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Architect: Robert Alvarado

Structural Engineer: Mark Heller

Construction Manager: Sheryl Staub

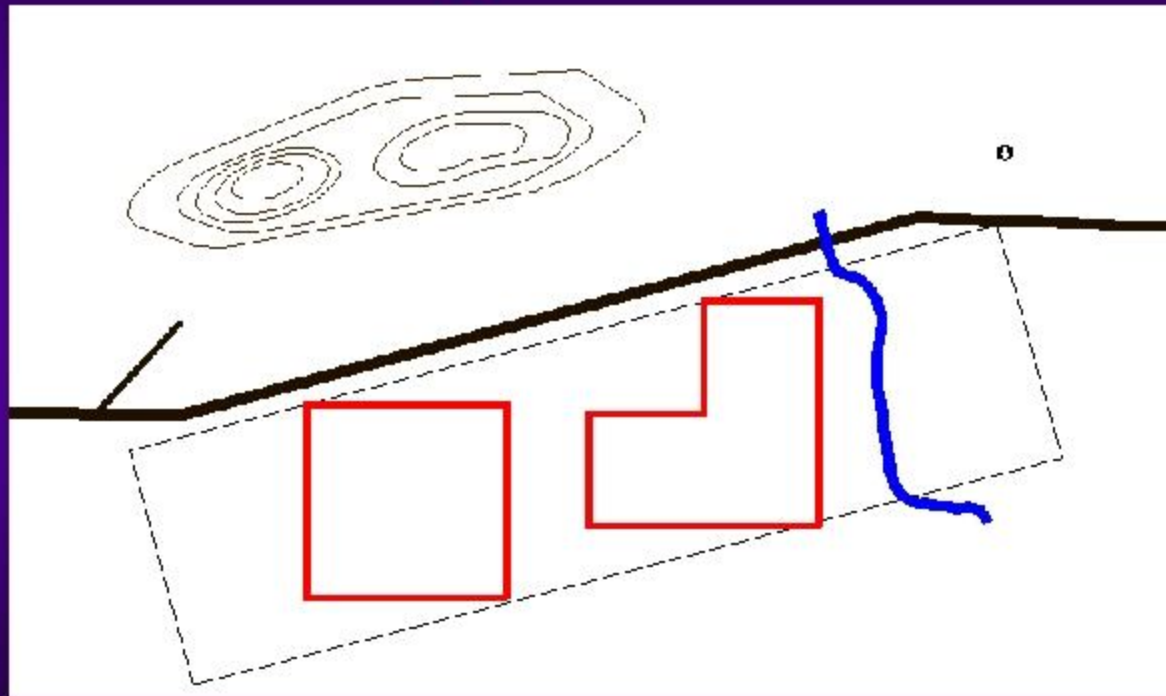
Apprentice: Gina Sandoval

Owner: Luciana Barroso

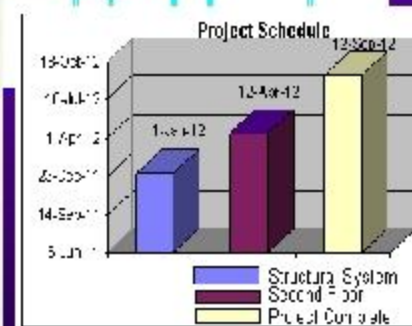
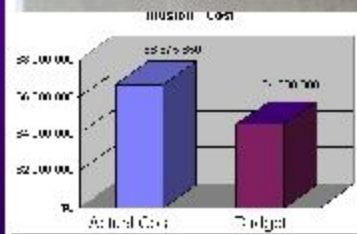
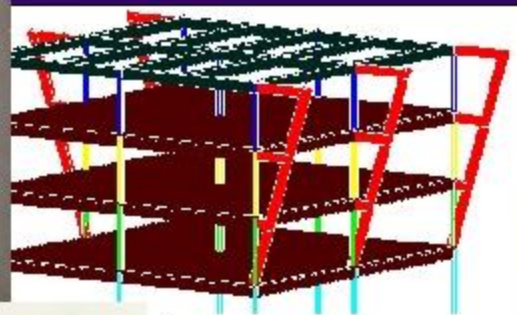
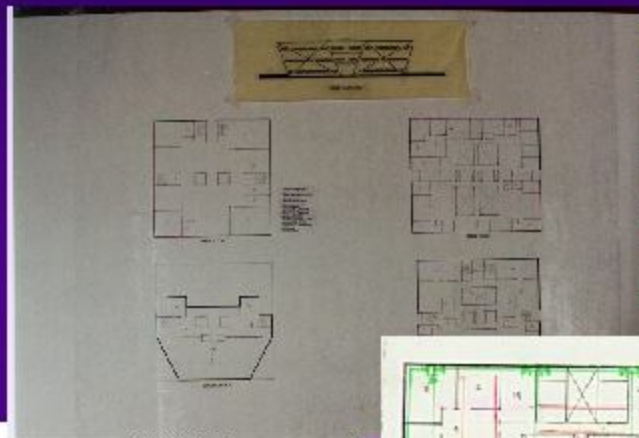
## Presentation Outline

- ◆ Proposed Conceptual Solutions
- ◆ Design Evolutions/Final Proposal
- ◆ Lessons Learned
- ◆ Summary

