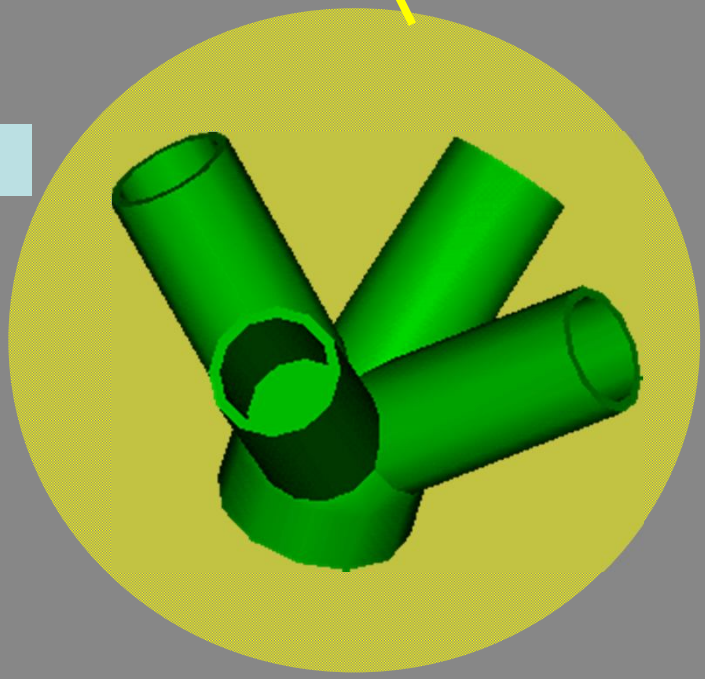


Beam on fixed columns C-C



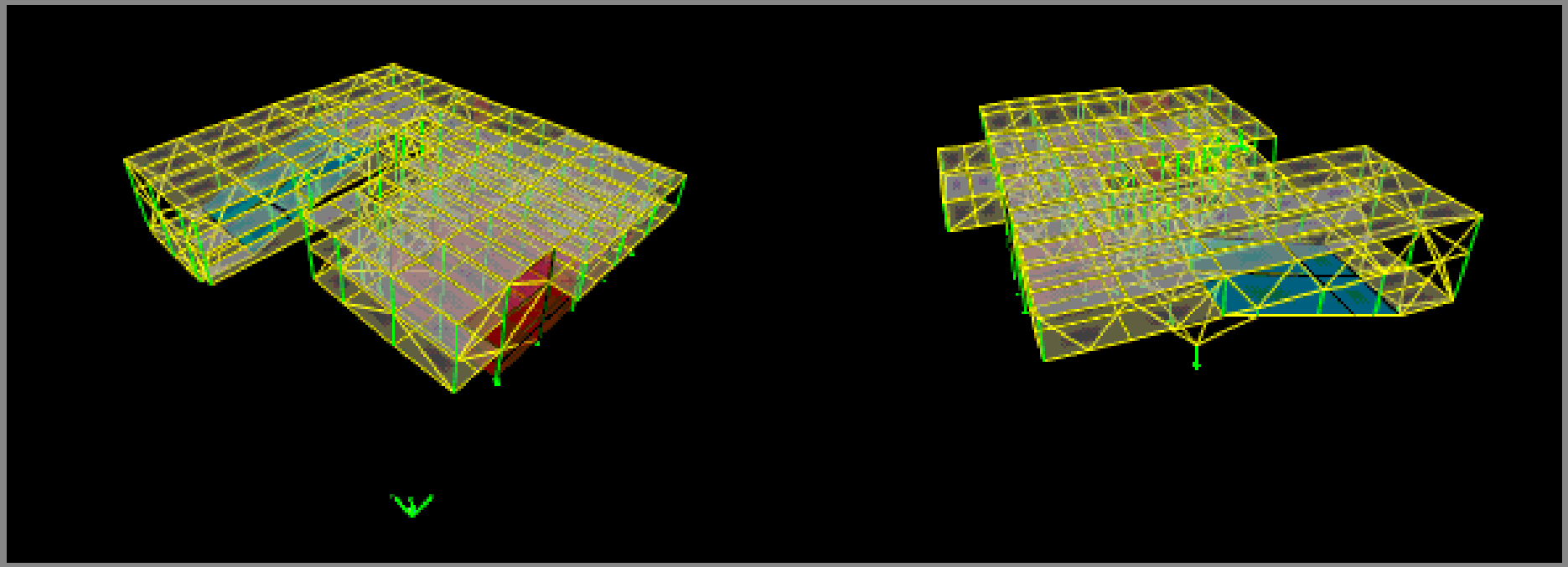






Pyramid - Truss

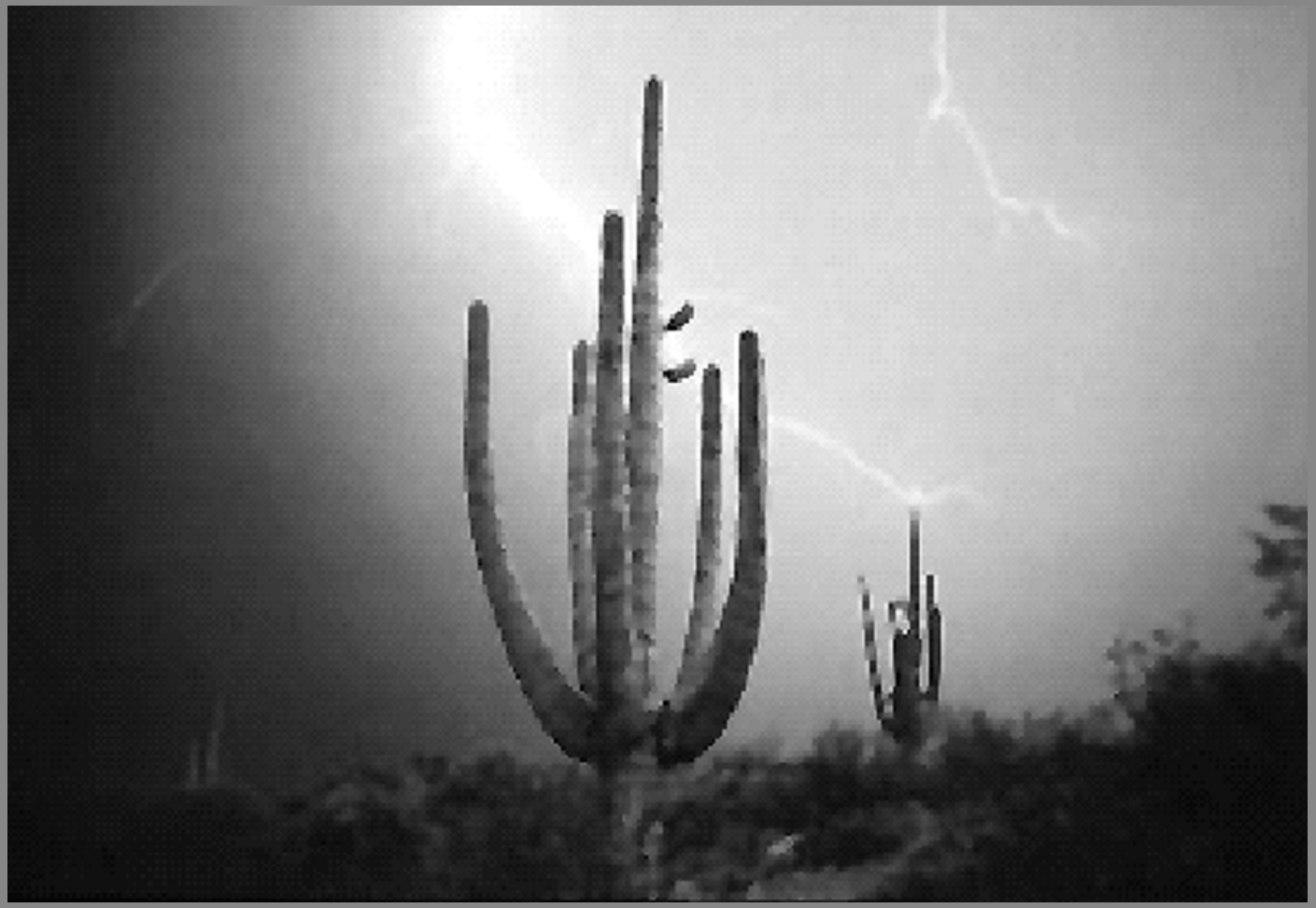
Cast Steel Node

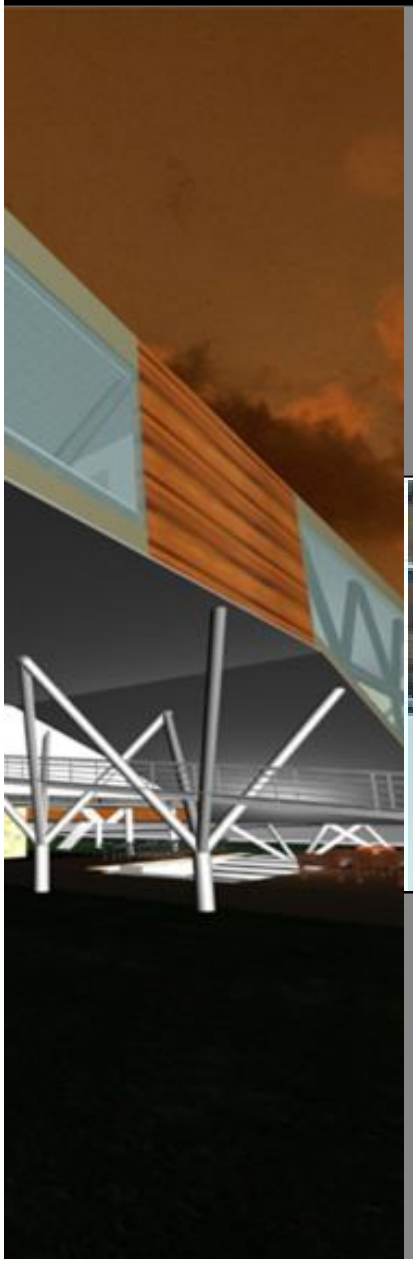


EQ LOADING: BASE SHEAR = 95 kips

ACTUAL Δ_{max} = 1.8 in $Drift_{max}$ = 0.51%

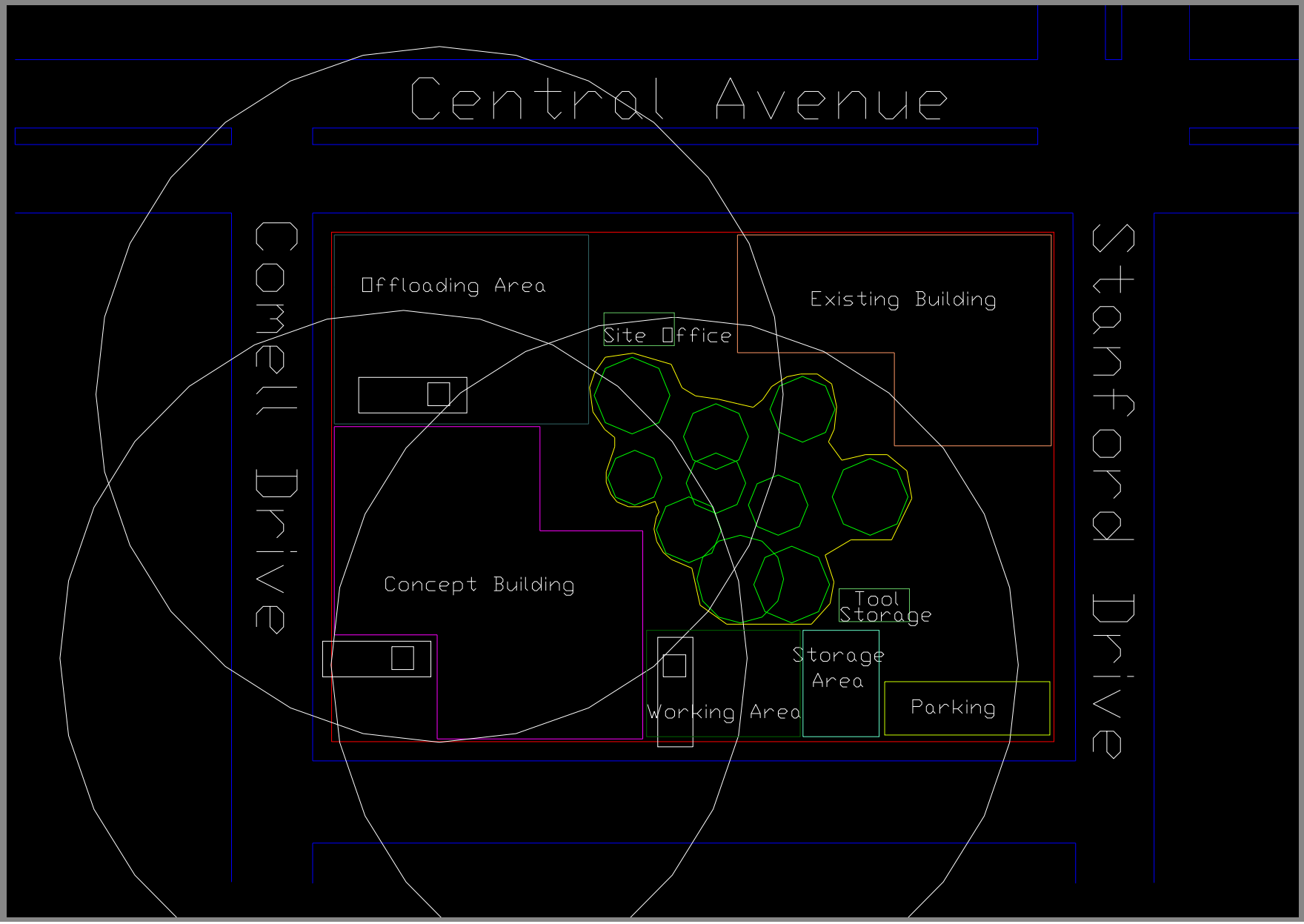
ALLOWABLE Δ_{max} = 2.0 in $Drift_{max}$ = 2.00%





- Just in time material deliveries
- Maximize shop pre-fabrication for steel
- Cast steel connections for pyramids

- Achieve thermal mass and insulation value
- Utilize the latest in solar technology


Central Avenue
Comell Drive
Stanford Drive
Offloading Area
Site Office
Existing Building
Concept Building
Tool Storage
Storage Area
Working Area
Parking

- Hydraulic Mobile Crane
  - 127 ft radius maximum
  - 70 ton crane @ 10 ft
  - Line pull rate – 495 fpm

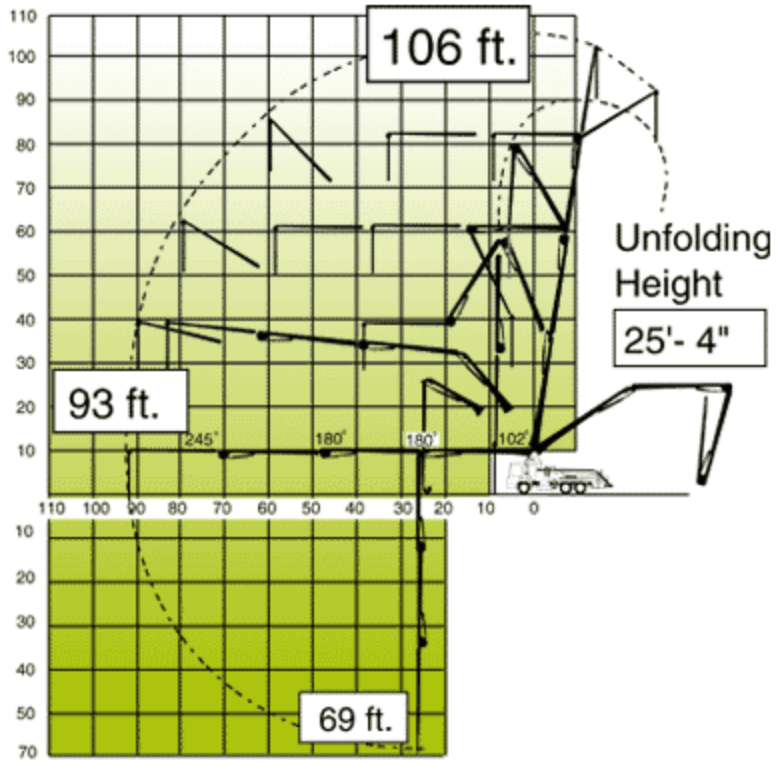
Maximum Allowable Lifting Capacities
Rated Lifting Capacities In Pounds
On Fully Extended Outriggers
See Set Up Note 2.

A-max Mode
0# COUNTERWEIGHT

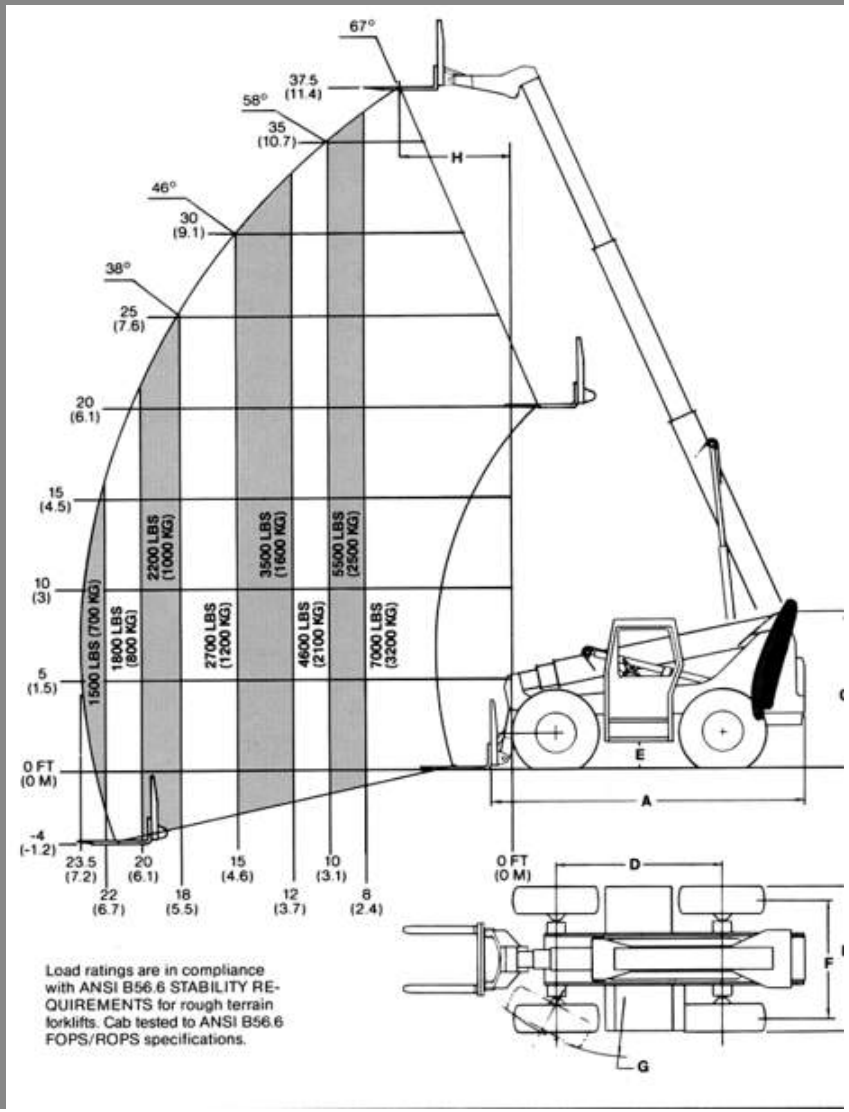
55 Ft. To 63.6 Ft. Main Boom

Load Radius In Feet	55 Ft.			63.6 Ft.			Load Radius In Feet
	Loaded Boom Angle (Deg.)	360°	Over Rear	Loaded Boom Angle (Deg.)	360°	Over Rear	
10	75.0	85,600	85,600				10
12	73.0	85,600	85,600	75.5	56,300	56,300	12
15	69.5	85,600	85,600	73.0	56,300	56,300	15
20	63.5	65,500	65,500	68.0	53,000	53,000	20
25	57.5	43,100	43,100	63.0	42,600	42,600	25
30	50.5	30,600	30,600	57.5	30,200	30,200	30
35	43.0	22,400	22,900	51.5	22,000	22,500	35
40	34.0	16,700	17,600	45.0	16,300	17,300	40
45	22.0	12,700	13,800	38.0	12,400	13,500	45
50				29.0	9,500	10,700	50
55				15.5	7,200	8,400	55
Min. Boom Angle/Cap.	0°	10,700	11,900	0°	6,500	7,700	Min. Boom Angle/Cap.