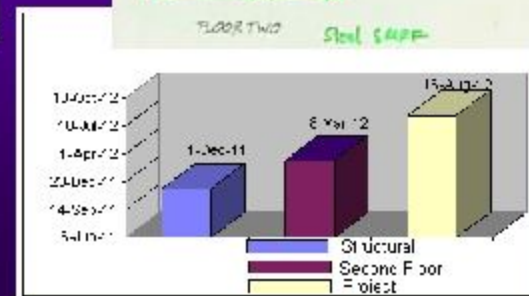
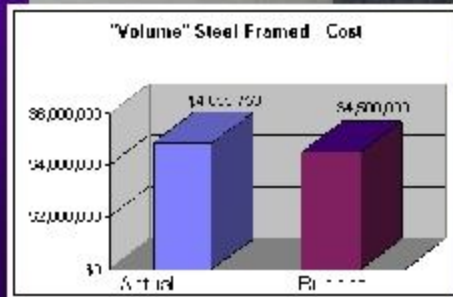
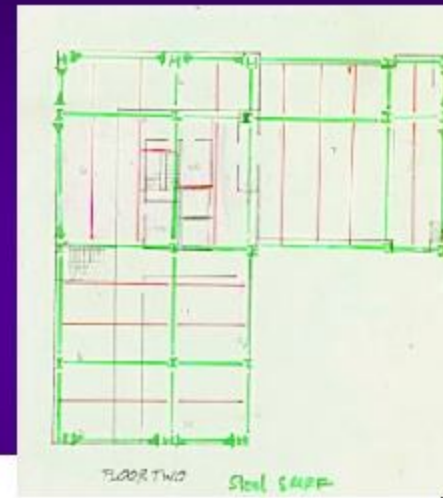
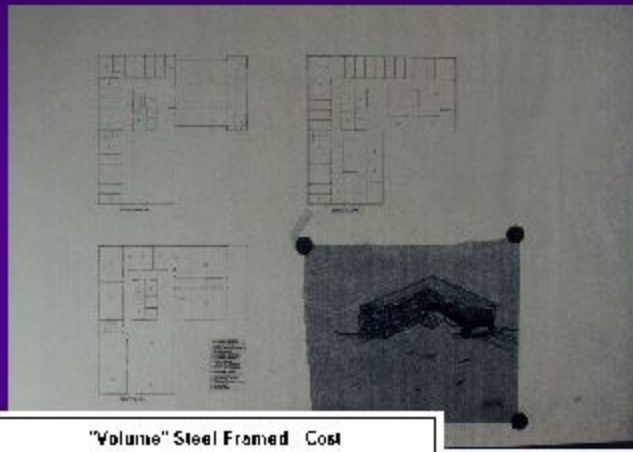
## Mountain Ridge Site



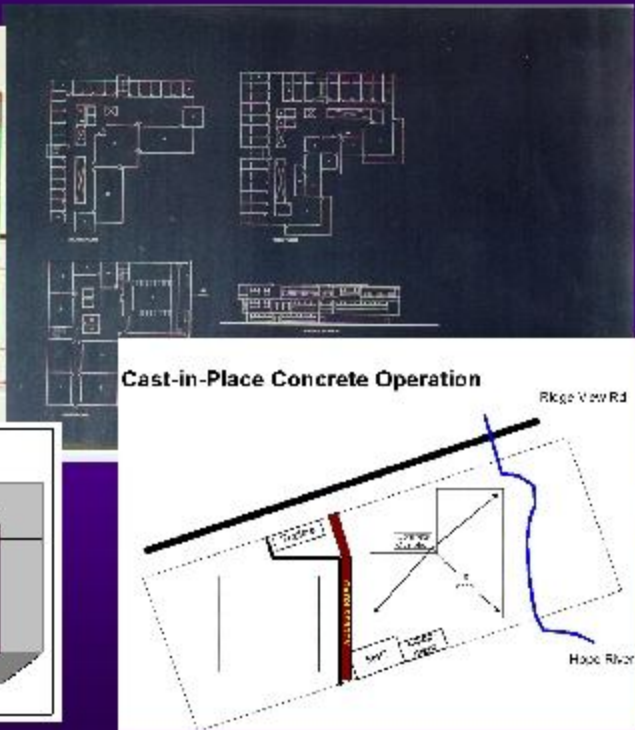
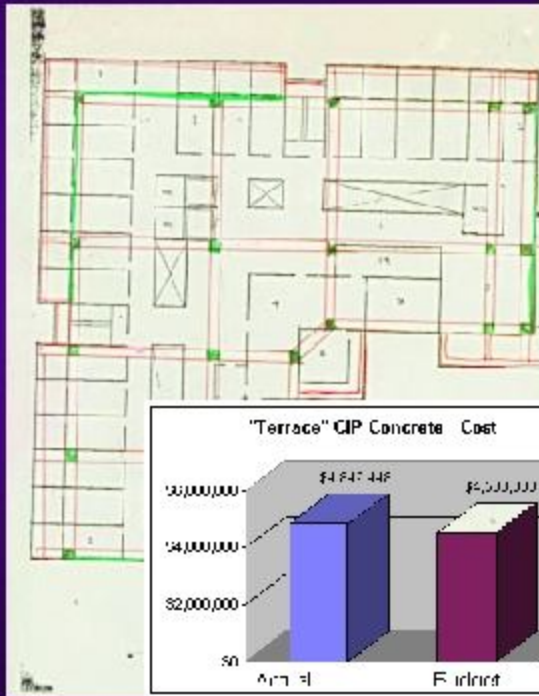
# A/E/C Conceptual - Illusion 1



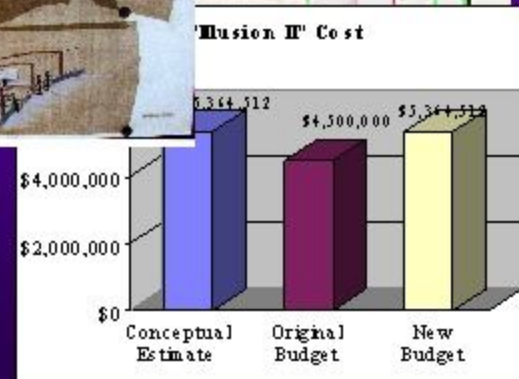
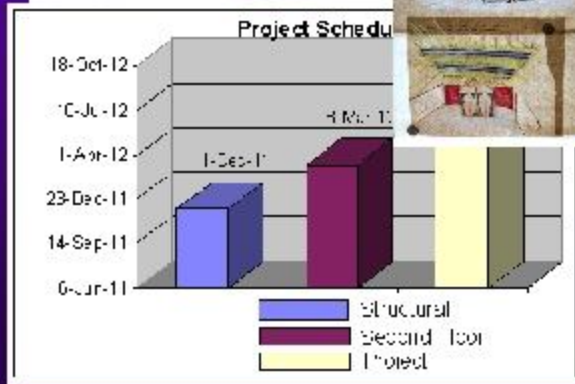
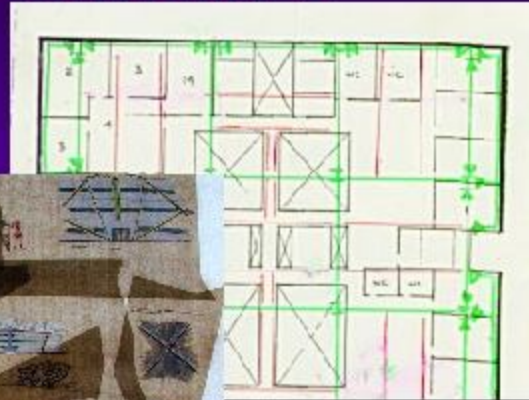
# A/E/C Conceptual - The Volume