- Concrete Pump
  - KVM 32XL/XG
- Hydraulic Excavator
  - Caterpillar 3126B
  - 48” bucket / 2.12 yd^3

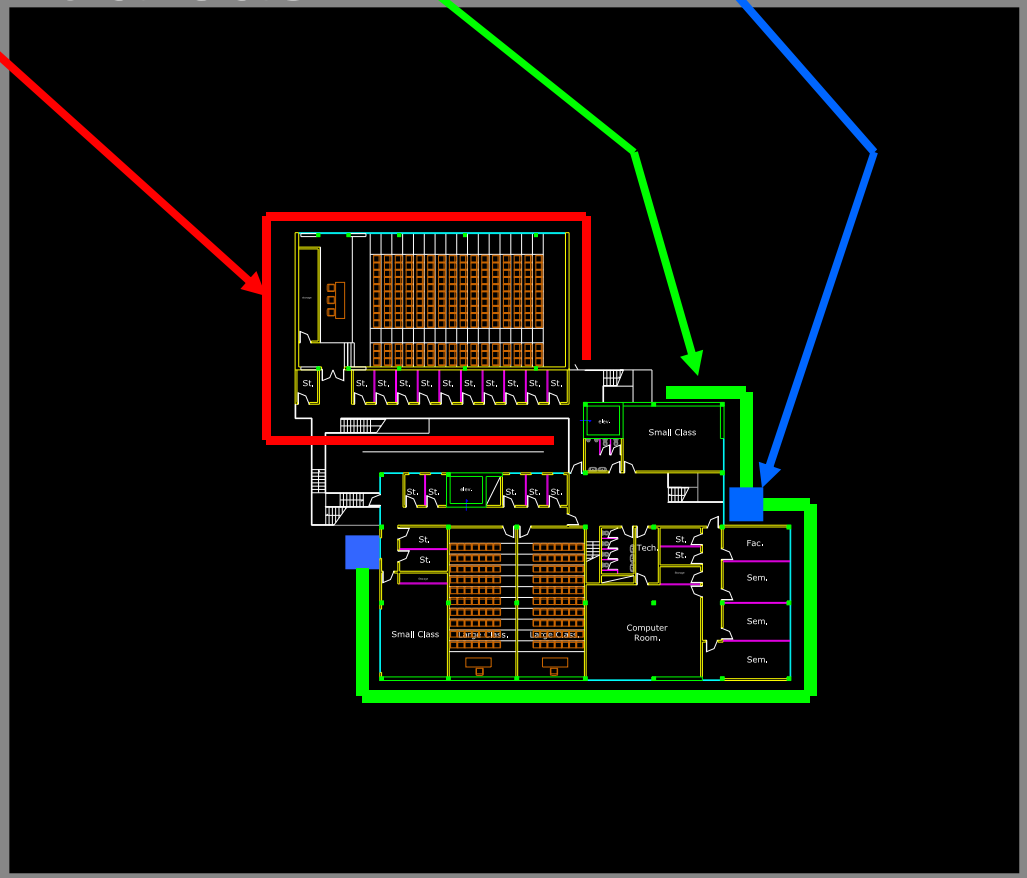


- Sky Trak 7038
  - 7000 lbs @ 37.5 ft



Fixed Scaffolding with Stairs

Scissor Lift areas



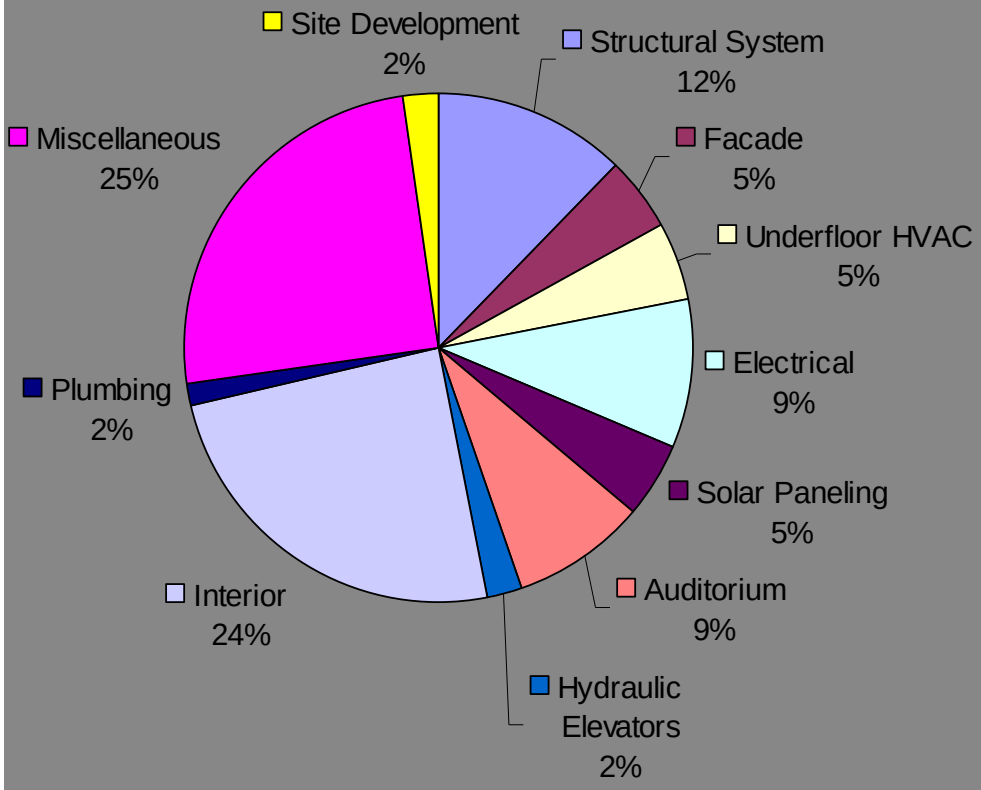
Inflation Adjusted over 12 years at 3% annually

Building Costs	Spring Quarter - Assembly	Winter Quarter - SF
Structural System	$1,016,728.15	$601,258.14
Facade	$371,688.63	$438,498.00
Underfloor HVAC	$429,990.00	$938,615.00
Electrical	$779,333.94	$577,499.00
Solar Paneling	$377,638.72	$107,475.00
Auditorium	$722,863.60	$650,582.00
Hydraulic Elevators	$166,262.80	$161,699.72
Interior	$2,018,351.56	$4,579,868.00
Plumbing	$128,997.00	Included in Interior costs
Miscellaneous	$2,048,856.34	Included in Interior costs
Site Development	$186,732.36	Included in Interior costs
TOTAL COST	**$8,247,443.10**	**$8,055,494.86**

Key Lesson Learned: World class architecture demands world class financing.

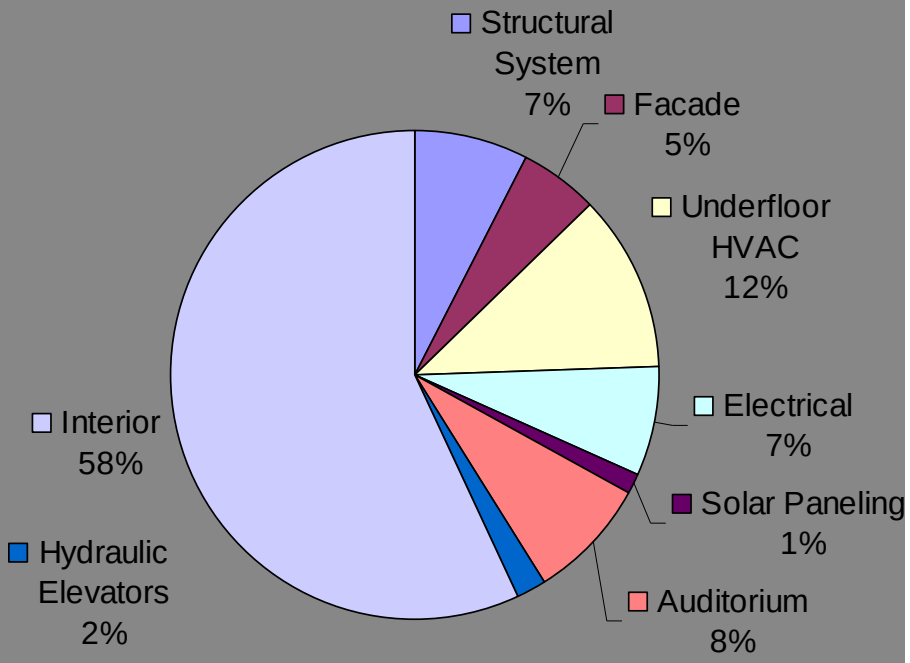
Building Costs Spring Quarter

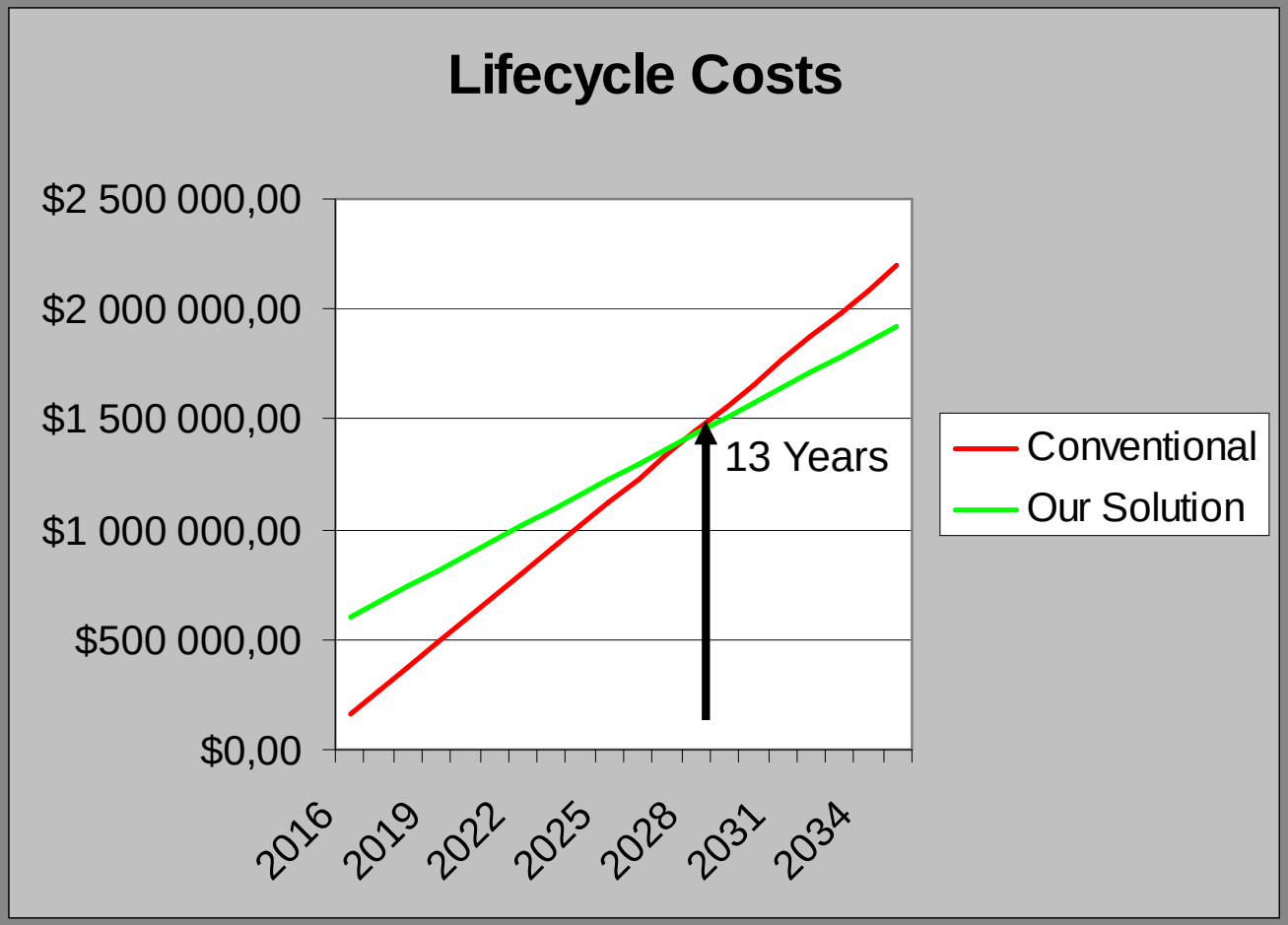
$ 8,247,443



Building Costs Winter Quarter

$ 8,055,495





Initial Investments:

Conventional

$ 55,000

Our Solution

$ 528,000

Lifecycle costs / year:

Conventional

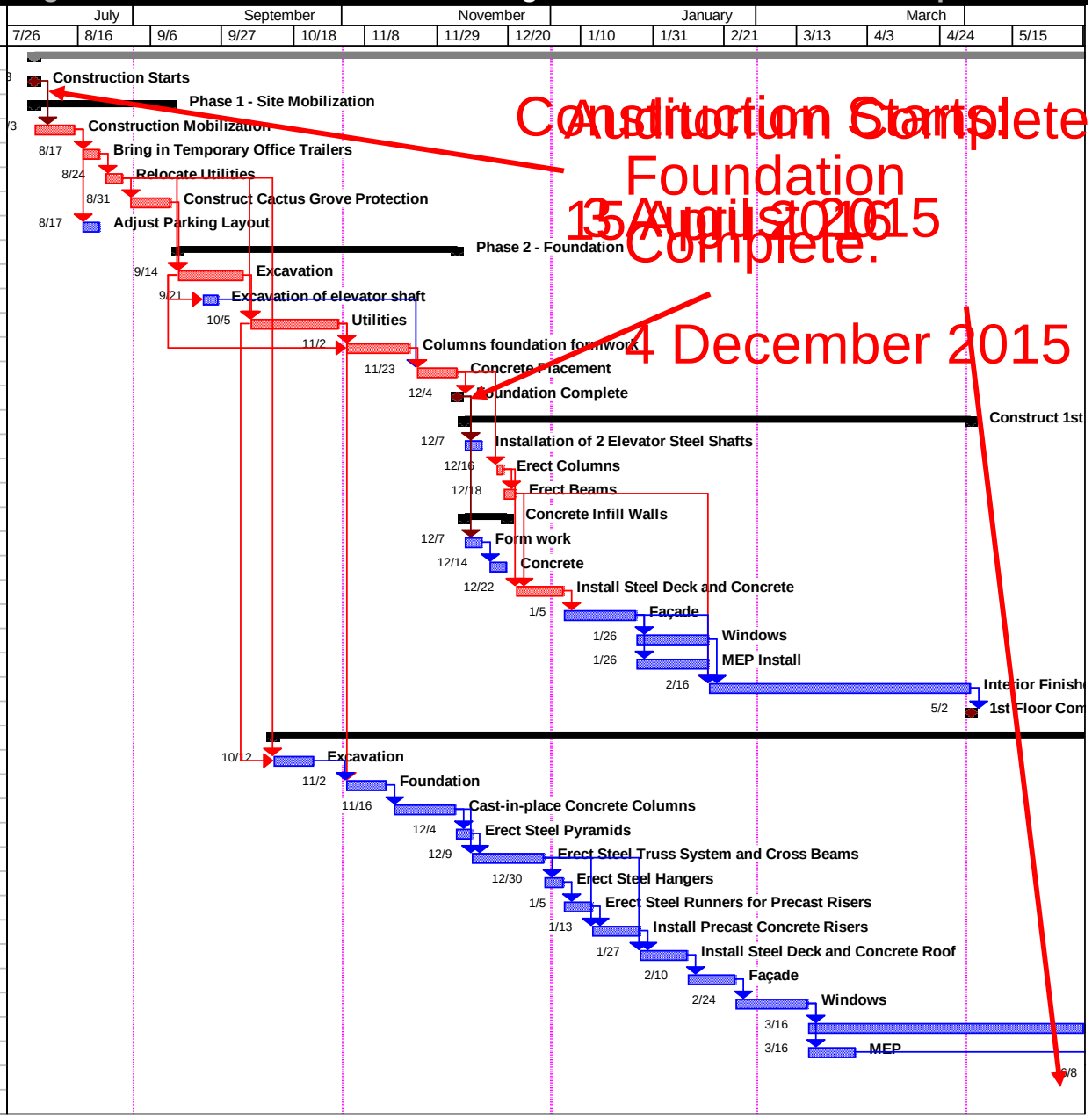
$ 107,000

Our Solution

$ 69,550

Schedule with Key Milestones

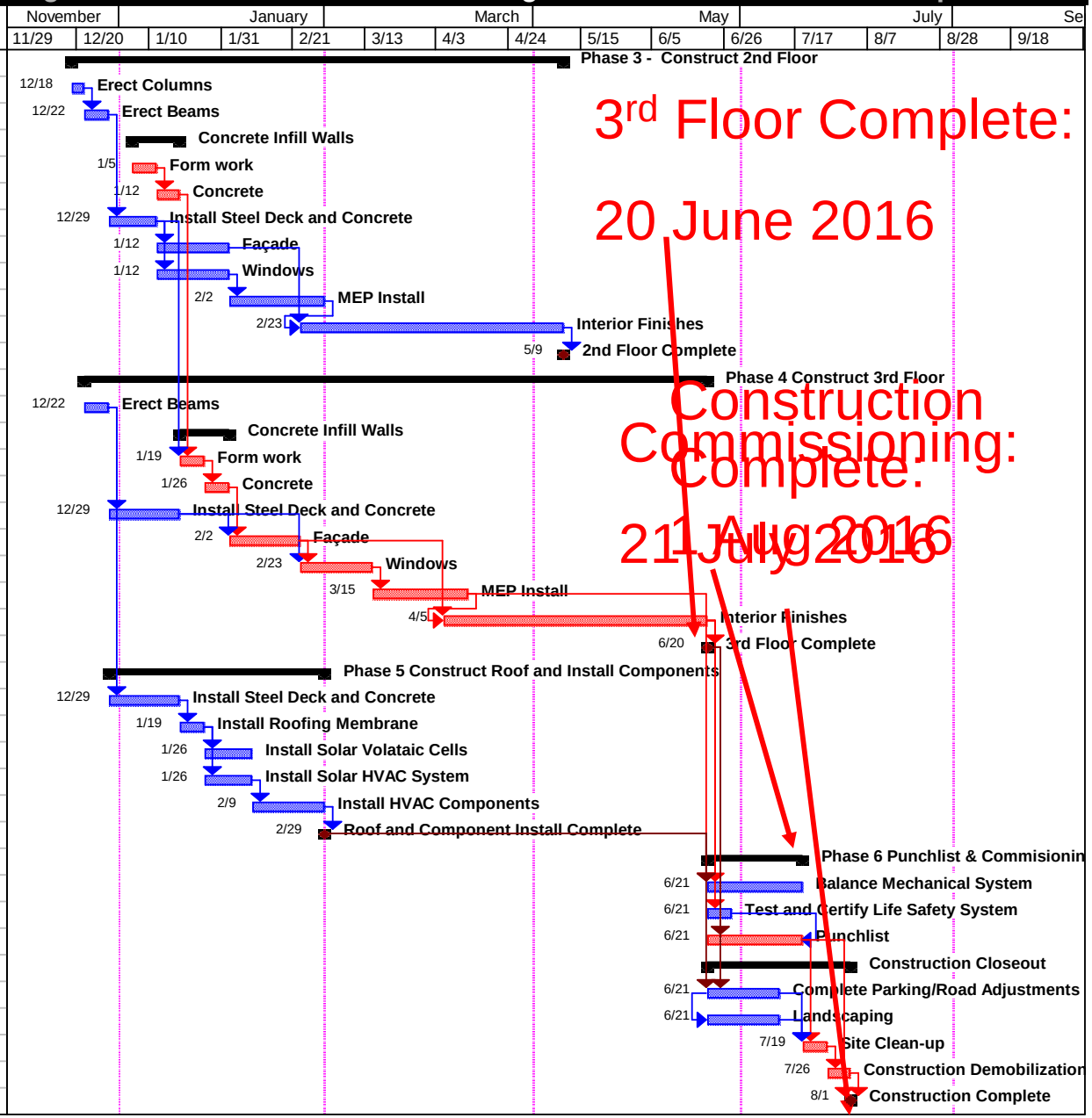
ID	Task Name	Dur
0	**Express 2003 Conceptual Schedule**	**261d?**
1	**Construction Starts**	0d
2	**Phase 1 - Site Mobilization**	**30d**
3	Construction Mobilization	2w
4	Bring in Temporary Office Trailers	1w
5	Relocate Utilities	1w
6	Construct Cactus Grove Protection	2w
7	Adjust Parking Layout	1w
8	**Phase 2 - Foundation**	**60d**
9	Excavation	15d
10	Excavation of elevator shaft	5d
11	Utilities	4w
12	Columns foundation formwork	15d
13	Concrete Placement	10d
14	***Foundation Complete***	0d
15	**Construct 1st Floor**	**106d**
16	Installation of 2 Elevator Steel Shafts	5d
17	Erect Columns	2d
18	Erect Beams	2d
19	**Concrete Infill Walls**	**10d**
20	Form work	1w
21	Concrete	5d
22	Install Steel Deck and Concrete	2w
23	Façade	3w
24	Windows	3w
25	MEP Install	3w
26	Interior Finishes	11w
27	***1st Floor Complete***	0d
28	**Phase 2 - Construct Auditorium**	**182d**
29	Excavation	10d
30	Foundation	10d
31	Cast-in-place Concrete Columns	14d
32	Erect Steel Pyramids	3d
33	Erect Steel Truss System and Cross Beams	15d
34	Erect Steel Hangers	4d
35	Erect Steel Runners for Precast Risers	6d
36	Install Precast Concrete Risers	10d
37	Install Steel Deck and Concrete Roof	10d
38	Façade	2w
39	Windows	15d
40	Interior Finishes	60d
41	MEP	10d
42	Punchlist	10d
43	***Auditorium Complete***	0d