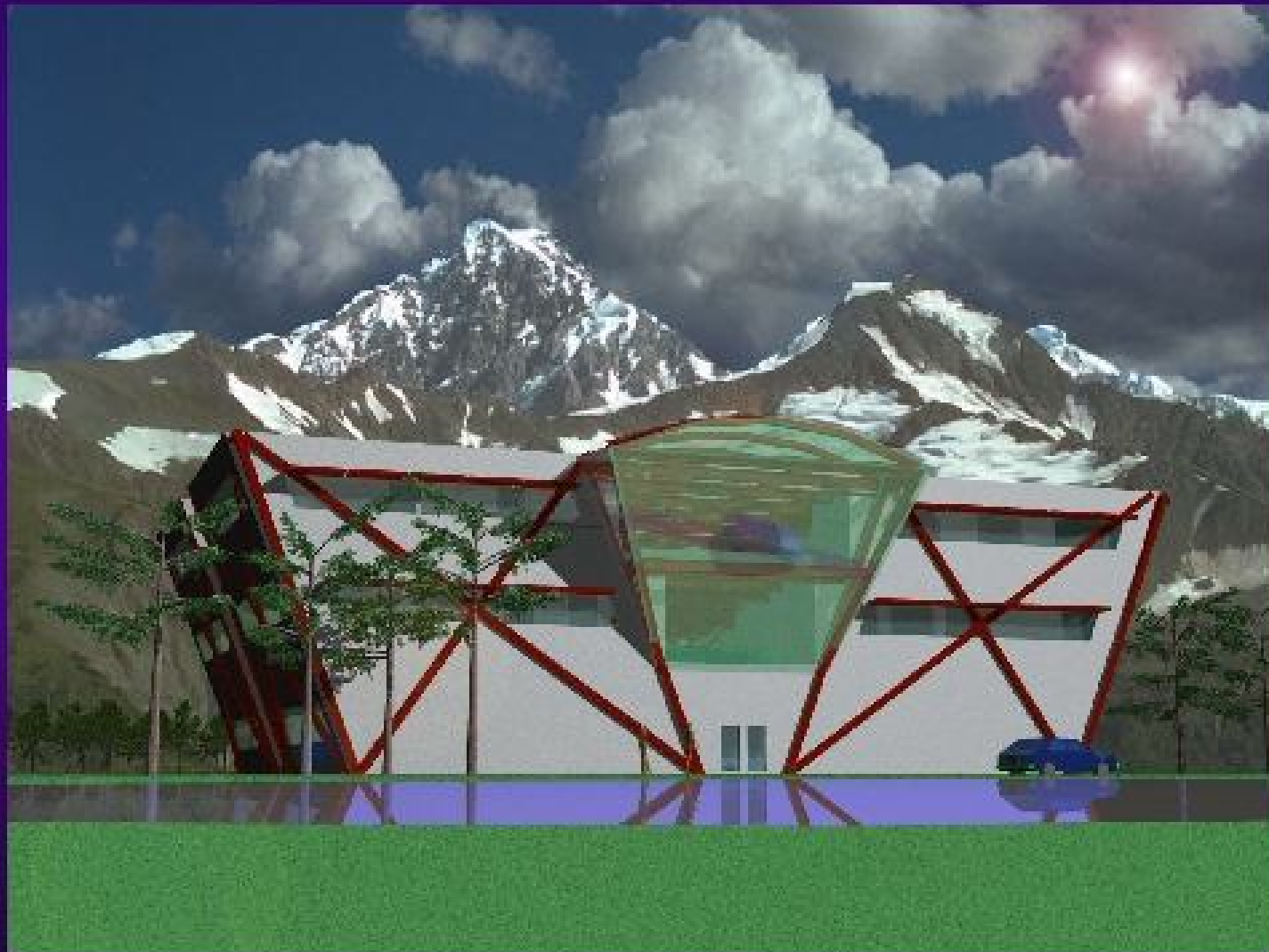
# A/E/C Conceptual - The Terrace



# A/E/C Conceptual - Illusion 2



# The Choice

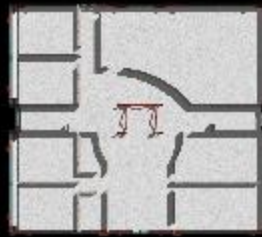




## Why?

- ◆ Architecture becomes an Icon
- ◆ The experience becomes one of space and structure
- ◆ Building program meets owners specifications
- ◆ The structural system speaks to the occupants
- ◆ The building meets construction budget and time requirements

# Architecture - First Floor Plans



FIRST FLOOR PLAN

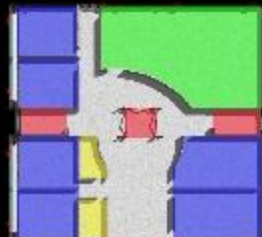
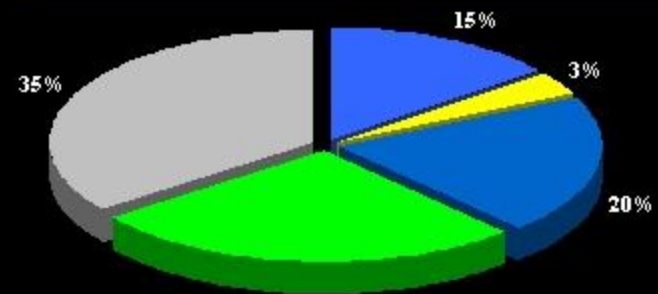


DIAGRAM A



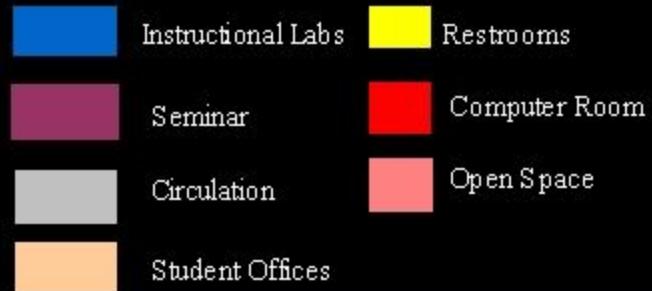
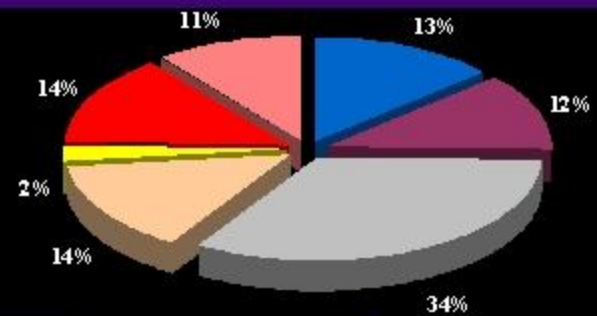
# Architecture - Second Floor Plans