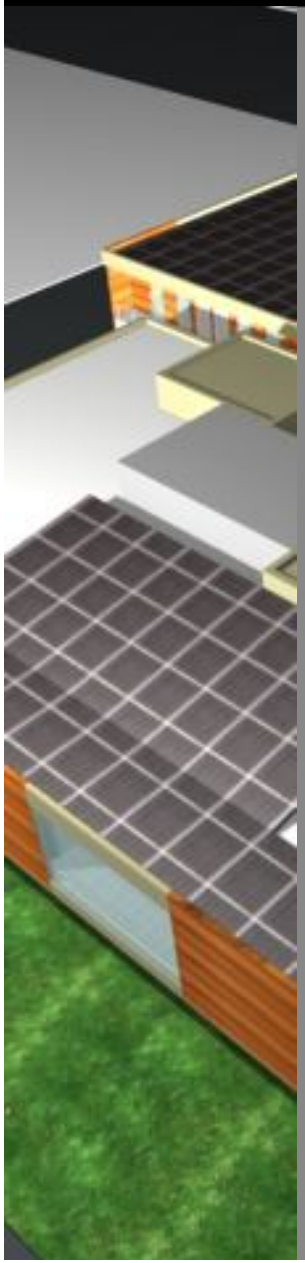


Schedule with Key Milestones

introduction | architect | engineer | construction manager | 4D model | process

ID	Task Name	Dur
44	**Phase 3 - Construct 2nd Floor**	**102d**
45	Erect Columns	2d
46	Erect Beams	1w
47	**Concrete Infill Walls**	**10d**
48	Form work	1w
49	Concrete	5d
50	Install Steel Deck and Concrete	2w
51	Façade	3w
52	Windows	3w
53	MEP Install	4w
54	Interior Finishes	11w
55	***2nd Floor Complete***	0d
56	**Phase 4 Construct 3rd Floor**	**130d**
57	Erect Beams	1w
58	**Concrete Infill Walls**	**10d**
59	Form work	1w
60	Concrete	5d
61	Install Steel Deck and Concrete	3w
62	Façade	3w
63	Windows	3w
64	MEP Install	4w
65	Interior Finishes	11w
66	***3rd Floor Complete***	0d
67	**Phase 5 Construct Roof and Install Components**	**45d**
68	Install Steel Deck and Concrete	3w
69	Install Roofing Membrane	1w
70	Install Solar Volataic Cells	2w
71	Install Solar HVAC System	2w
72	Install HVAC Components	3w
73	***Roof and Component Install Complete***	0d
74	**Phase 6 Punchlist & Commisioning**	**20d?**
75	Balance Mechanical System	4w
76	Test and Certify Life Safety System	5d?
77	Punchlist	4w
78	**Construction Closeout**	**30d**
79	Complete Parking/Road Adjustments	3w
80	Landscaping	3w
81	Site Clean-up	1w
82	Construction Demobilization	1w
83	**Construction Complete**	0d

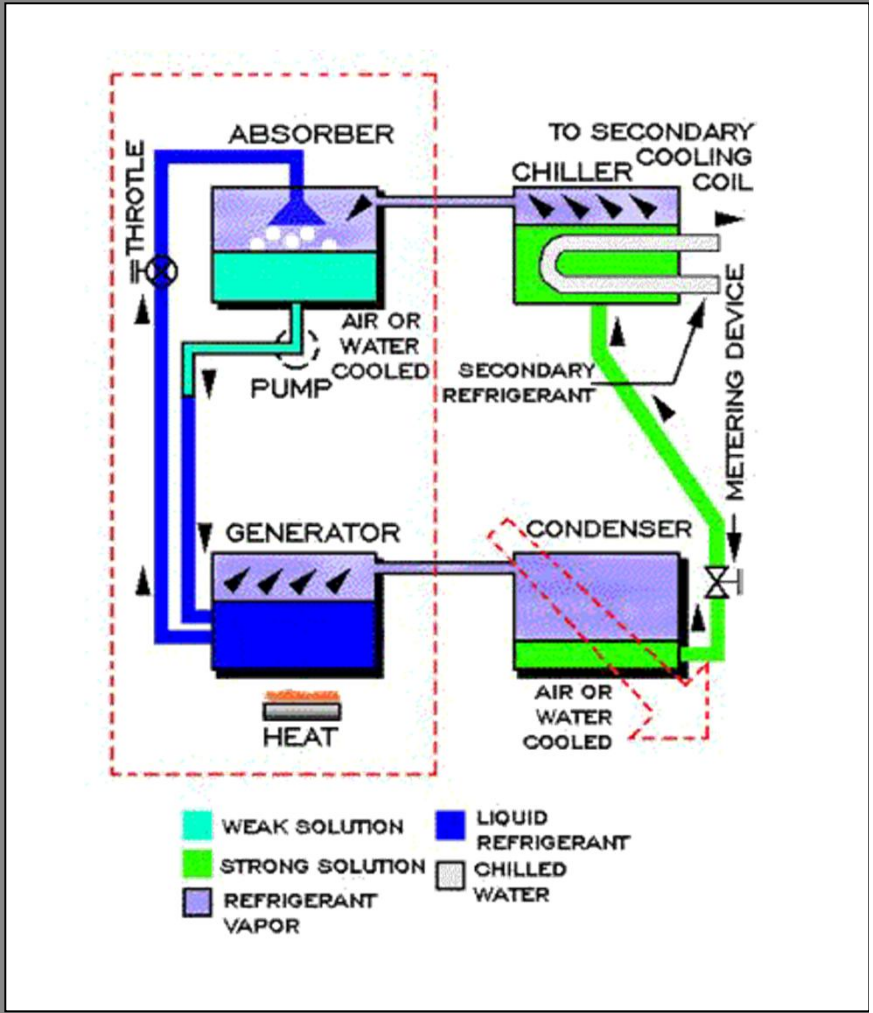




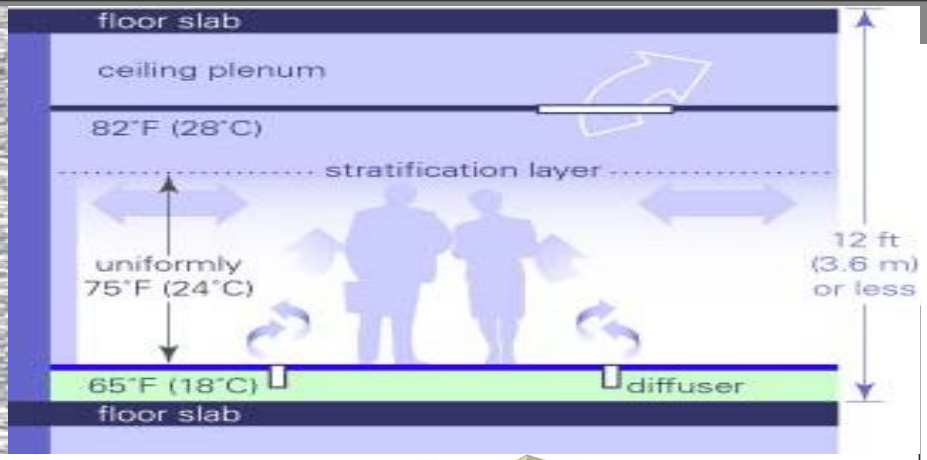
- Objective:
  - Minimize building energy demands
  - Improve learning environment
- Solution:
  - Use the greatest natural resources in NM…the sun:
    - Photovoltaic Cells
    - Solar Hot Water Heating
    - Solar Cooling
  - Maximize occupant comfort & experience

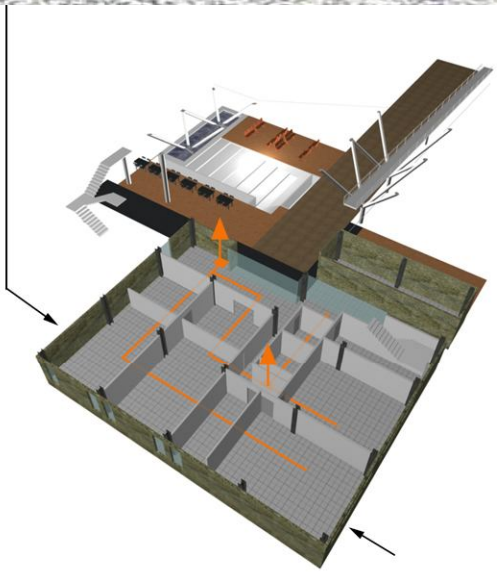
Solar System Solutions:

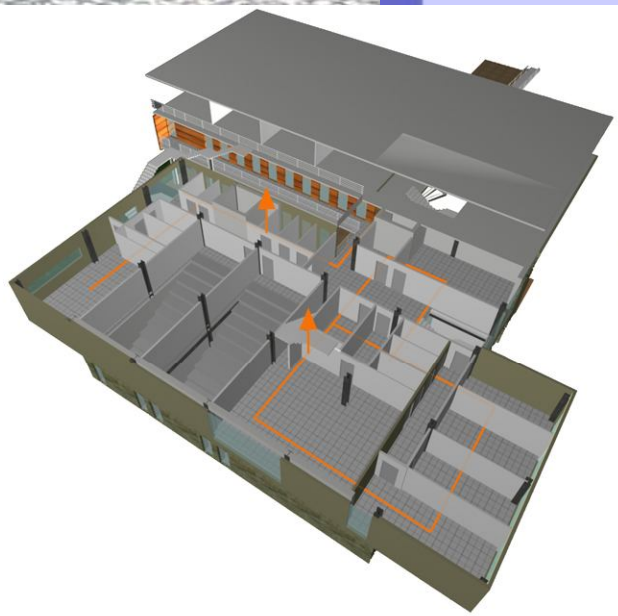
- Absorption Cooling and Refrigeration
  - 160 tons cooling
- Solar Hot Water Heating
  - 240 gal capacity
- Photovoltaic Cells
  - 60kWhr/day electricity

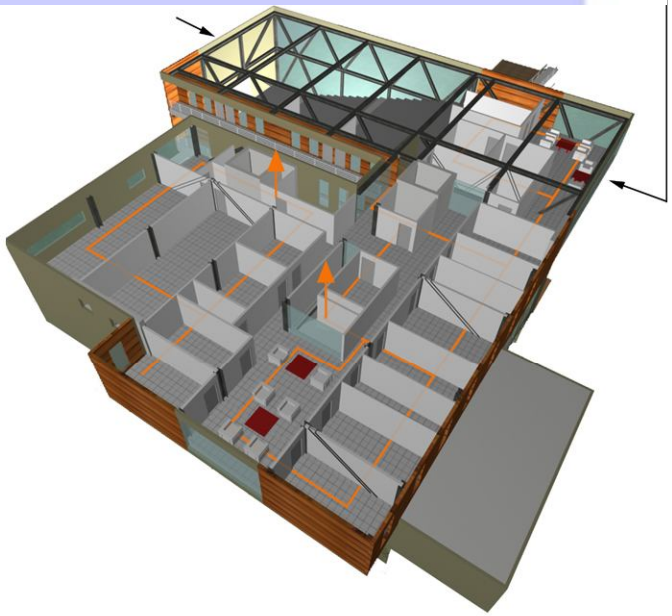


Conceptual Mechanical Solution









01 02 03

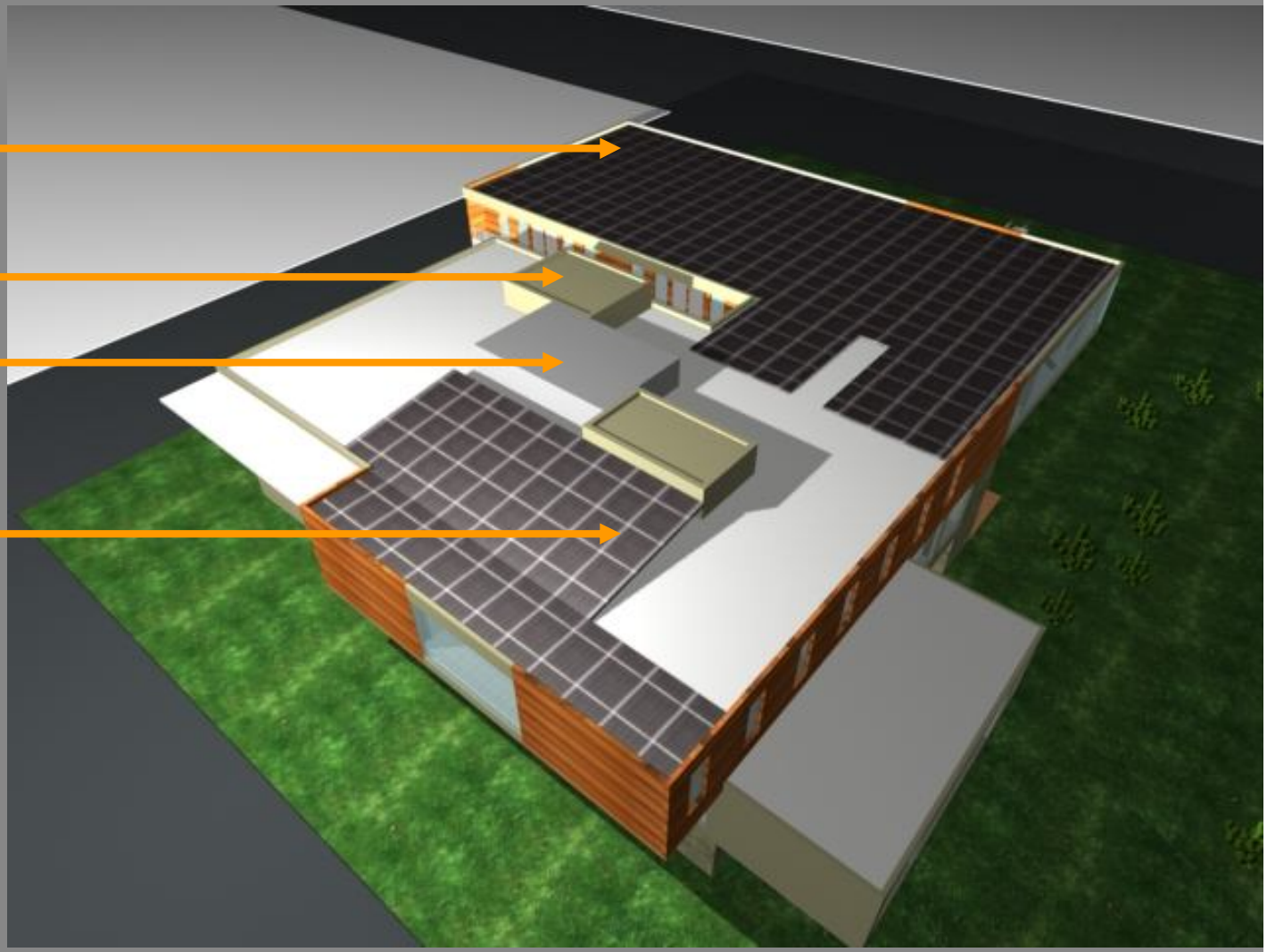
Solar System Organization

Photovoltaic Cells

Mechanical

Absorption Cooling & Refrigeration

Heat Source for Solar Hot Water and Solar Cooling



LEED™ Scorecard. Version 2.0

38 LEED SILVER

nts Platinum 52 or more points

Y	?	N				
8	2	3	**Sustainable Sites**	Possible Points	14	
Y	?	N				
Y			Prereq 1	**Erosion & Sedimentation Control**	0	
1			Credit 1	**Site Selection**	1	
1			Credit 2	**Urban Redevelopment**	1	
		1	Credit 3	**Brownfield Redevelopment**	1	
1			Credit 4.1	**Alternative Transportation**, Public Transportation Access	1	
1			Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	1	
		1	Credit 4.3	**Alternative Transportation**, Alternative Fuel Refueling Stations	1	
	1		Credit 4.4	**Alternative Transportation**, Parking Capacity	1	
1			Credit 5.1	**Reduced Site Disturbance**, Protect or Restore Open Space	1	
1			Credit 5.2	**Reduced Site Disturbance**, Development Footprint	1	
1			Credit 6.1	**Stormwater Management**, Rate and Quantity	1	
		1	Credit 6.2	**Stormwater Management**, Treatment	1	
1			Credit 7.1	**Landscape & Exterior Design to Reduce Heat Islands**, Non-R	1	
	1		Credit 7.2	**Landscape & Exterior Design to Reduce Heat Islands**, Roof	1	
	1		Credit 8	**Light Pollution Reduction**	1	

Y	?	N				
0	0	5	**Water Efficiency**	Possible Points	5	
Y	?	N				
		1	Credit 1.1	**Water Efficient Landscaping**, Reduce by 50%	1	
		1	Credit 1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation	1	
		1	Credit 2	**Innovative Wastewater Technologies**	1	
		1	Credit 3.1	**Water Use Reduction**, 20% Reduction	1	
		1	Credit 3.2	**Water Use Reduction**, 30% Reduction	1	

Y	?	N				
12	4	1	**Energy & Atmosphere**	Possible Points	17	
Y	?	N				
Y			Prereq 1	**Fundamental Building Systems Commissioning**	0	
Y			Prereq 2	**Minimum Energy Performance**	0	
Y			Prereq 3	**CFC Reduction in HVAC&R Equipment**	0	
2			Credit 1.1	**Optimize Energy Performance**, 20% New / 10% Existing	2	
2			Credit 1.2	**Optimize Energy Performance**, 30% New / 20% Existing	2	
2			Credit 1.3	**Optimize Energy Performance**, 40% New / 30% Existing	2	
	2		Credit 1.4	**Optimize Energy Performance**, 50% New / 40% Existing	2	
	2		Credit 1.5	**Optimize Energy Performance**, 60% New / 50% Existing	2	
1			Credit 2.1	**Renewable Energy**, 5%	1	
1			Credit 2.2	**Renewable Energy**, 10%	1	
1			Credit 2.3	**Renewable Energy**, 20%	1	
		1	Credit 3	**Additional Commissioning**	1	
1			Credit 4	**Ozone Depletion**	1	
1			Credit 5	**Measurement & Verification**	1	
1			Credit 6	**Green Power**	1	