SECOND FLOOR PLAN



DIAGRAM B



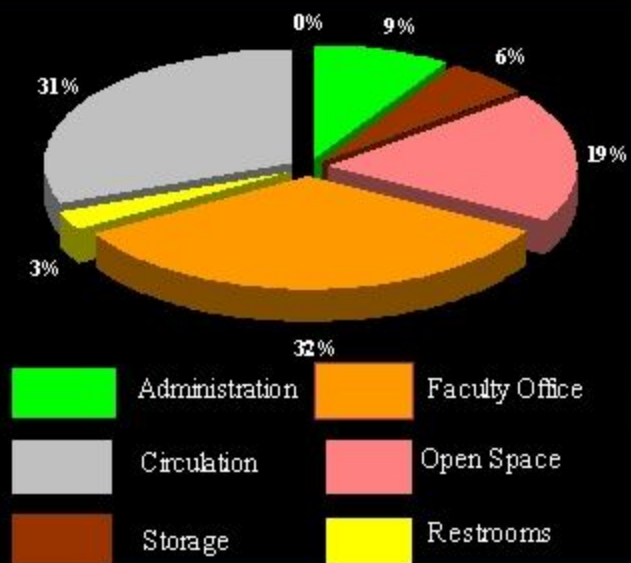
# Architecture - Plans



THIRD FLOOR PLAN

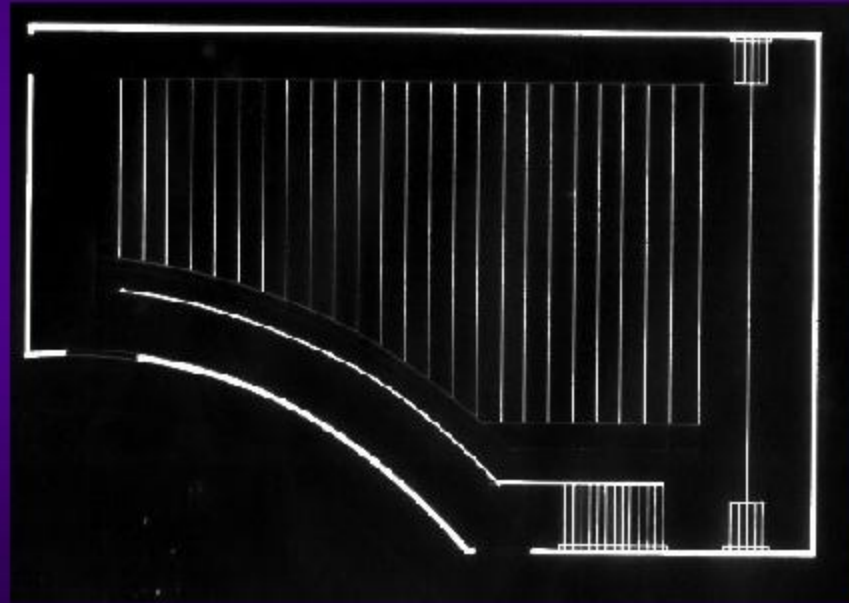


DIAGRAM C

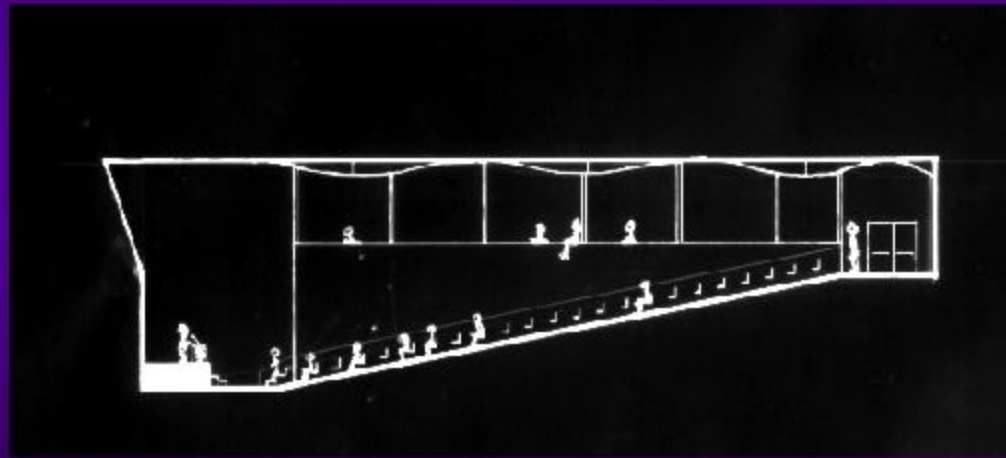




# Architecture - Auditorium



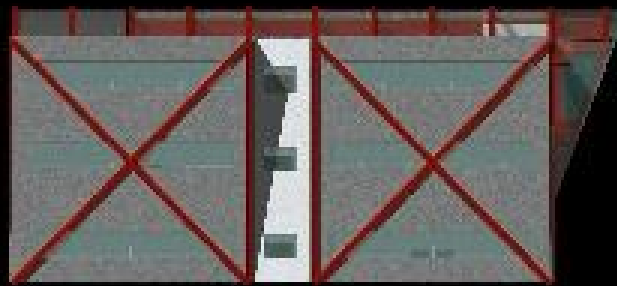
# Architecture - Auditorium Section



# Architecture - Elevations



SOUTH ELEVATION



EAST ELEVATION



# Architecture - Sections



SOUTH SECTION

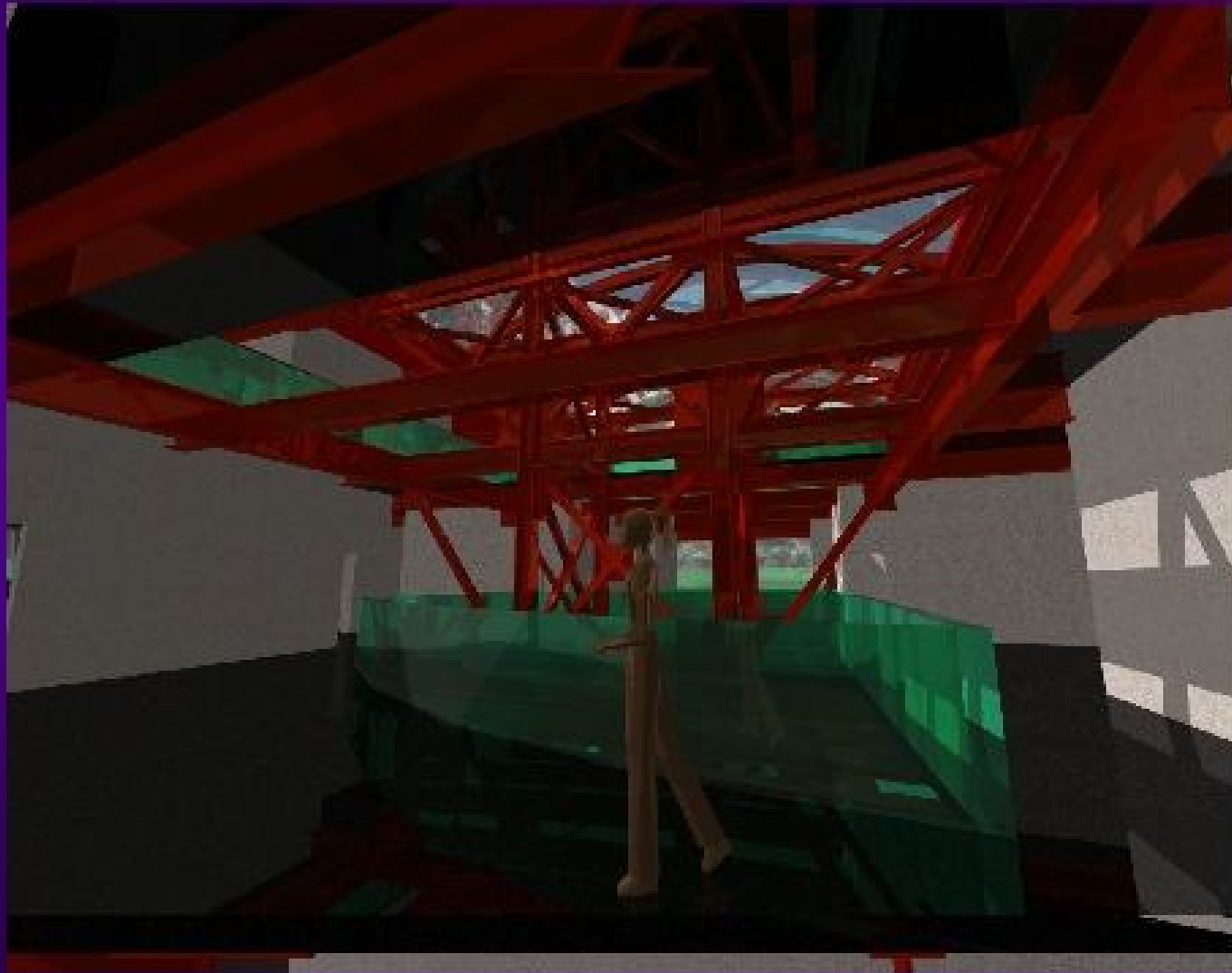


WEST SECTION

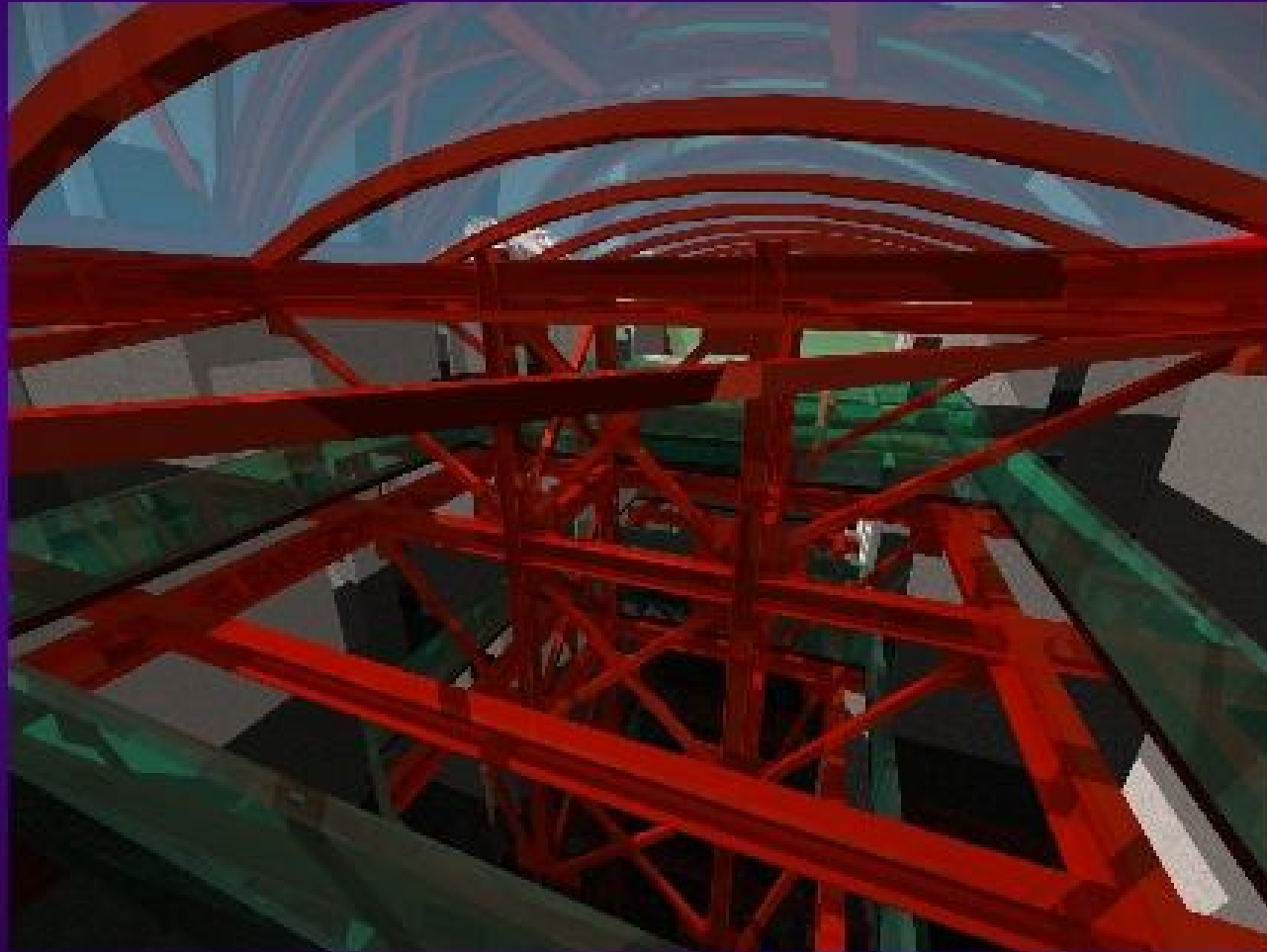
# Architecture - Site



# Architecture - Interiors



# Architecture - Interiors



# Engineering Load Data

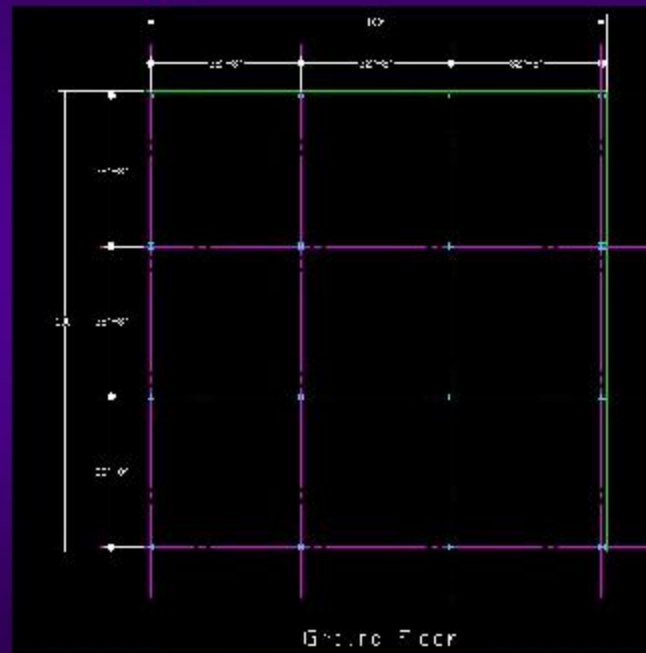
## Lateral Loading (seismic)

Zone 3	$Z = 0.3$
Soil Type S1	$S = 1.0$
Importance	$I = 1.0$
System	$R_w = 9$
C	2.68
Base Shear	$V = 385k (9\%)$

## Load Factors

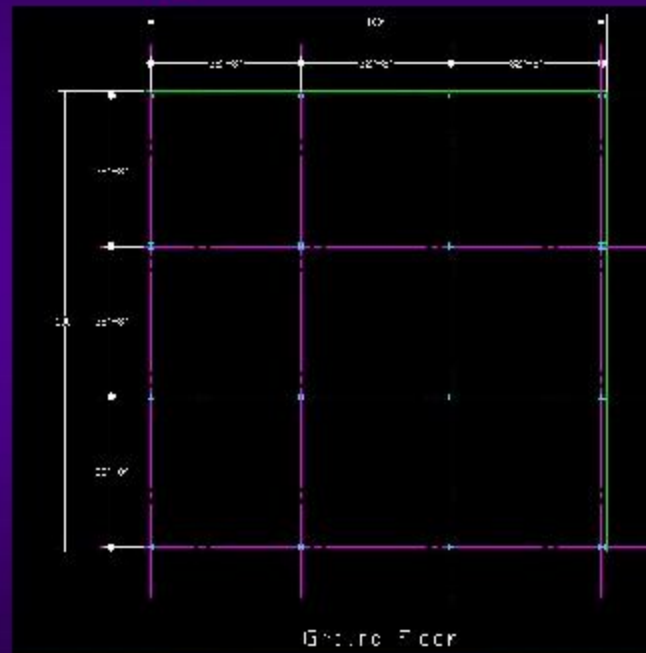
1st, 2nd, 3rd	$1.2D+1.6L$
Roof	$1.2D+1.6S + 0.5L$
Lateral	$1.2D+1.5E+0.5L$
	$1.2Pdl+0.5Pll+3RwPe/8$