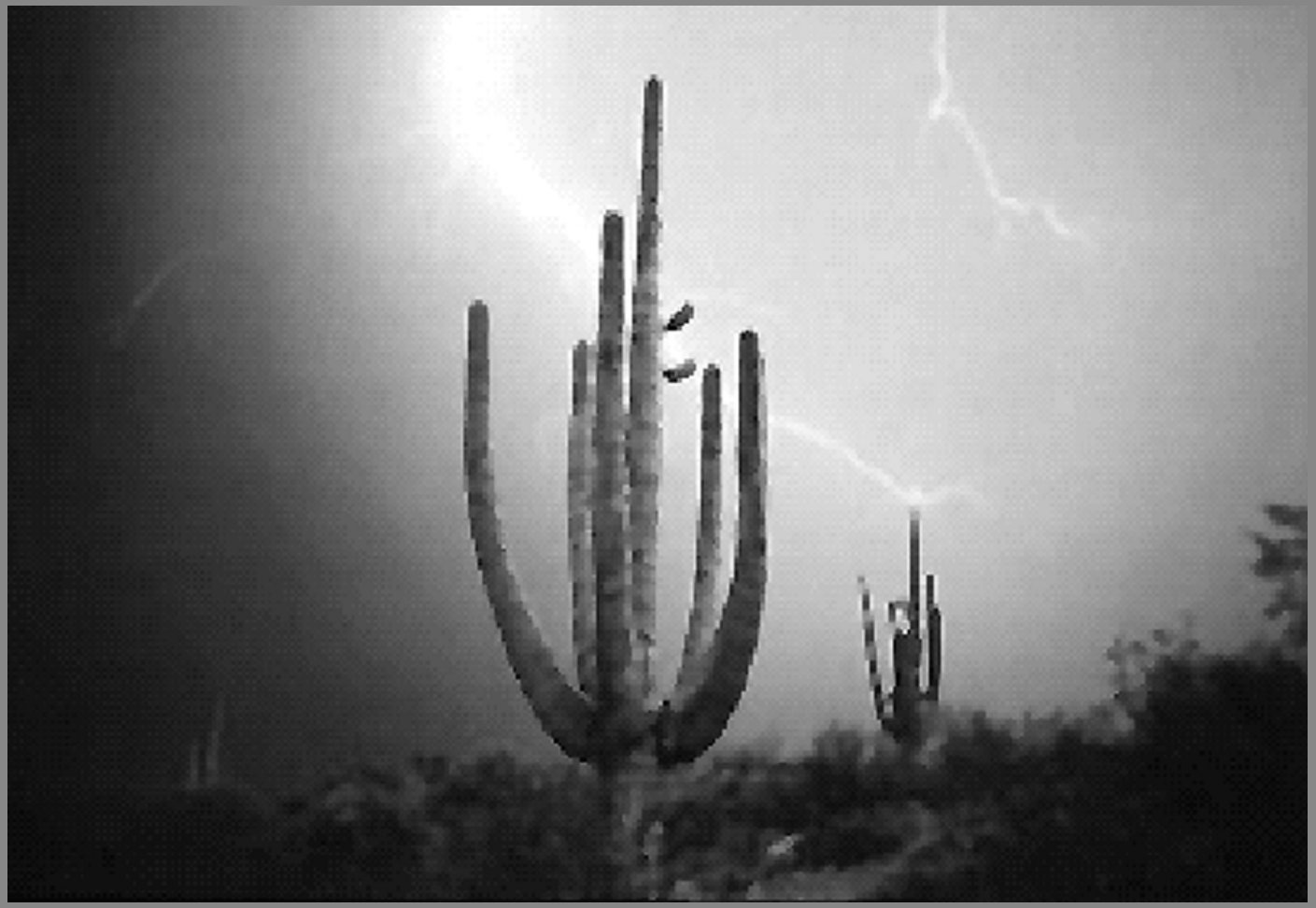
Possible Points 69

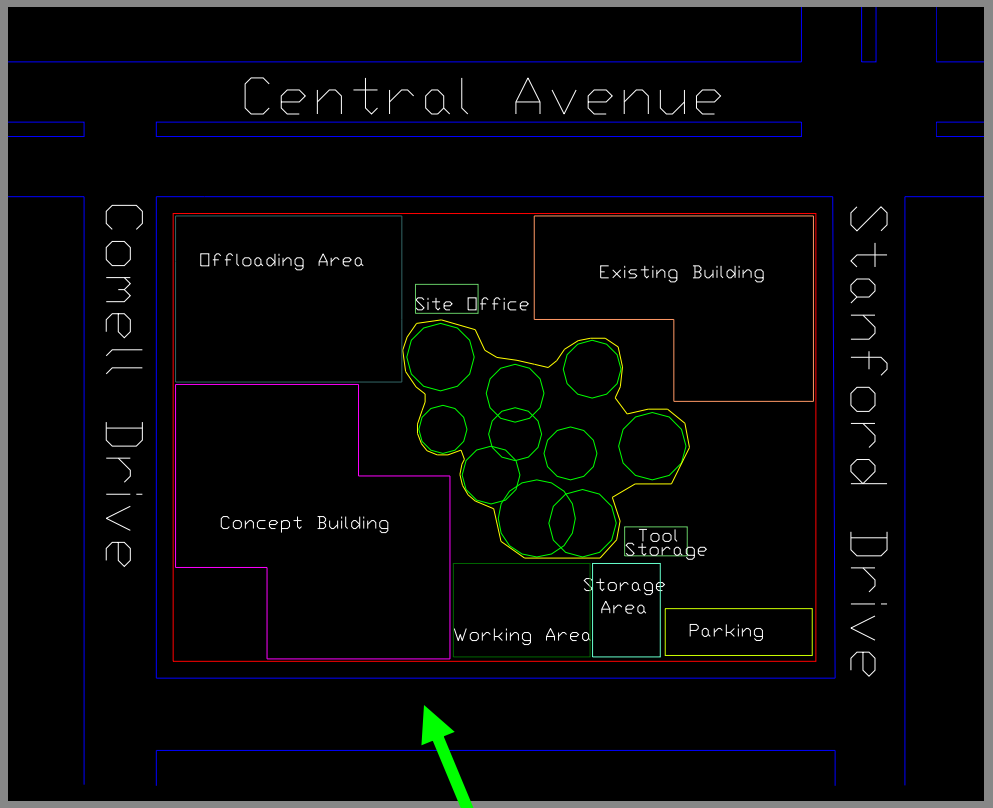
Y	?	N				
4	2	7	**Materials & Resources**	Possible Points	13	
Y	?	N				
Y			Prereq 1	**Storage & Collection of Recyclables**	0	
		1	Credit 1.1	**Building Reuse**, Maintain 75% of Existing Shell	1	
		1	Credit 1.2	**Building Reuse**, Maintain 100% of Existing Shell	1	
		1	Credit 1.3	**Building Reuse**, Maintain 100% Shell & 50% Non-Shell	1	
1			Credit 2.1	**Construction Waste Management**, Divert 50%	1	
		1	Credit 2.2	**Construction Waste Management**, Divert 75%	1	
		1	Credit 3.1	**Resource Reuse**, Specify 5%	1	
		1	Credit 3.2	**Resource Reuse**, Specify 10%	1	
1			Credit 4.1	**Recycled Content**, Specify 25%	1	
	1		Credit 4.2	**Recycled Content**, Specify 50%	1	
1			Credit 5.1	**Local/Regional Materials**, 20% Manufactured Locally	1	
		1	Credit 5.2	**Local/Regional Materials**, of 20% Above, 50% Harvested Locally	1	
1			Credit 6	**Rapidly Renewable Materials**	1	
	1		Credit 7	**Certified Wood**	1	

Y	?	N				
12	2	1	**Indoor Environmental Quality**	Possible Points	15	
Y	?	N				
Y			Prereq 1	**Minimum IAQ Performance**	0	
Y			Prereq 2	**Environmental Tobacco Smoke** (ETS) **Control**	0	
1			Credit 1	**Carbon Dioxide** (CO_2) **Monitoring**	1	
	1		Credit 2	**Increase Ventilation Effectiveness**	1	
1			Credit 3.1	**Construction IAQ Management Plan**, During Construction	1	
1			Credit 3.2	**Construction IAQ Management Plan**, Before Occupancy	1	
1			Credit 4.1	**Low-Emitting Materials**, Adhesives & Sealants	1	
1			Credit 4.2	**Low-Emitting Materials**, Paints	1	
1			Credit 4.3	**Low-Emitting Materials**, Carpet	1	
1			Credit 4.4	**Low-Emitting Materials**, Composite Wood	1	
	1		Credit 5	**Indoor Chemical & Pollutant Source Control**	1	
1			Credit 6.1	**Controllability of Systems**, Perimeter	1	
1			Credit 6.2	**Controllability of Systems**, Non-Perimeter	1	
1			Credit 7.1	**Thermal Comfort**, Comply with ASHRAE 55-1992	1	
1			Credit 7.2	**Thermal Comfort**, Permanent Monitoring System	1	
1			Credit 8.1	**Daylight & Views**, Daylight 75% of Spaces	1	
		1	Credit 8.2	**Daylight & Views**, Views for 90% of Spaces	1	

Y	?	N				
2	0	3	**Innovation & Design Process**	Possible Points	5	
Y	?	N				
1			Credit 1.1	**Innovation in Design**: Specific Title	1	
		1	Credit 1.2	**Innovation in Design**: Specific Title	1	
		1	Credit 1.3	**Innovation in Design**: Specific Title	1	
		1	Credit 1.4	**Innovation in Design**: Specific Title	1	
1			Credit 2	**LEED™ Accredited Professional**	1	

4D MODEL



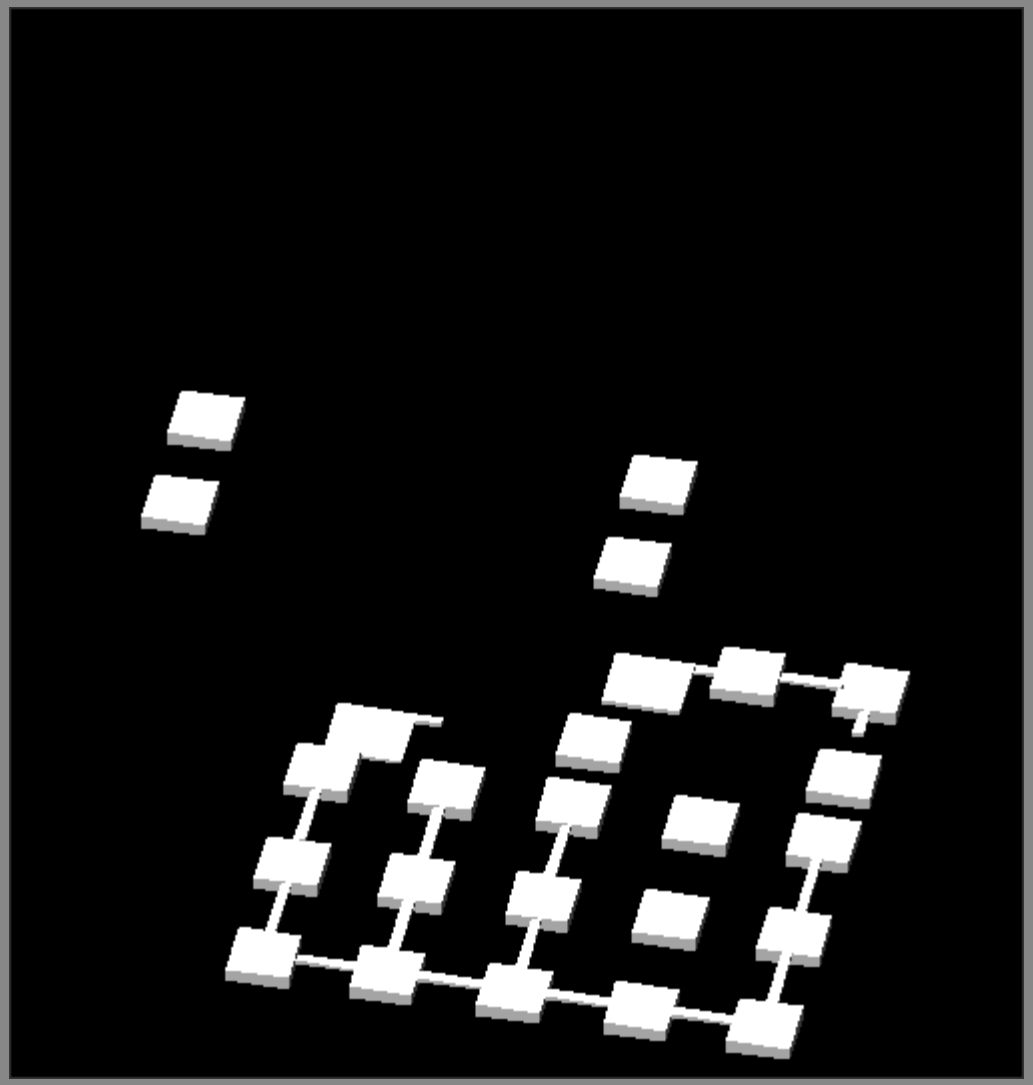


Viewpoint: Building Emphasis

- Project Begins 3 Aug 2015
  - Mobilization and Job Site Set-up
  - Utilities
  - Excavation
  - Adjusted Parking Layout
  - Foundation Formwork Columns: Full Height vs. 1-1/2 Story
- Construction Alternatives:
  - Truss Size: 2 – 60 ft vs. 3 – 40 ft
  - Concrete ICF Infill walls vs. Precast Concrete Panels
  - Square Footings vs. Strip Footings
  - Erection sequence of pyramids and truss
  - Cast Steel connections vs. built up connection

2015 Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug 2016

4D Model – Building



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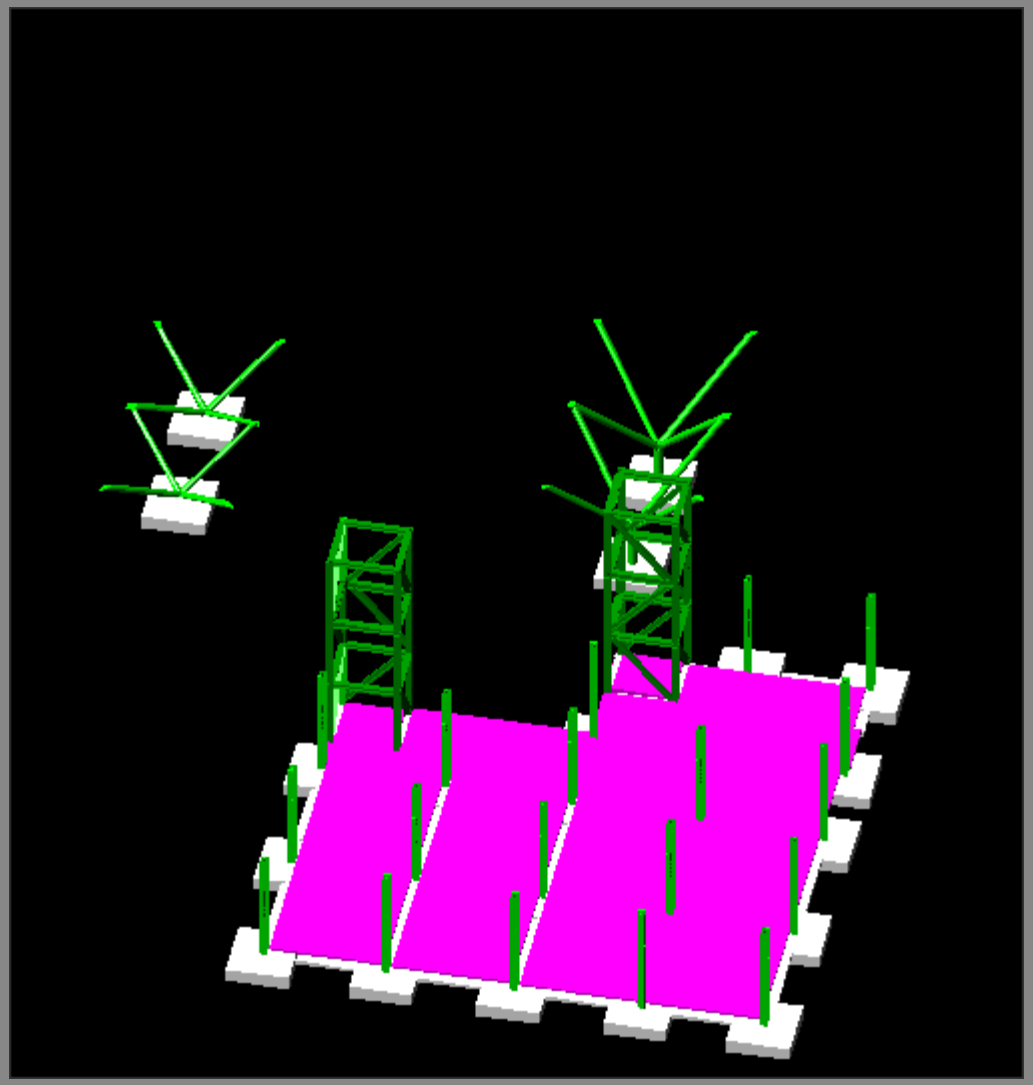
4D Model – Building



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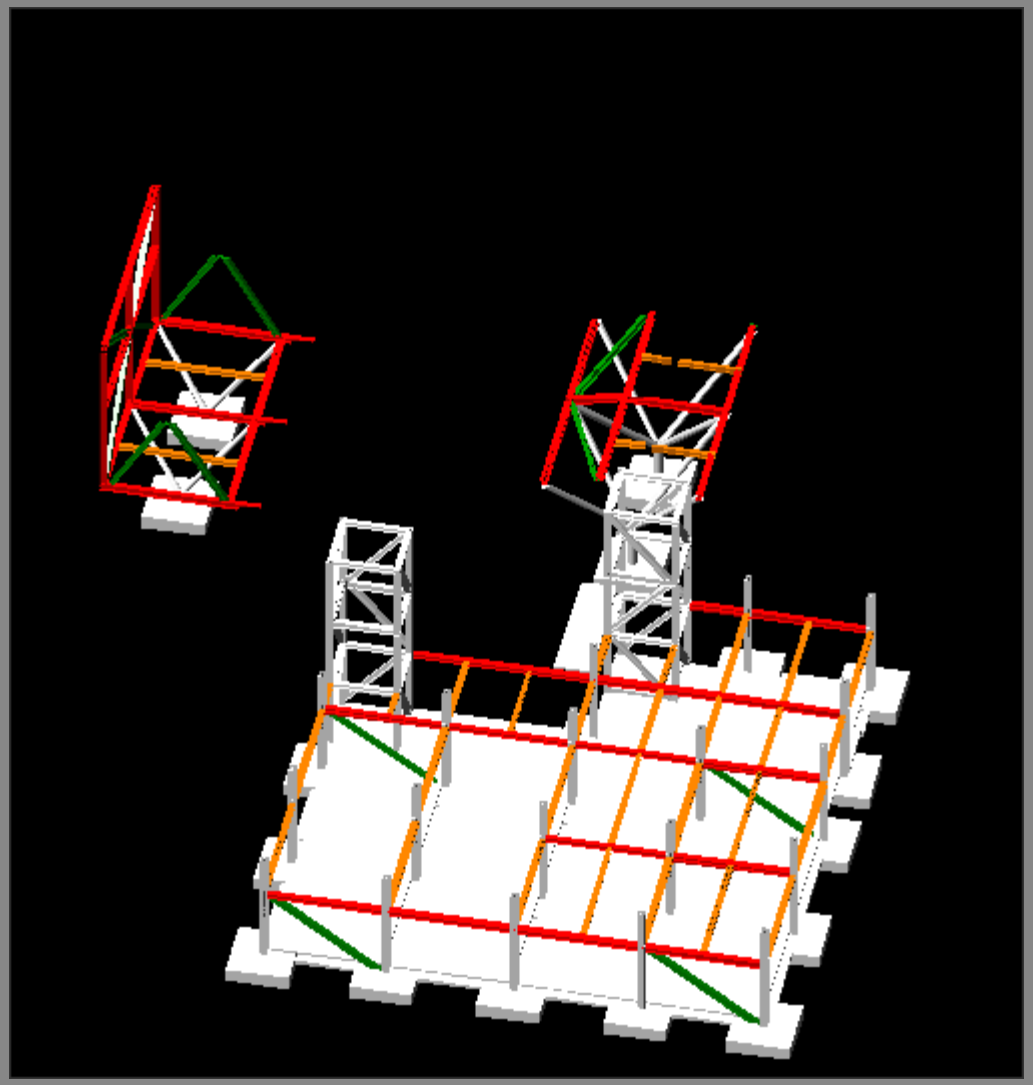
4D Model – Building



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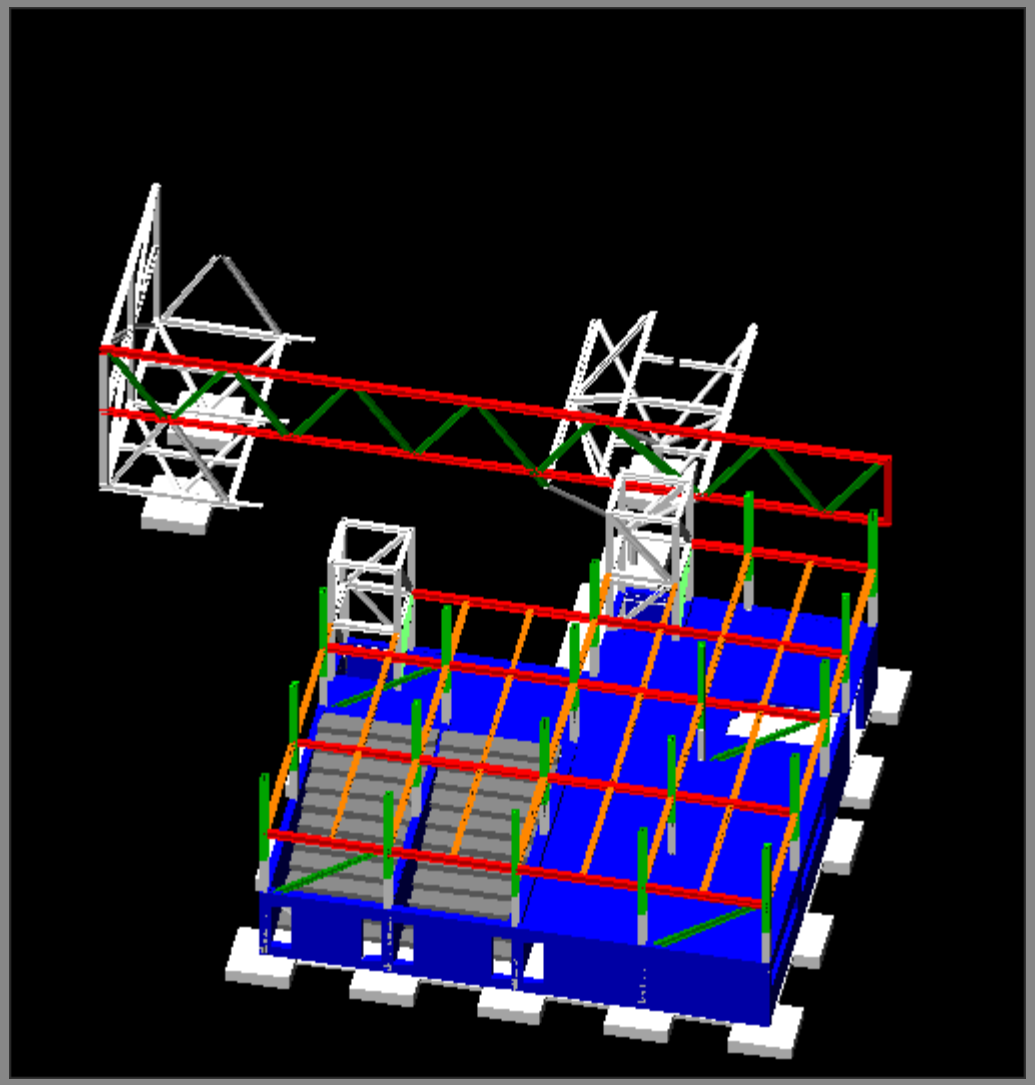