# Engineering Evolution



CONCEPTUAL

# Engineering Evolution



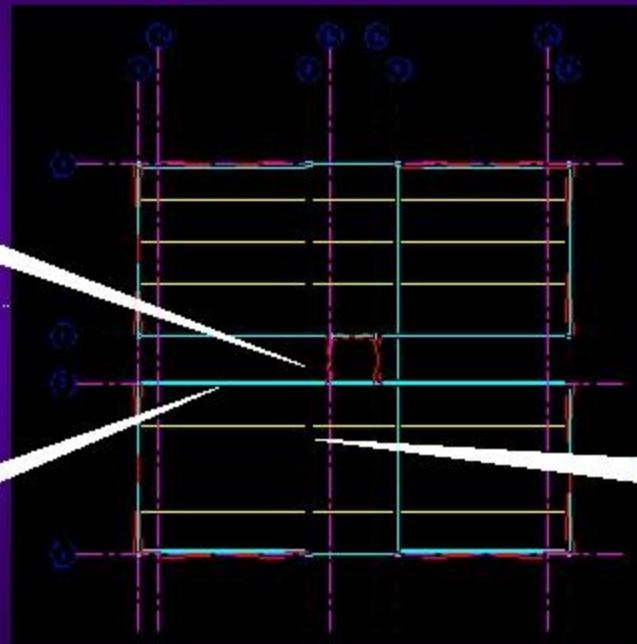
CONCEPTUAL

# Engineering Evolution

Mu = 118 k-ft  
Size = W18x35

Mu = 935 k-ft  
Size = W18x71

Mu = 1514 k-ft  
Size = W24x94



ITERATION 1

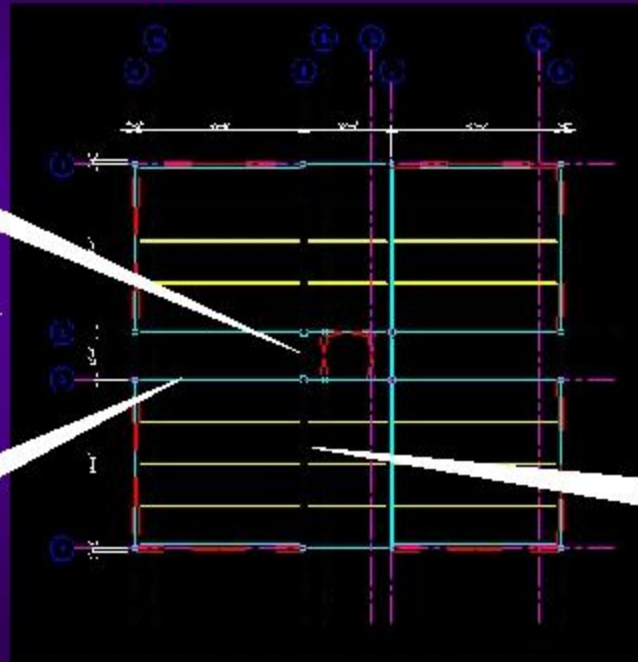


# Engineering Evolution

Mu = 118 k-ft  
Size = W18x35

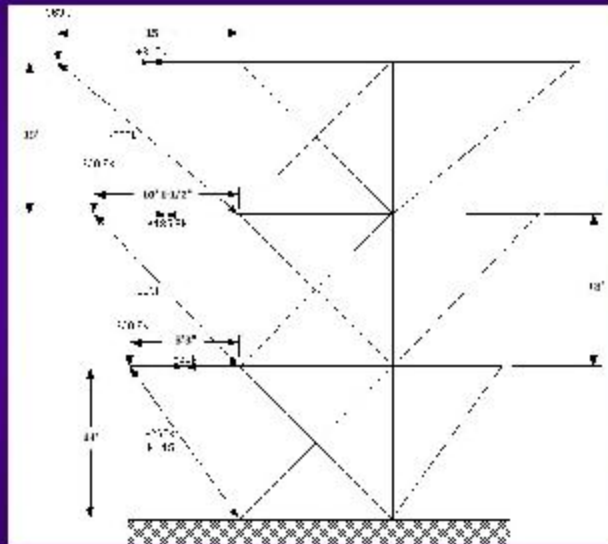
Mu = 500k-ft  
Size = W18x40

Mu = 1514k-ft  
Size = W24x94

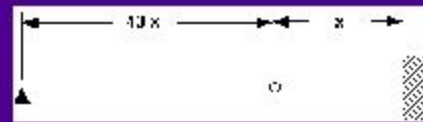


ITERATION 2

# Engineering Evolution

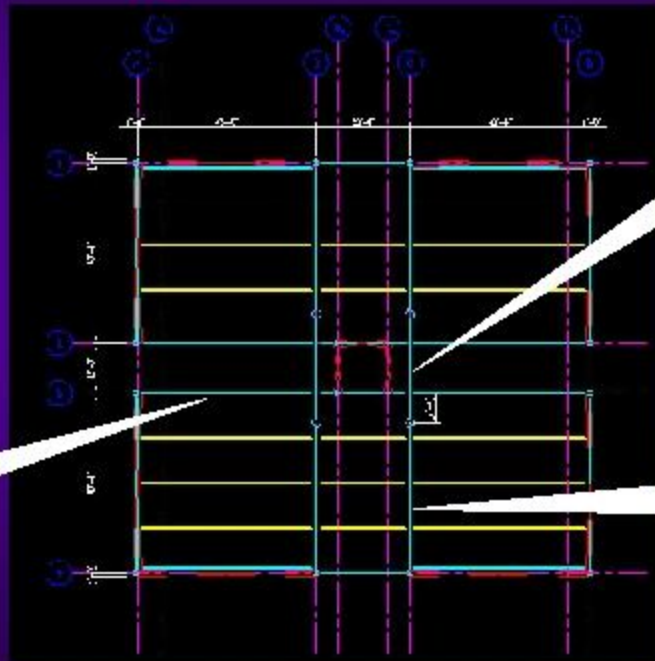


OPTIMIZATION



OPTIMIZATION

# Engineering Evolution



Mu = 500k-ft  
Size = W18x40

Mu = 986 k-ft  
Size = W24x62

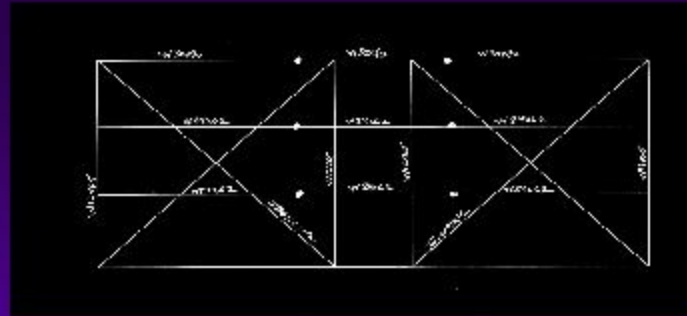
Mu = 1020 k-ft  
Size = W24x62

FINAL