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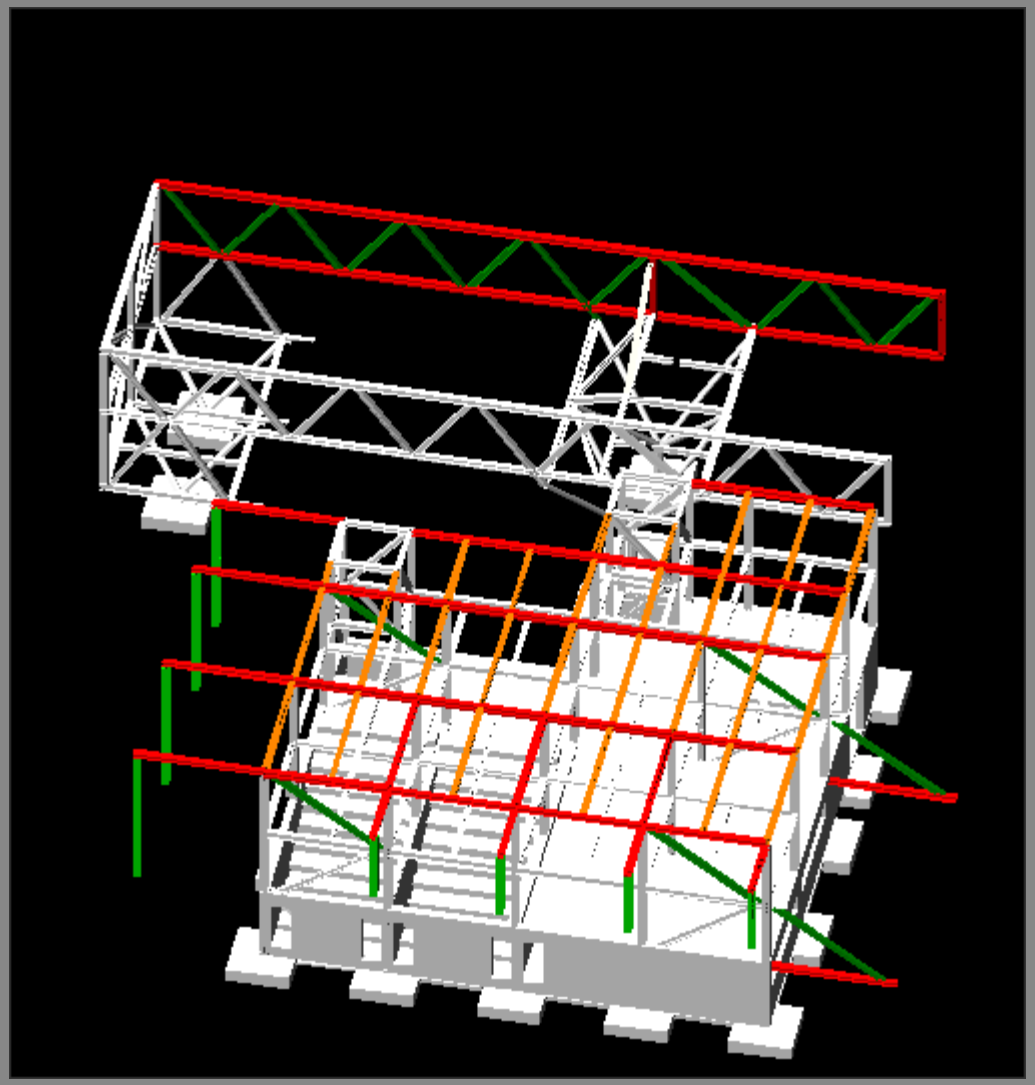
4D Model – Building



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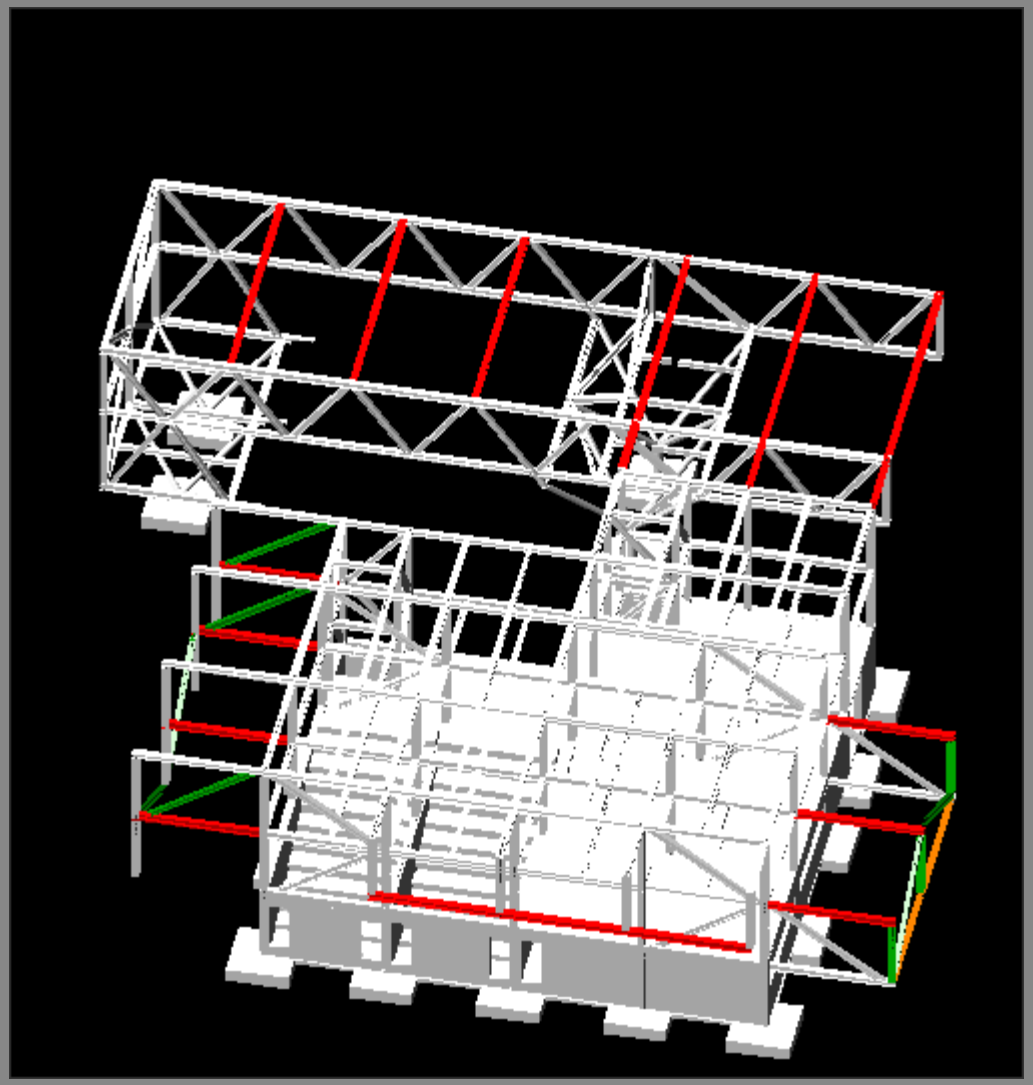

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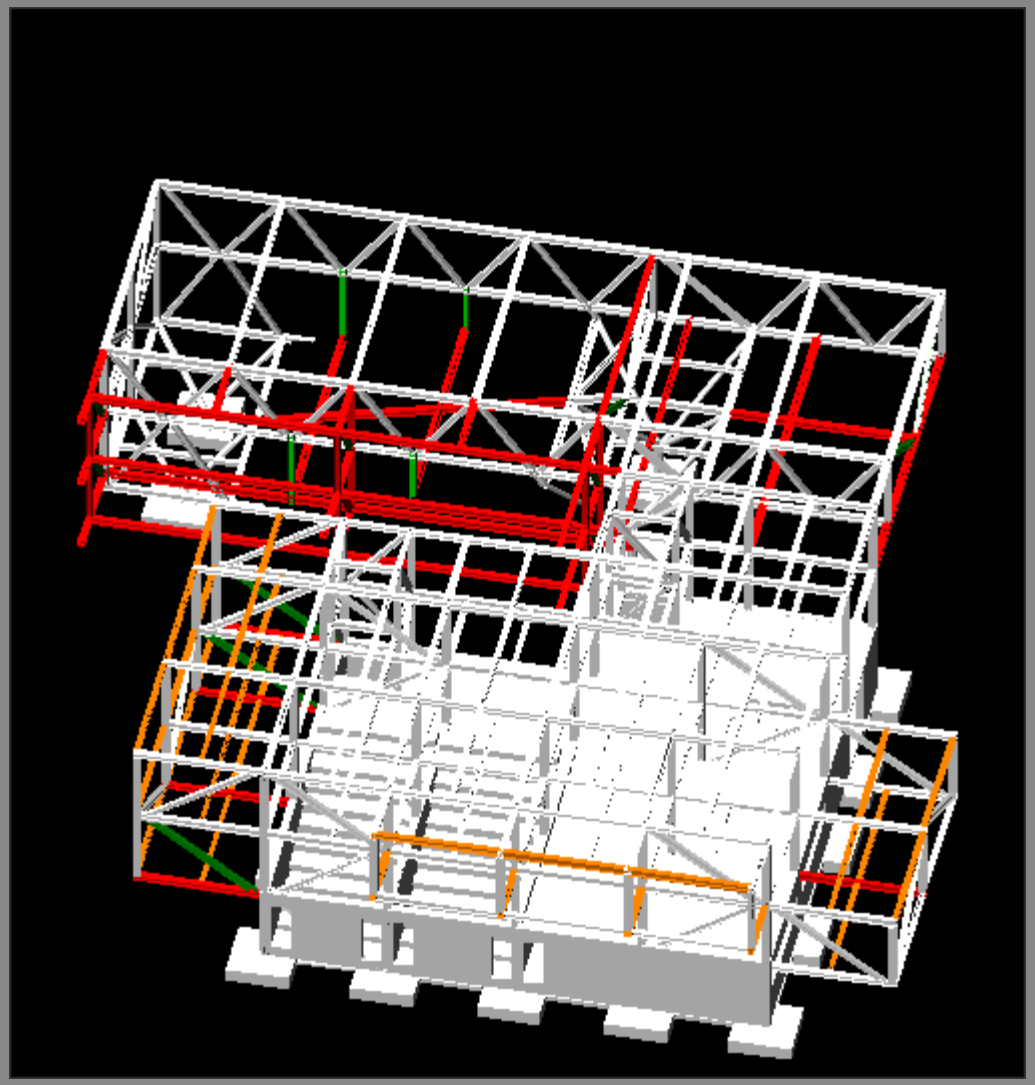

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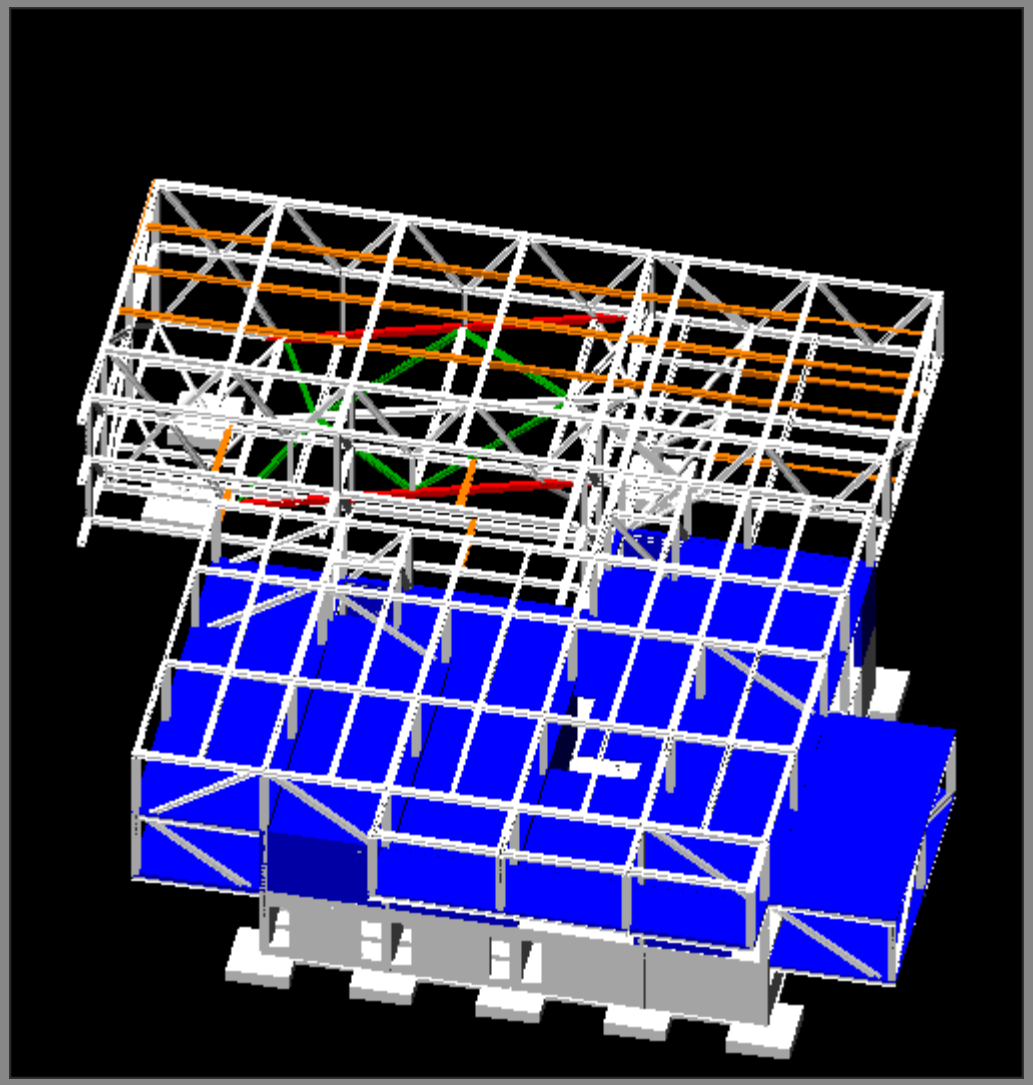

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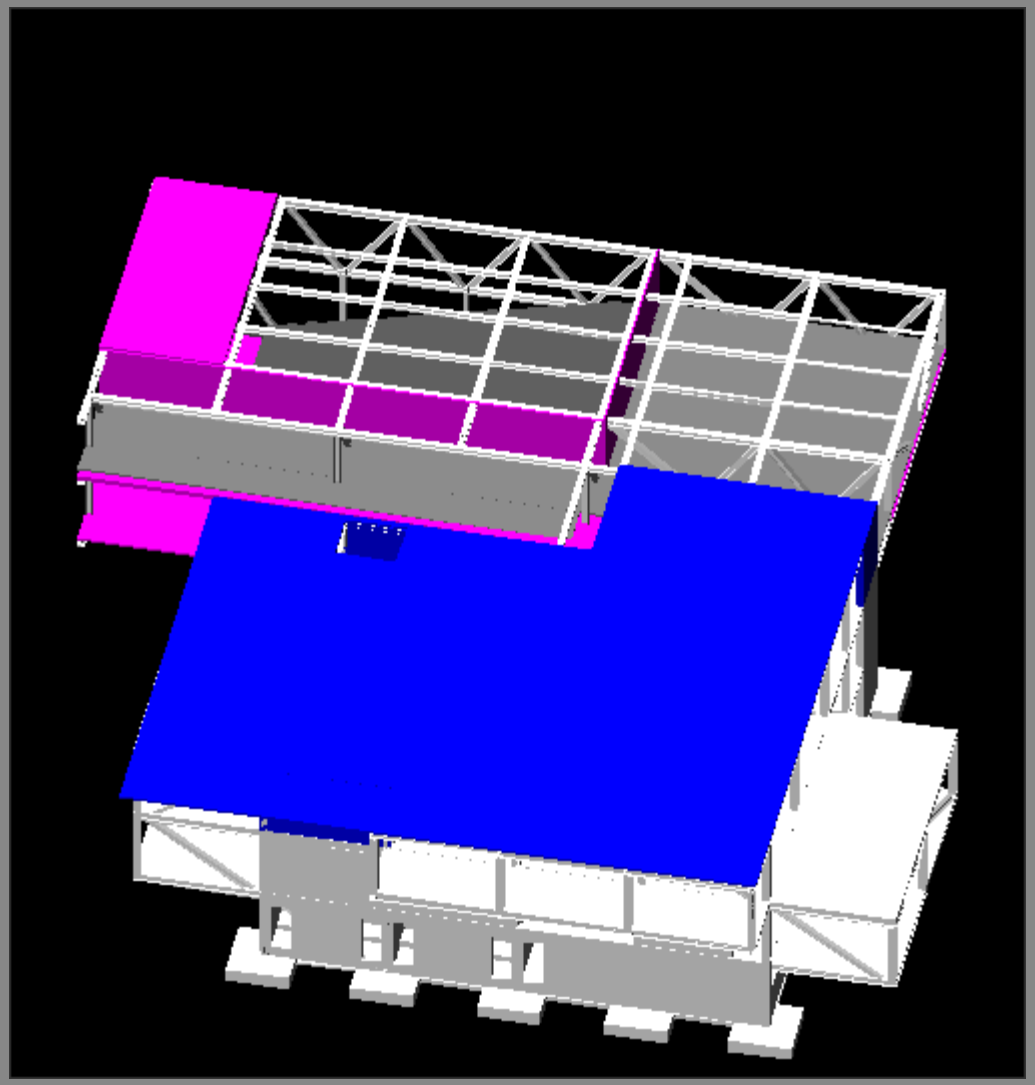

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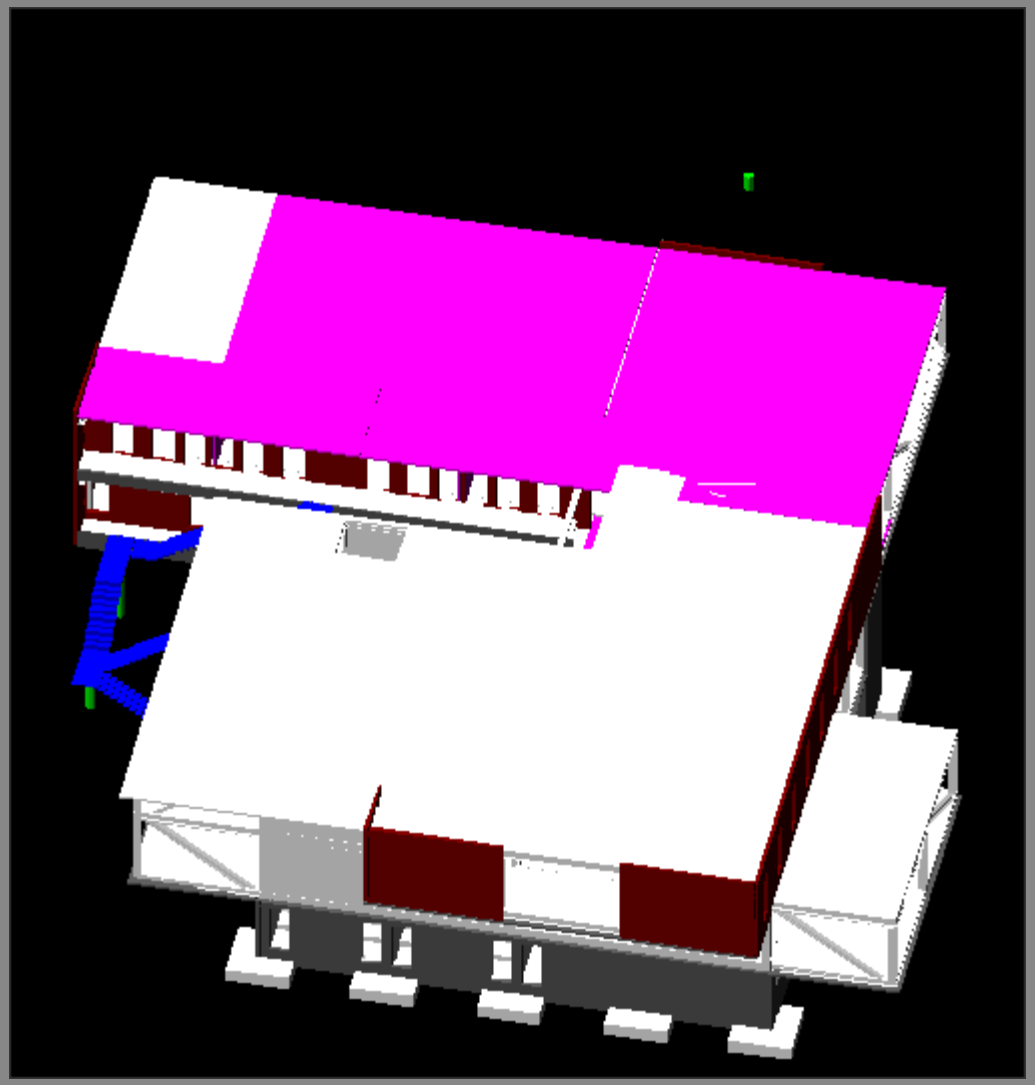
4D Model – Building



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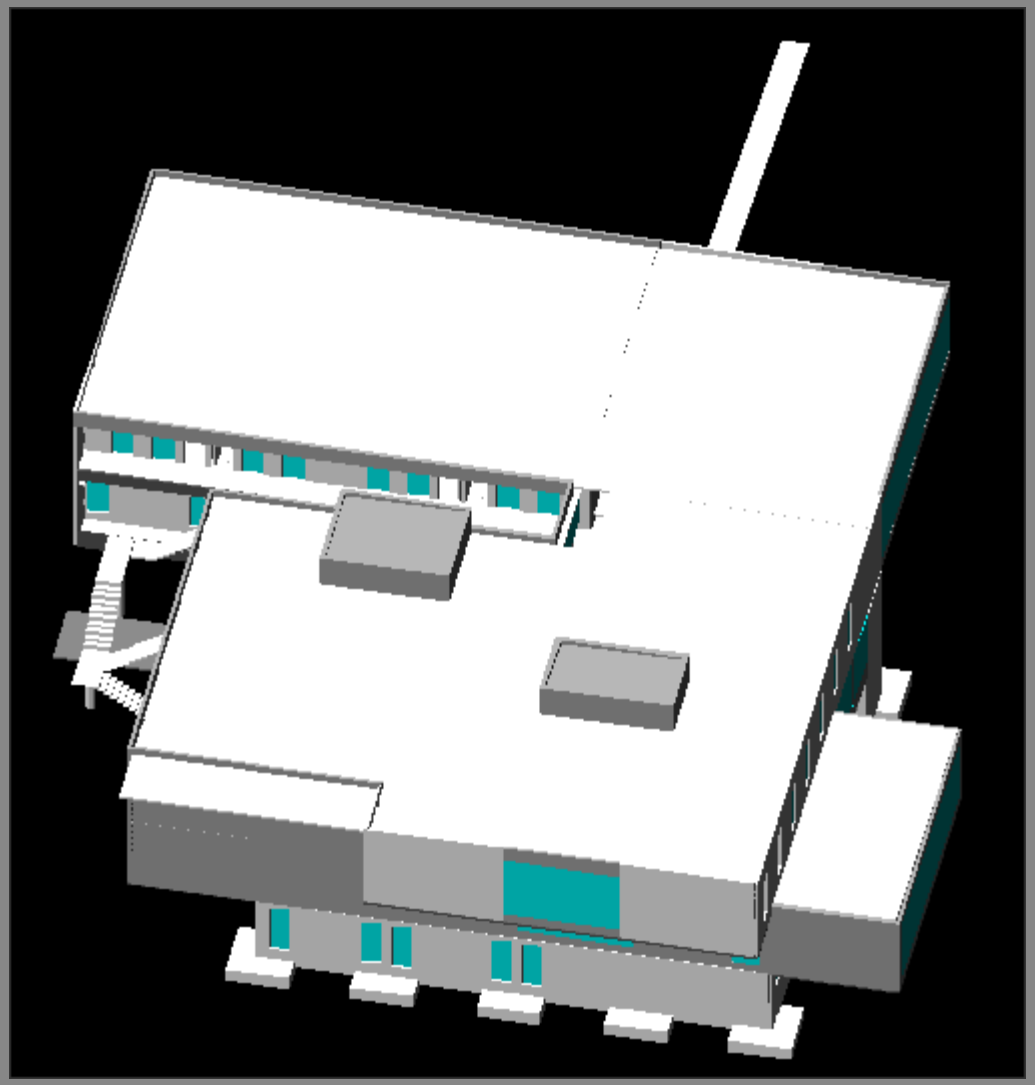
4D Model – Building Complete



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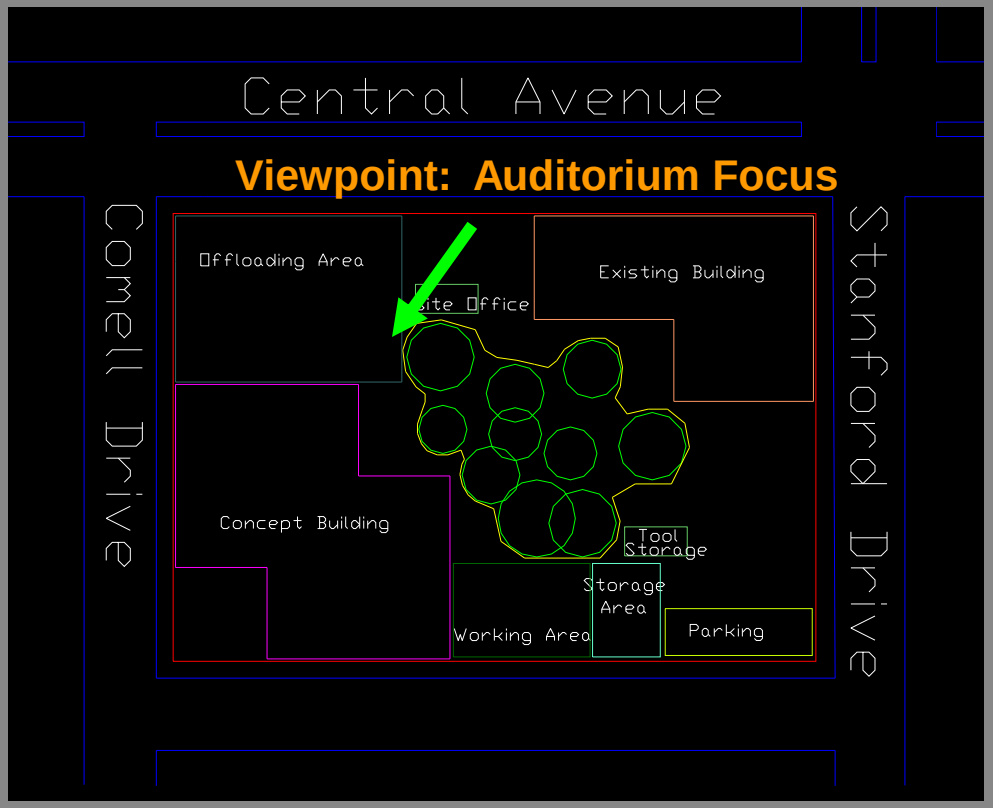

- Auditorium
  - Critical
  - Complex
  - Costly
  - Dangerous

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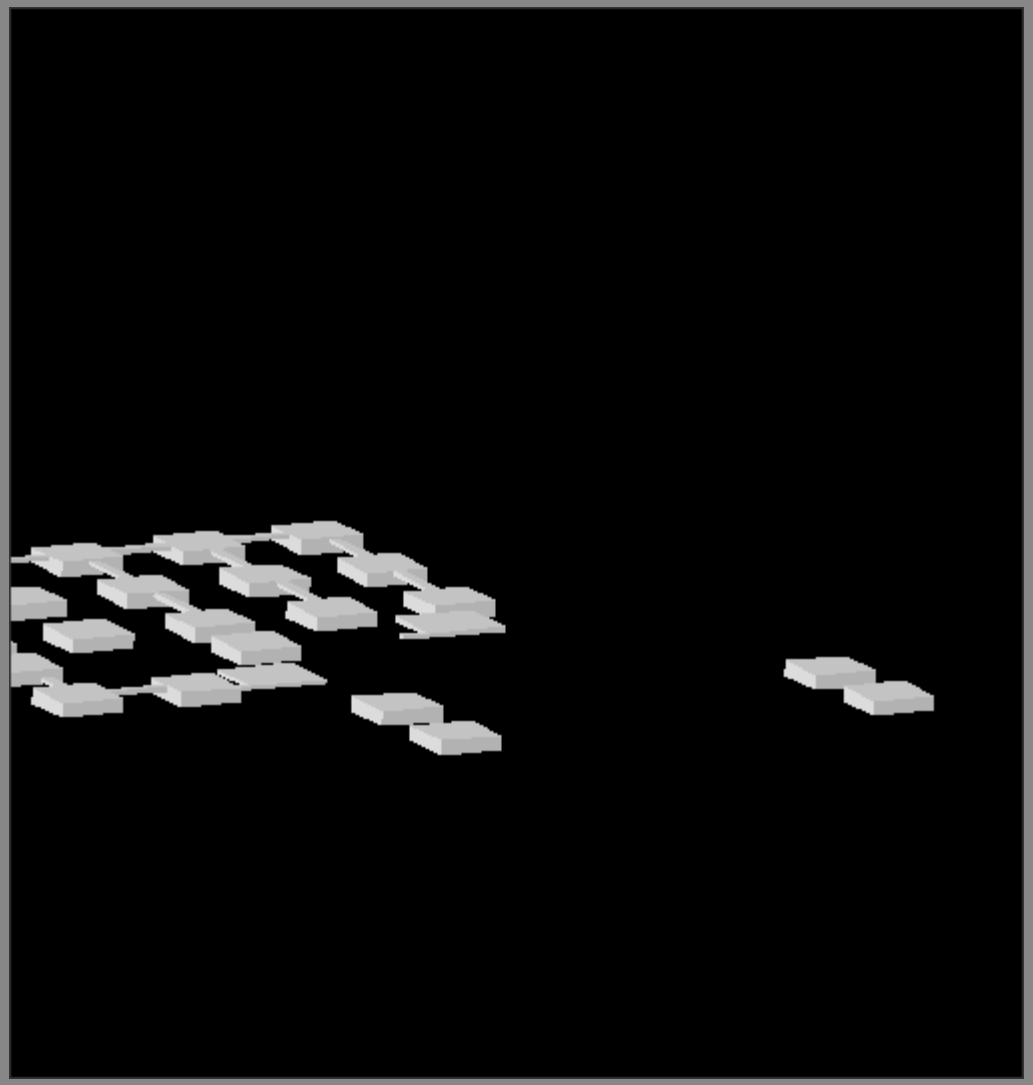
4D Model – Auditorium



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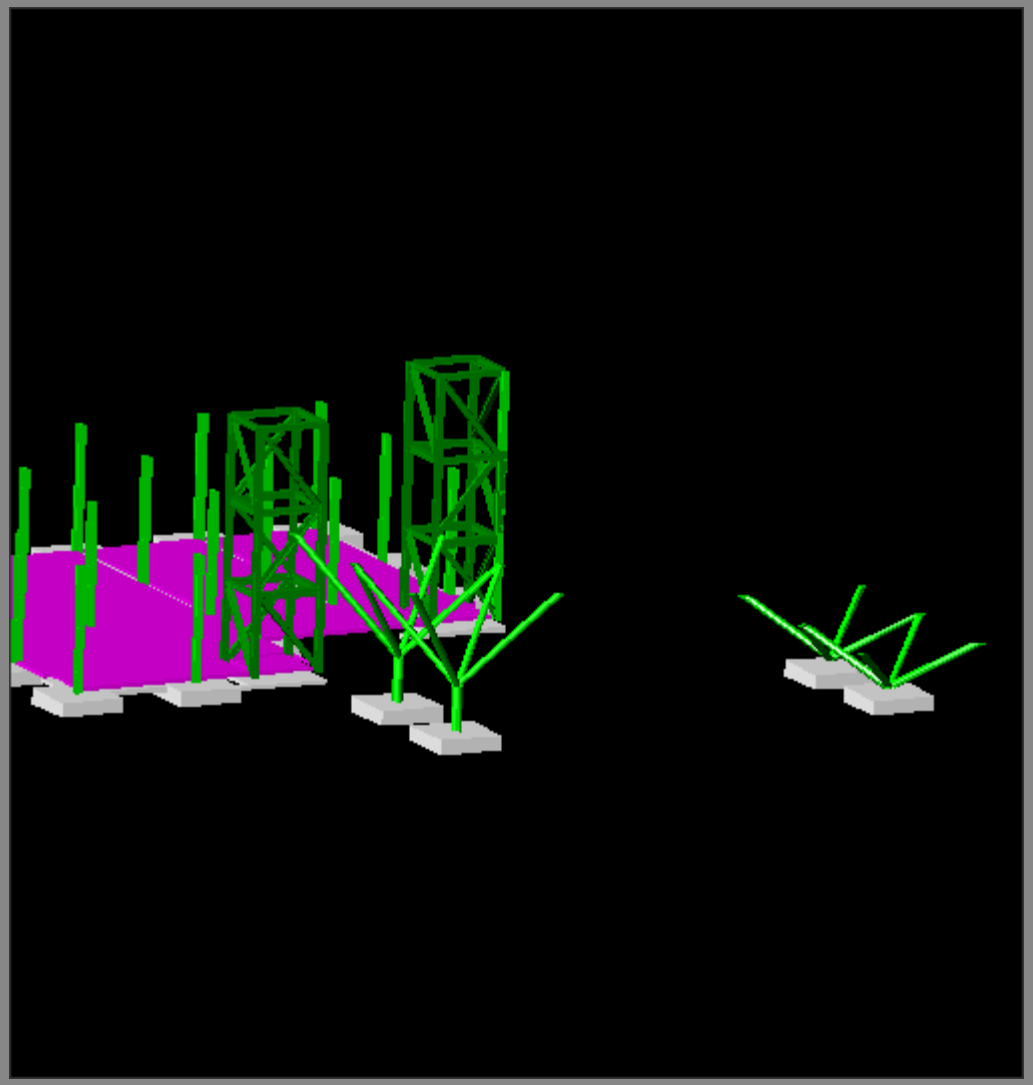

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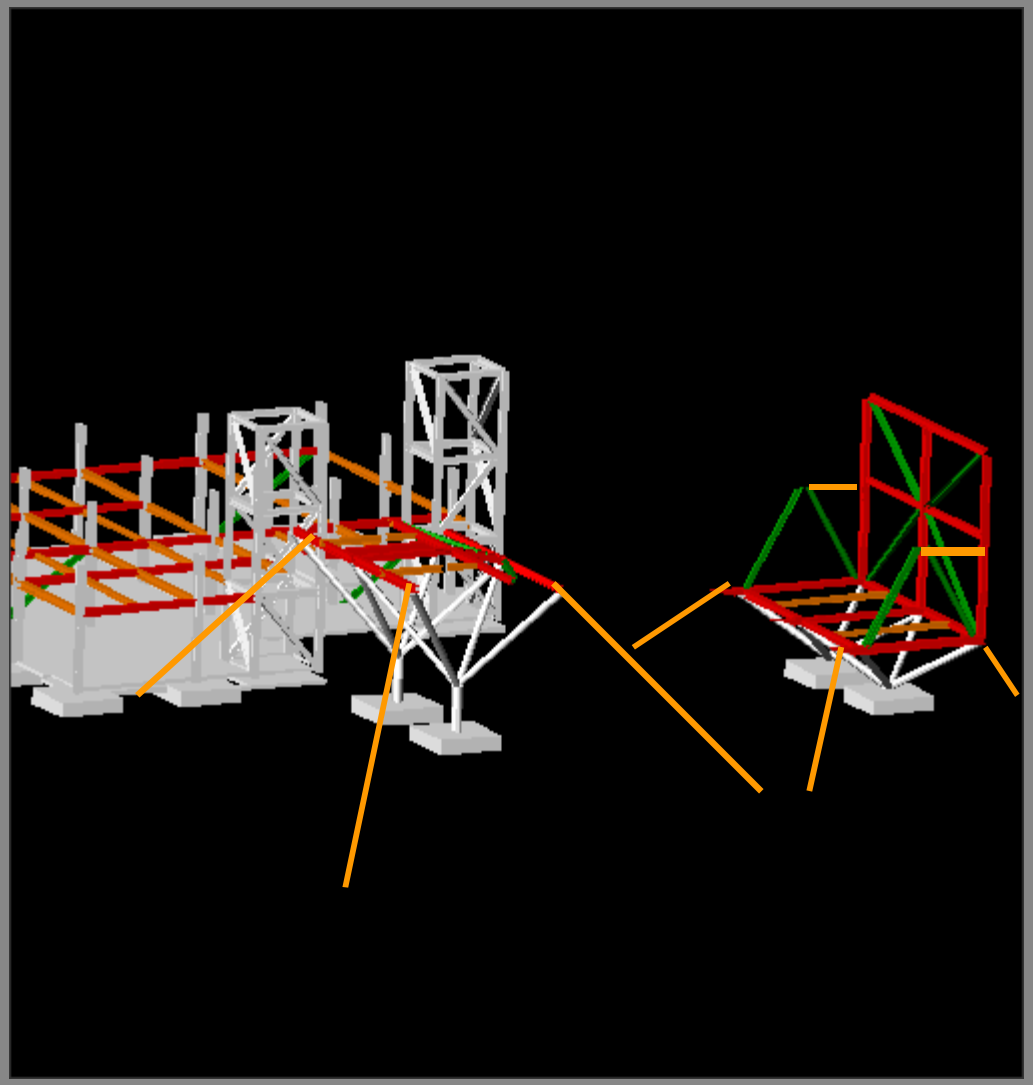

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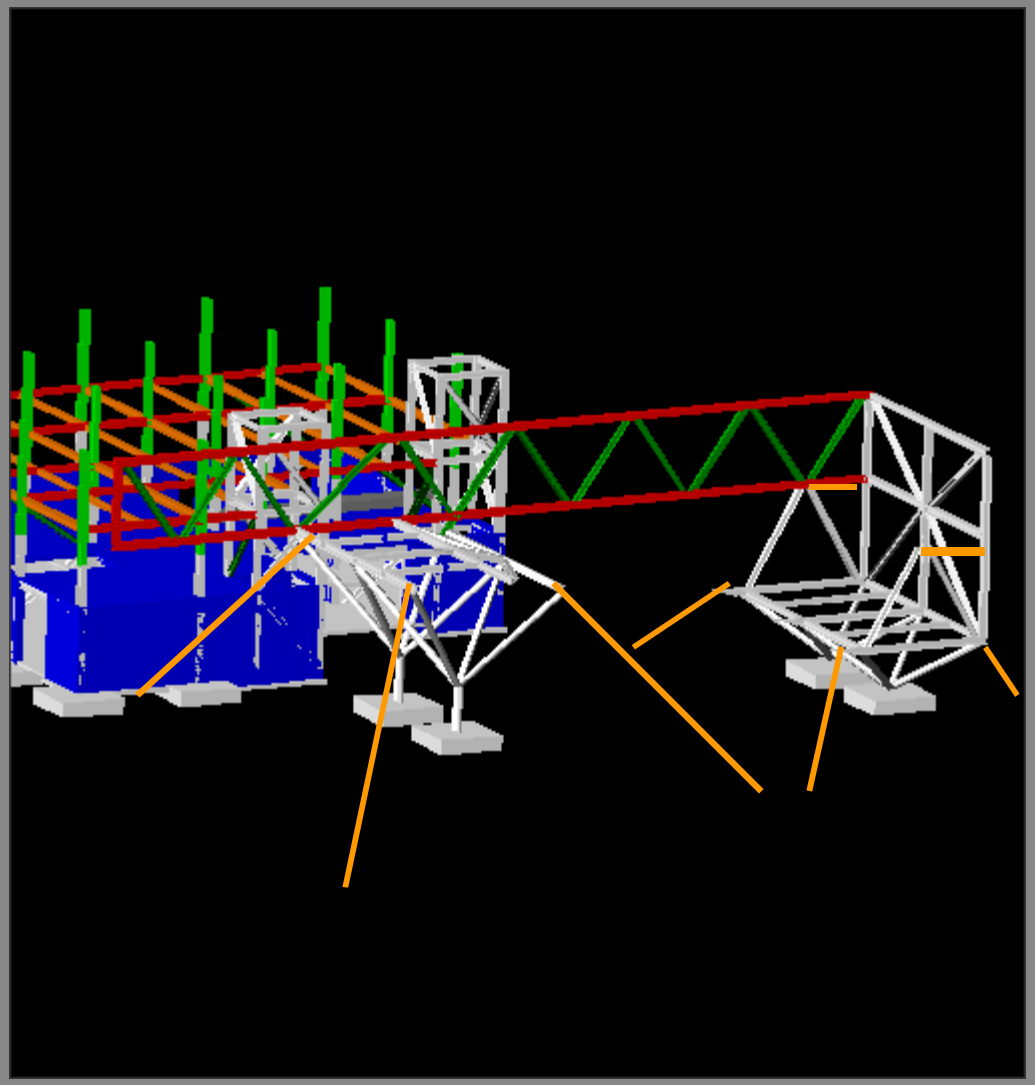

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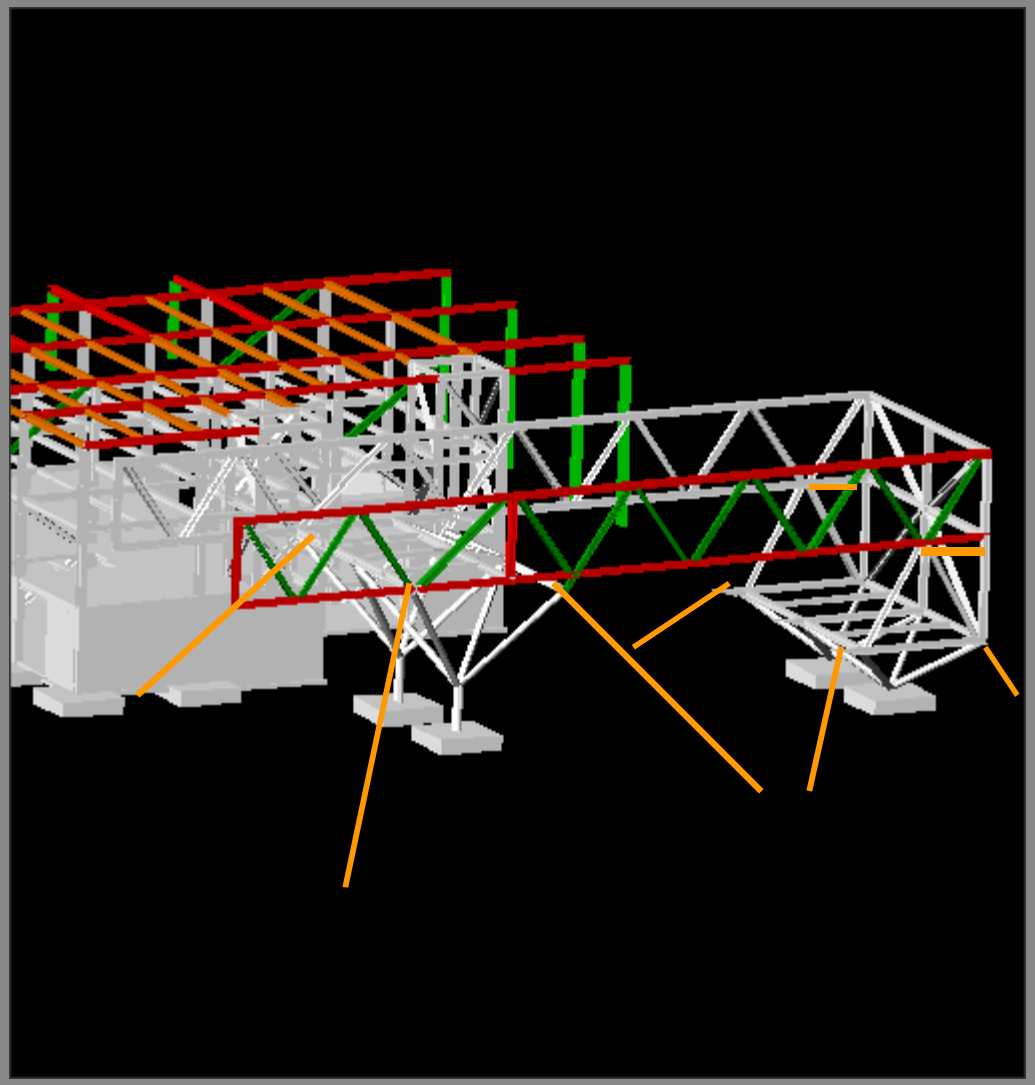

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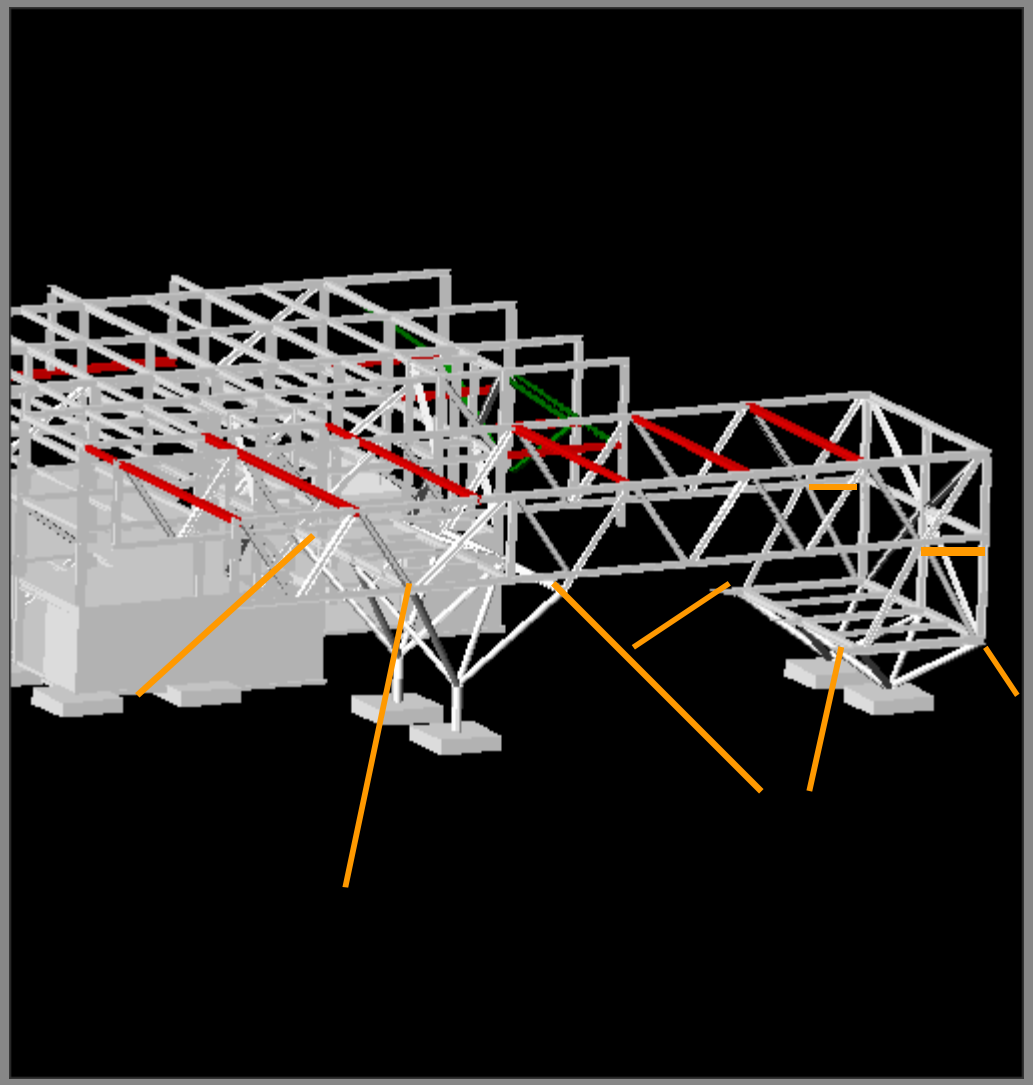

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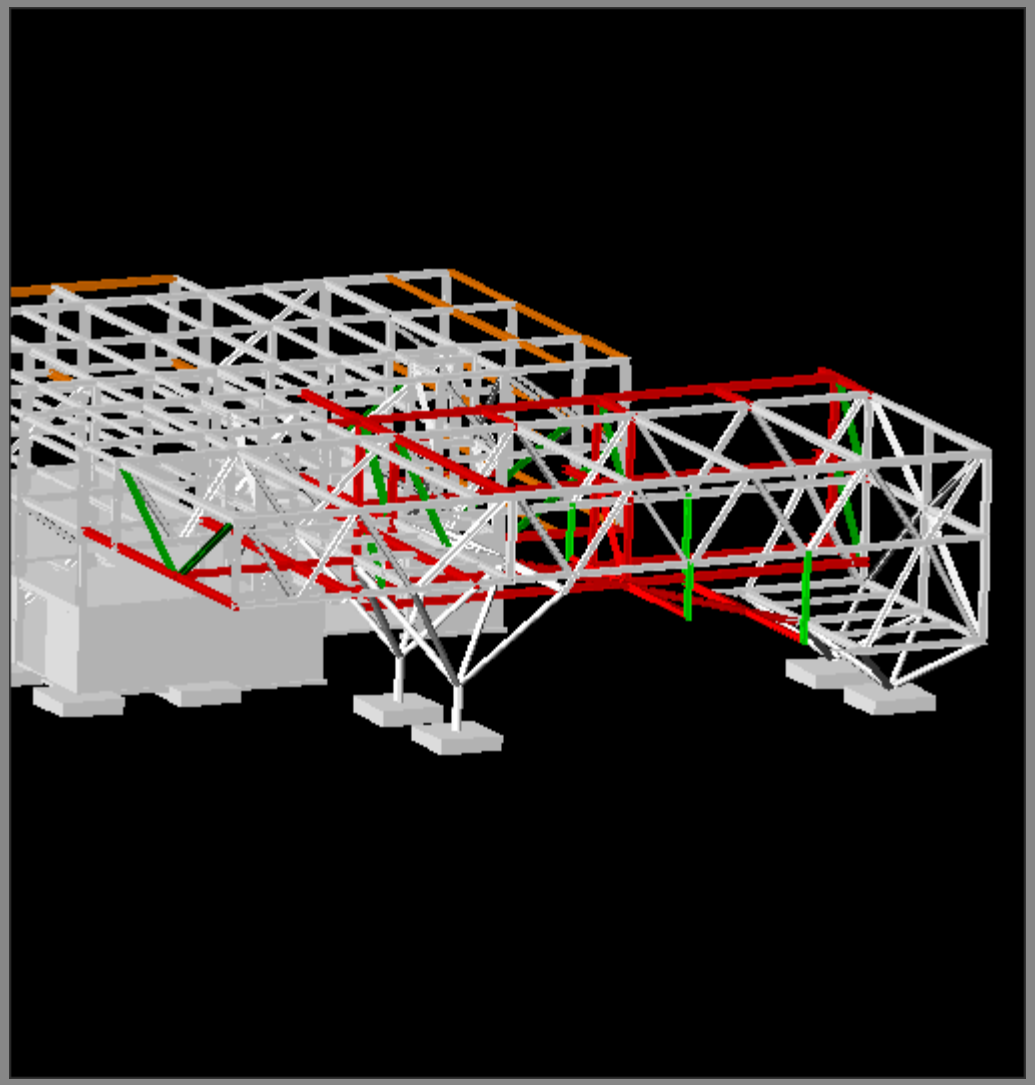

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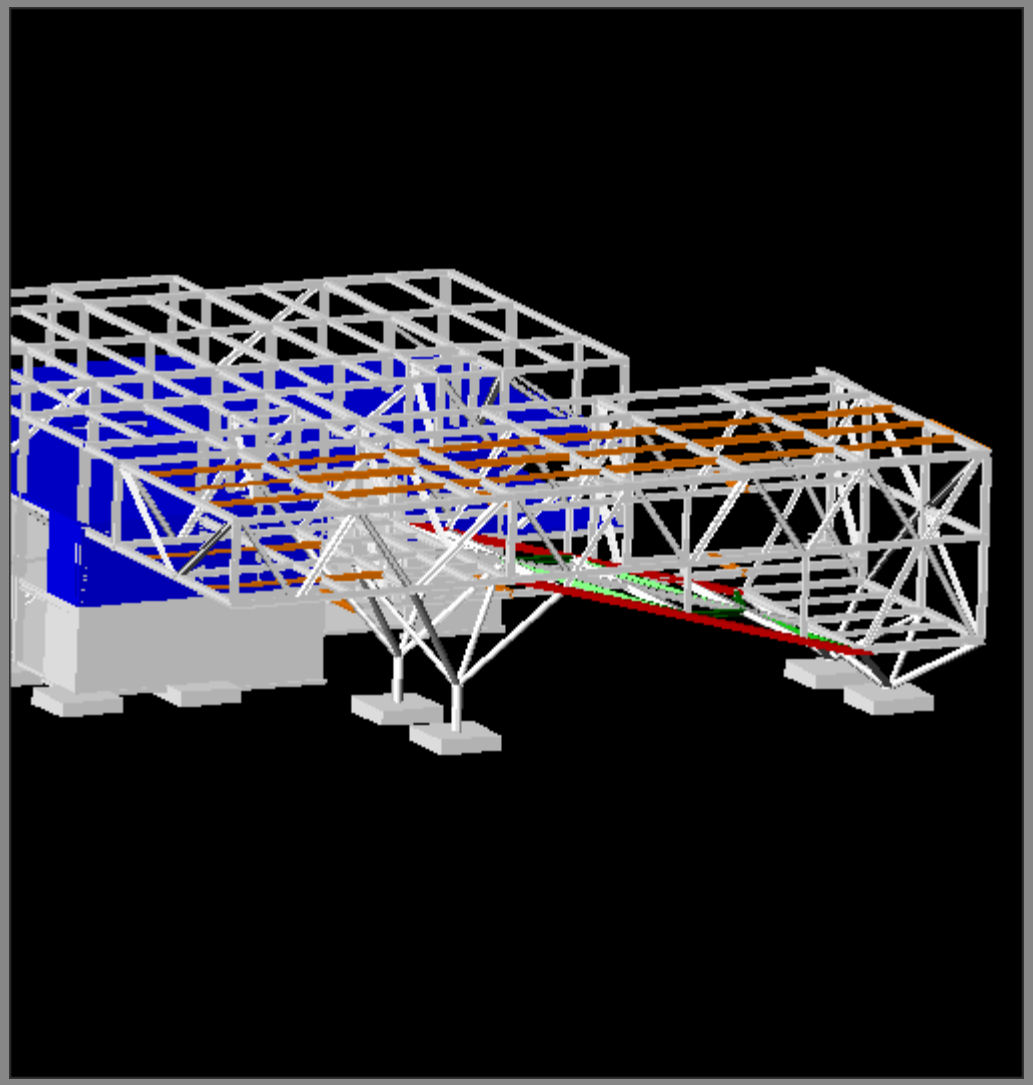

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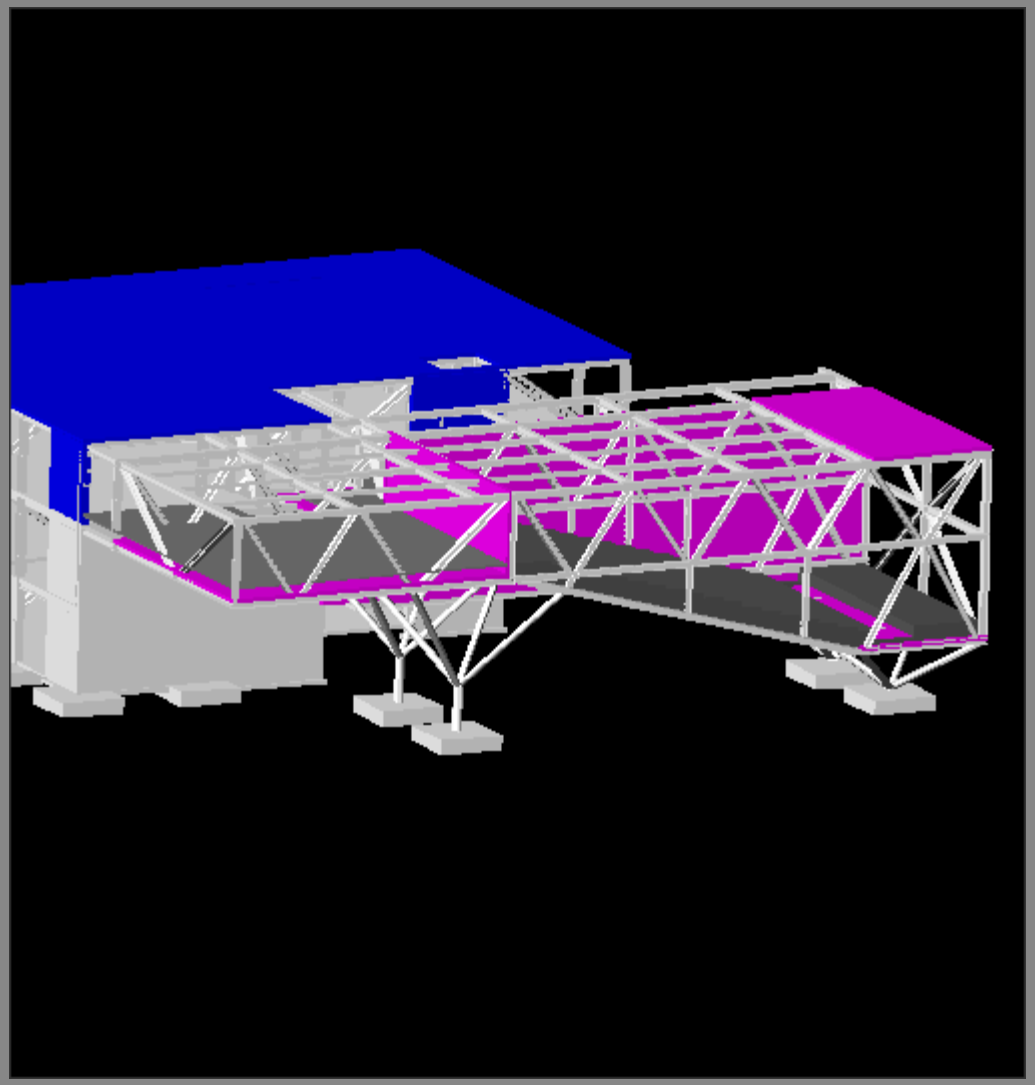
4D Model – Auditorium



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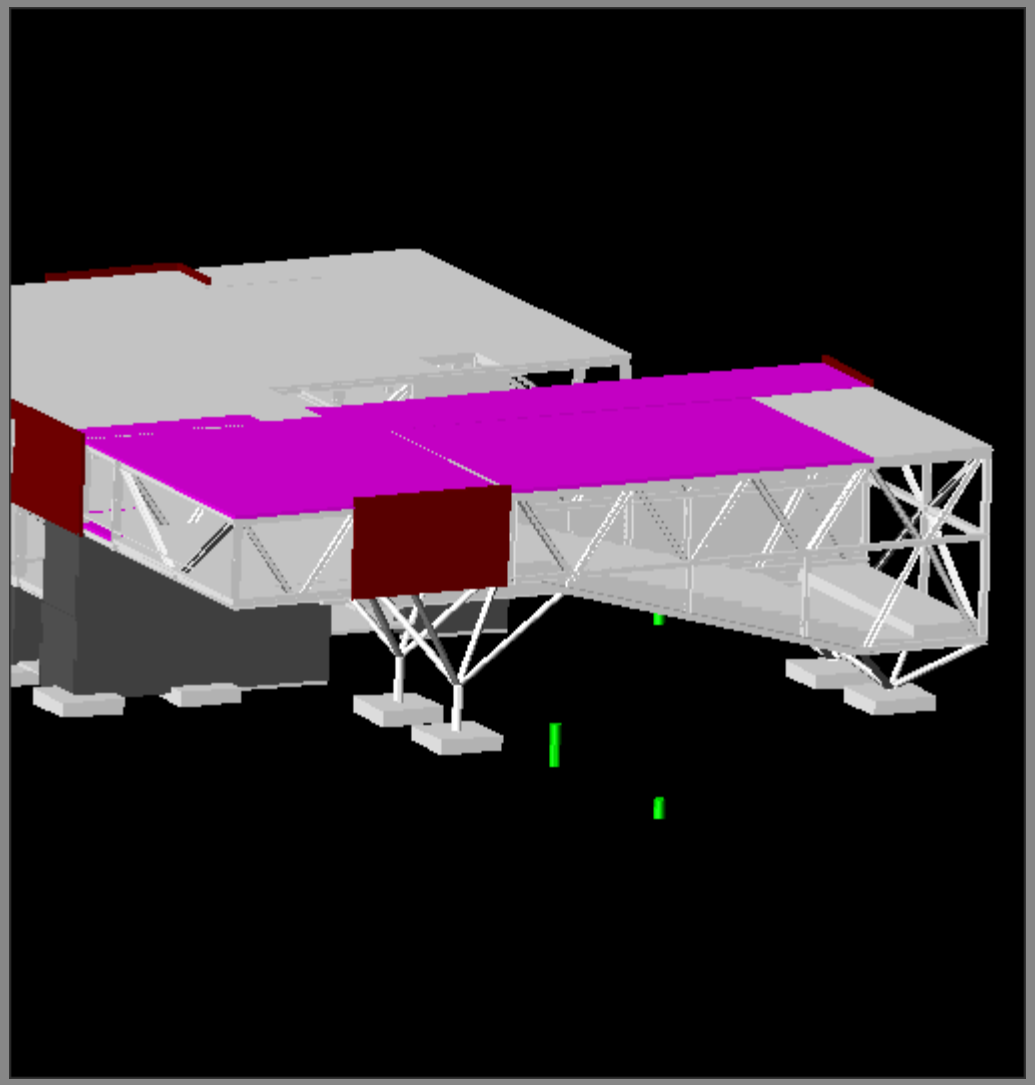

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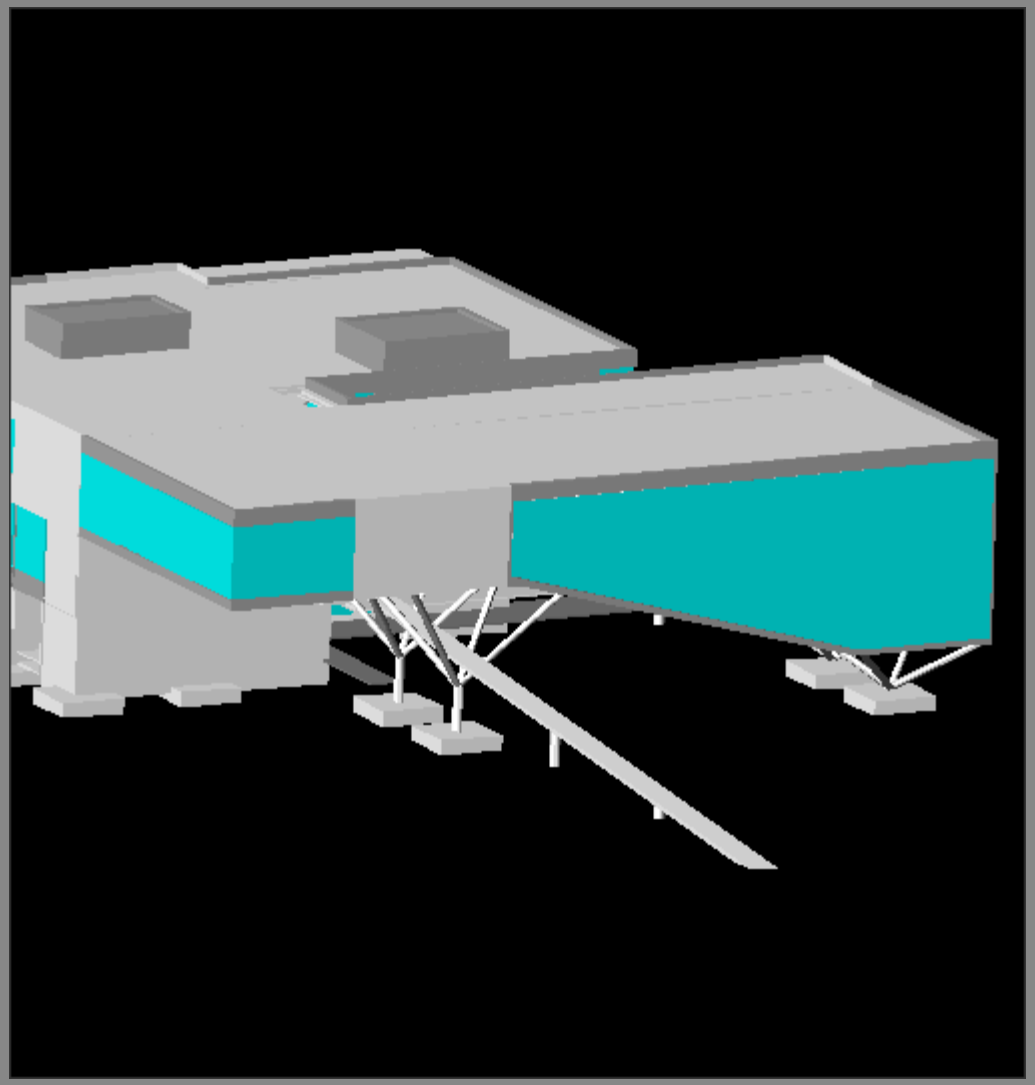
4D Model – Auditorium



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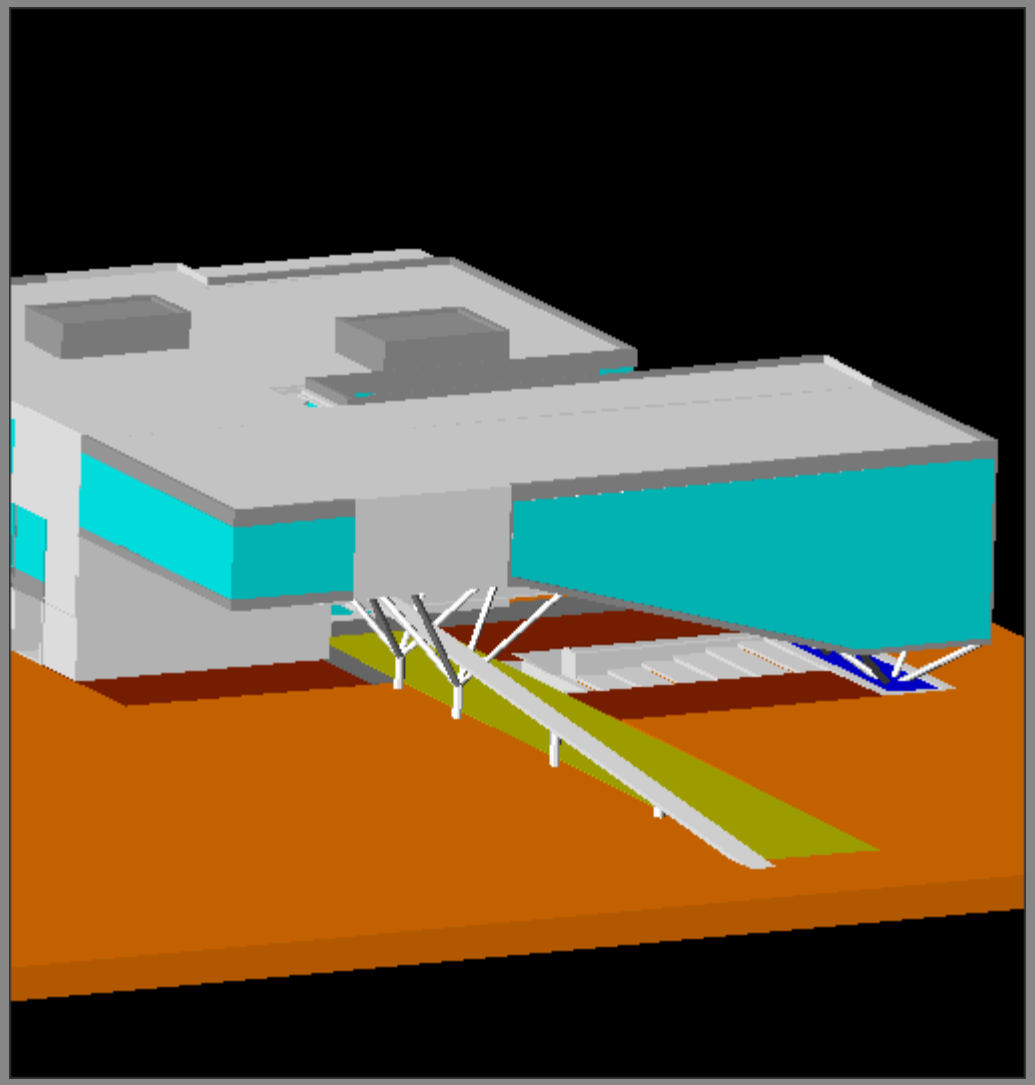
4D Model – Complete



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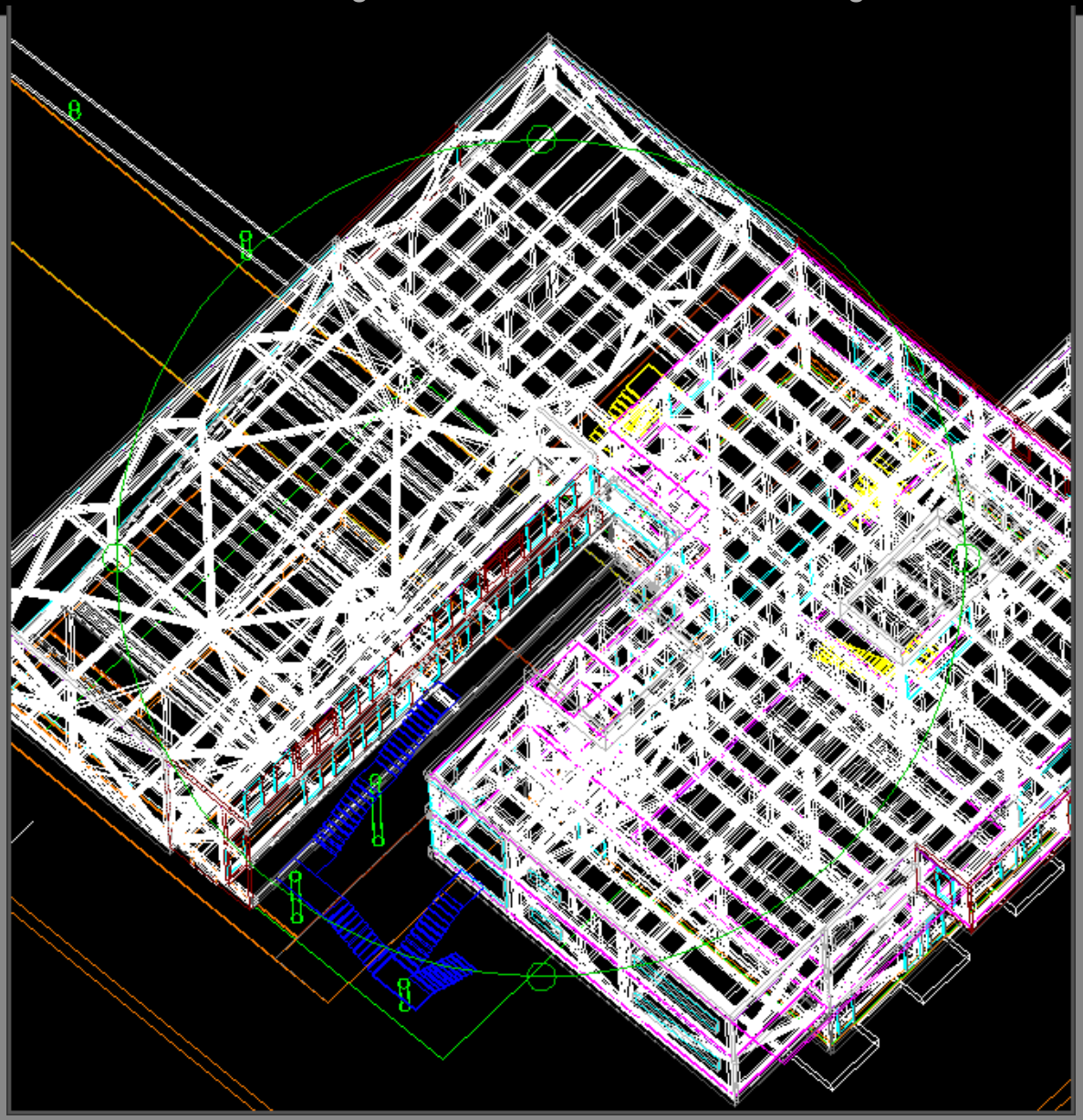
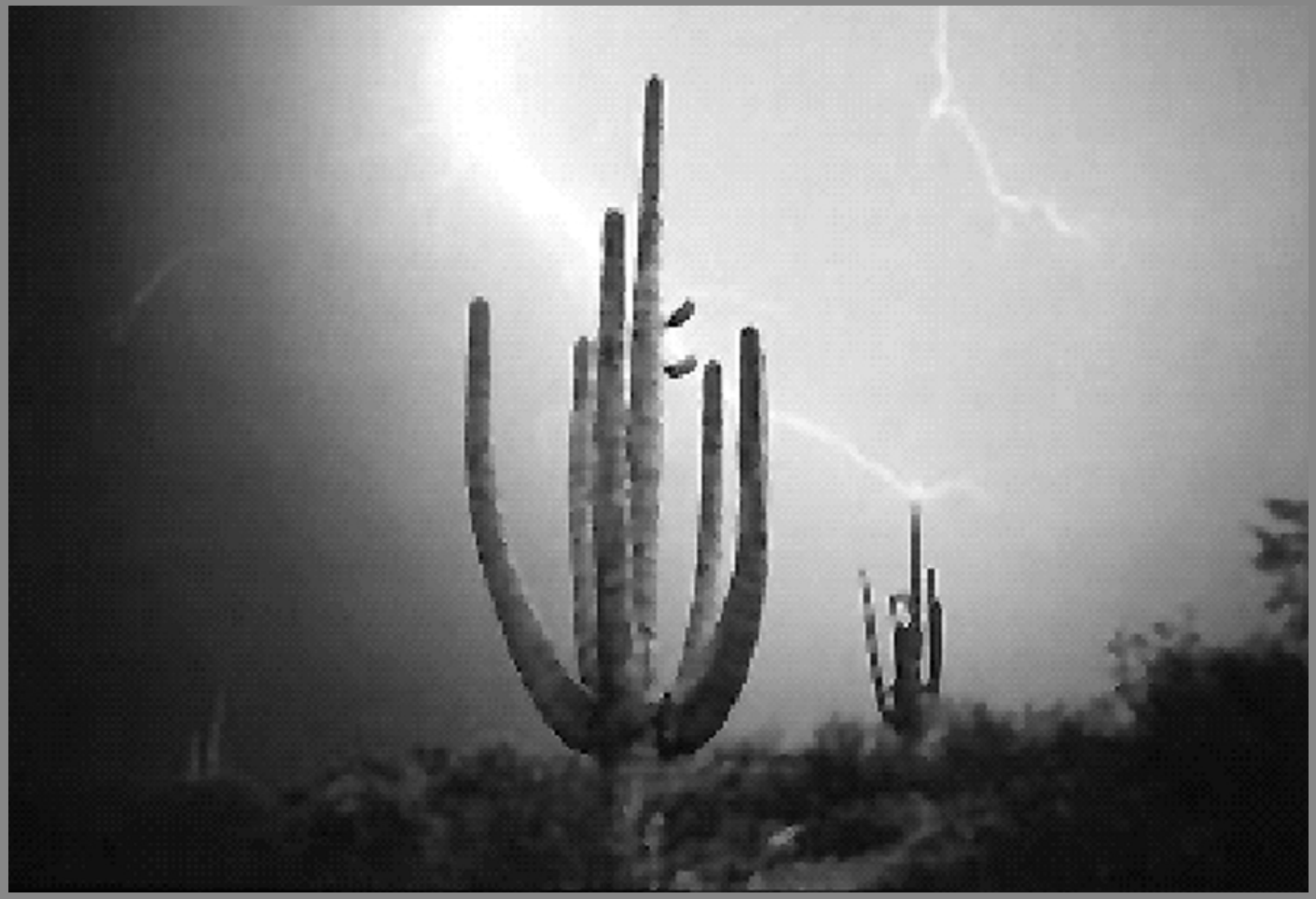


Statistics:

- 195 Layers
- > 500 man hrs effort
- A/E/C layer & const. order iterations made together as group

TEAM PROCESS



- Pyramid Development — AEO
  - Auditorium Support
  - Ramp Location
- Y-Y-Y-X Configuration — AEO
- Structural system and building experience — AE
- Deck configurations and Type — EC
- Core material type: steel vs. concrete — AEC
- MEP in Auditorium — AEC

Communication and Coordination process

- Weekly team meeting - phone conference and net meeting - Biggest decisions

  A / E / C

- MSN Messenger meetings - between 2 and 3 times by week - 1 to 1 - Interaction

  A / E - E / C - E / E - C / C

- Think Tank - Discussion forum - Propositions

  A / E / C

- Owner - phone conference - architecture input

  O - A / E / C

1. Always triple the expected amount of time you think a task will take.
2. When having meetings on the web, be upfront in your communication.
3. Try to understand which knowledge the other part of the team really needs
4. Learn how to explain and communicate knowledge to others
5. Size of File in Mb $\propto$ # of Saves / Hour

Improvements from Winter Quarter:

- Increased interaction with our mentors
- Increased A / E / C :
  - Winter quarter interaction: A → E → C
  - Spring quarter interaction: E → C → A
- E-part became central, because of our complex structure

Thank You!

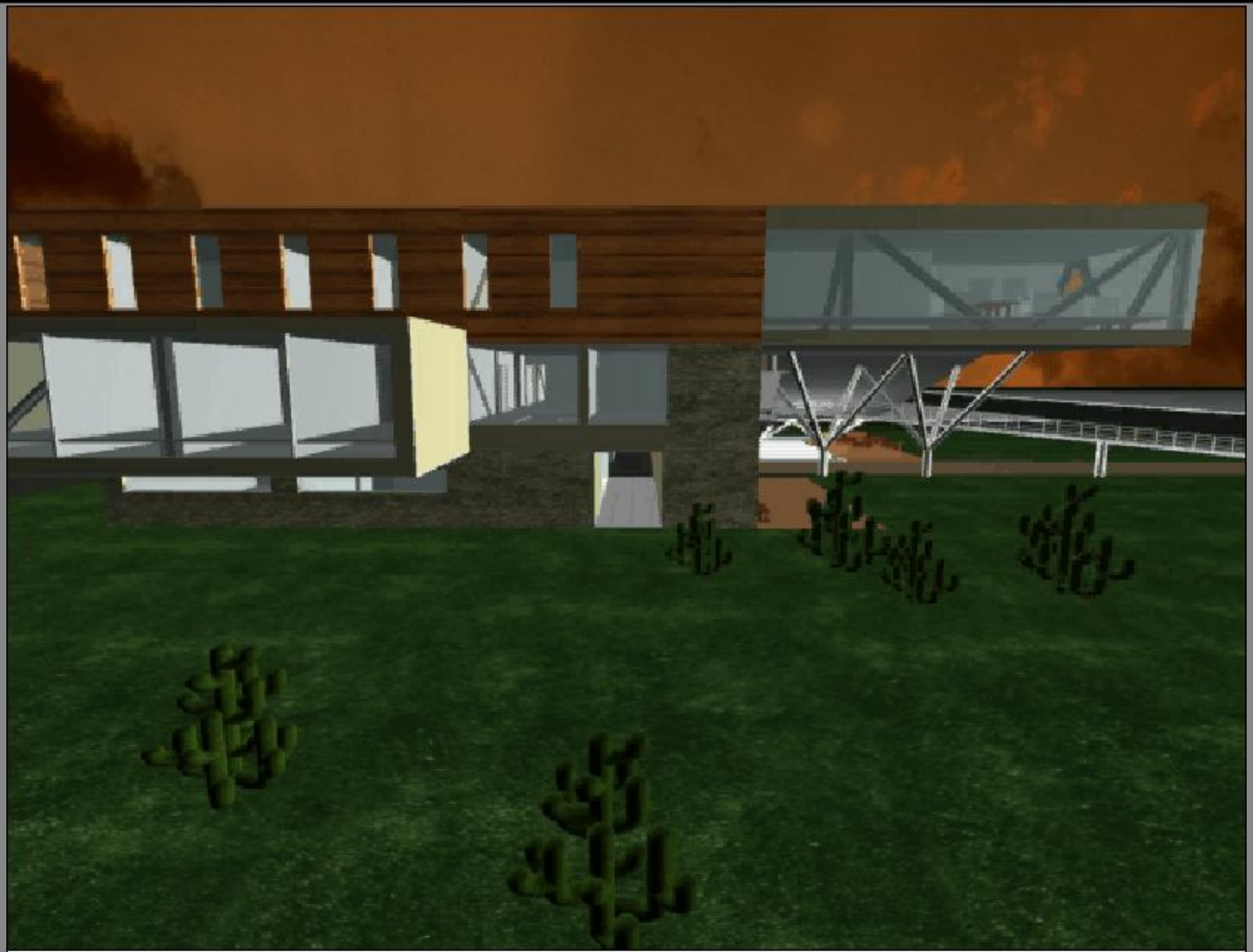
- KTH, Kjell Nilver
- Mentors:
  - David Bendet,
  - Johan Berg
  - Helmut Krawinkler,
  - Greg Luth
  - Eduardo Miranda
  - C.B. Tatum
  - Skanska Teknik
  - Hans Verheij (owner)
  - Frank Werner
  - & many others…..

- Fujitsu computer, Imagine Lab (Georgia Tech,…)
- Coke, coffee, pizza hut, Ryan's bike, Noreen’s rollerblades, British Airways, Alamo Rental Cars, …
- And the members of the other teams who helped us.

Thank You!

… and RENATE of course.

Questions?



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