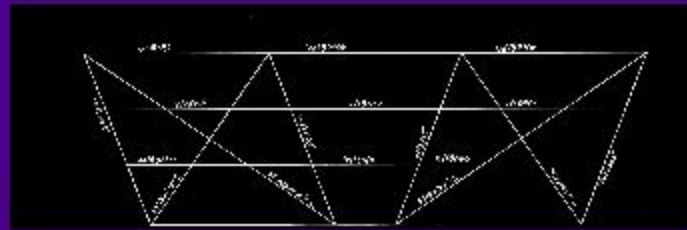


# Engineering

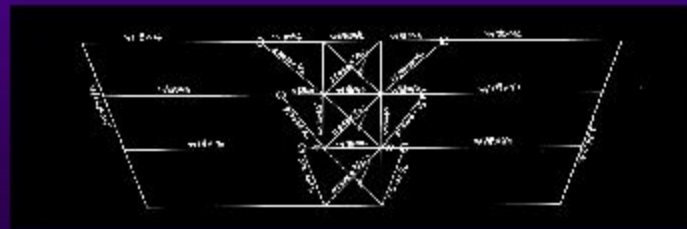
East/West Elevations



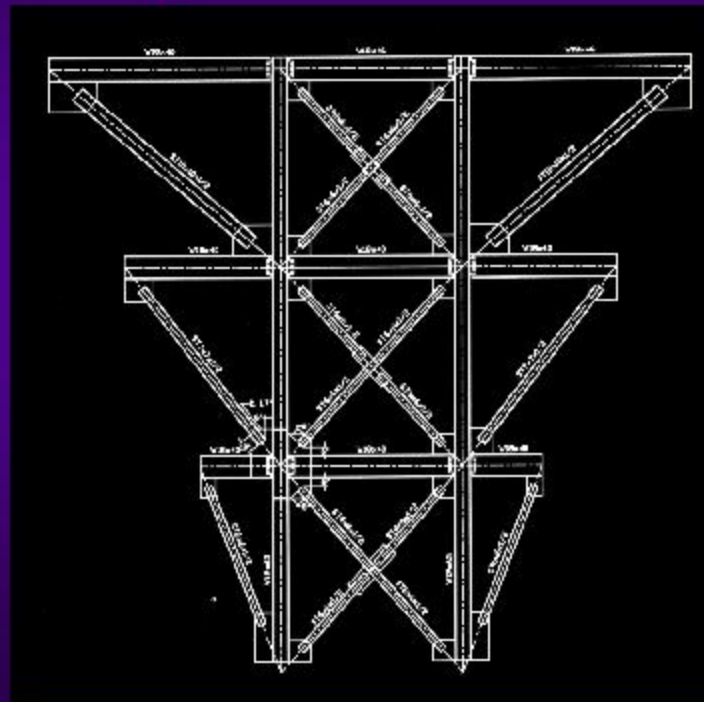
North/South Elevations



Interior Frames



# Engineering - Details



# Engineering - Details

SAMPLE CALCULATION

Max. Force (ST6x6x1/2)

$$F = 10.4 \text{ in}^2 * 46 \text{ ksi} = 478.4\text{k}$$

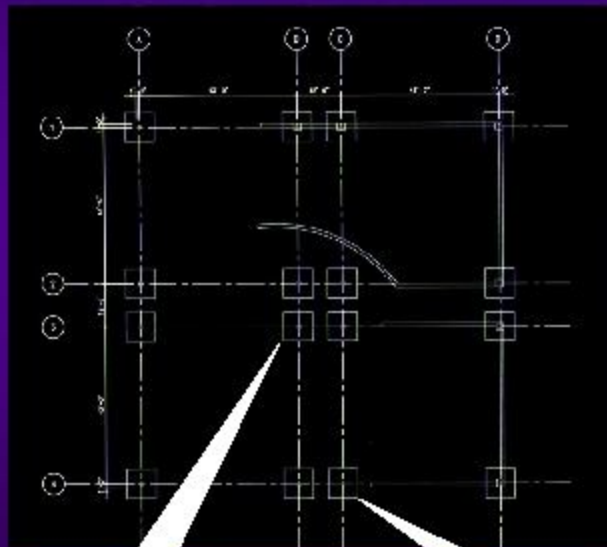
Weld Length (70 ksi)

$$l = (478.4) * 16 * (2)^{1/2} / (70) * (5)$$

$$l = 31'' \text{ (4 welds)} = 8''$$



# Engineering - Foundation



9'x9'

8'x8'

- Spread Footings
- Retaining Wall

## SAMPLE CALCULATION

$N = 30$ , Sand

$q = 0.11(30) = 3.3$  tsf

$B^2 = 197 \text{ tons}/3.3 \text{ tsf}$

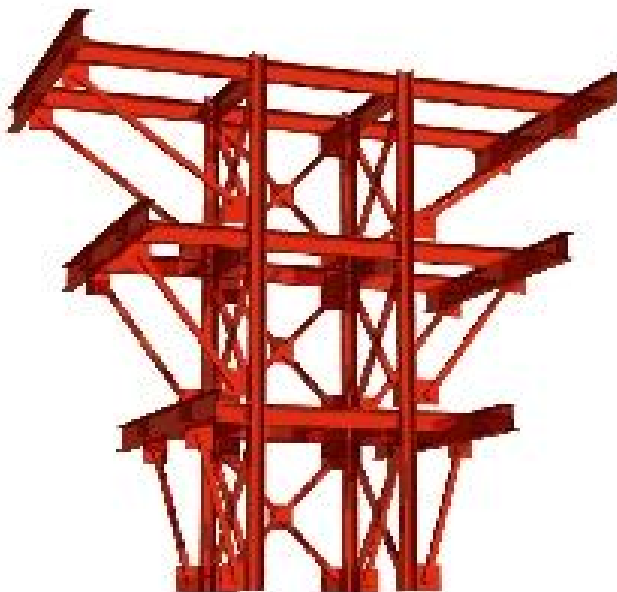
$B = 8 \text{ ft}$



# Engineering - HVAC

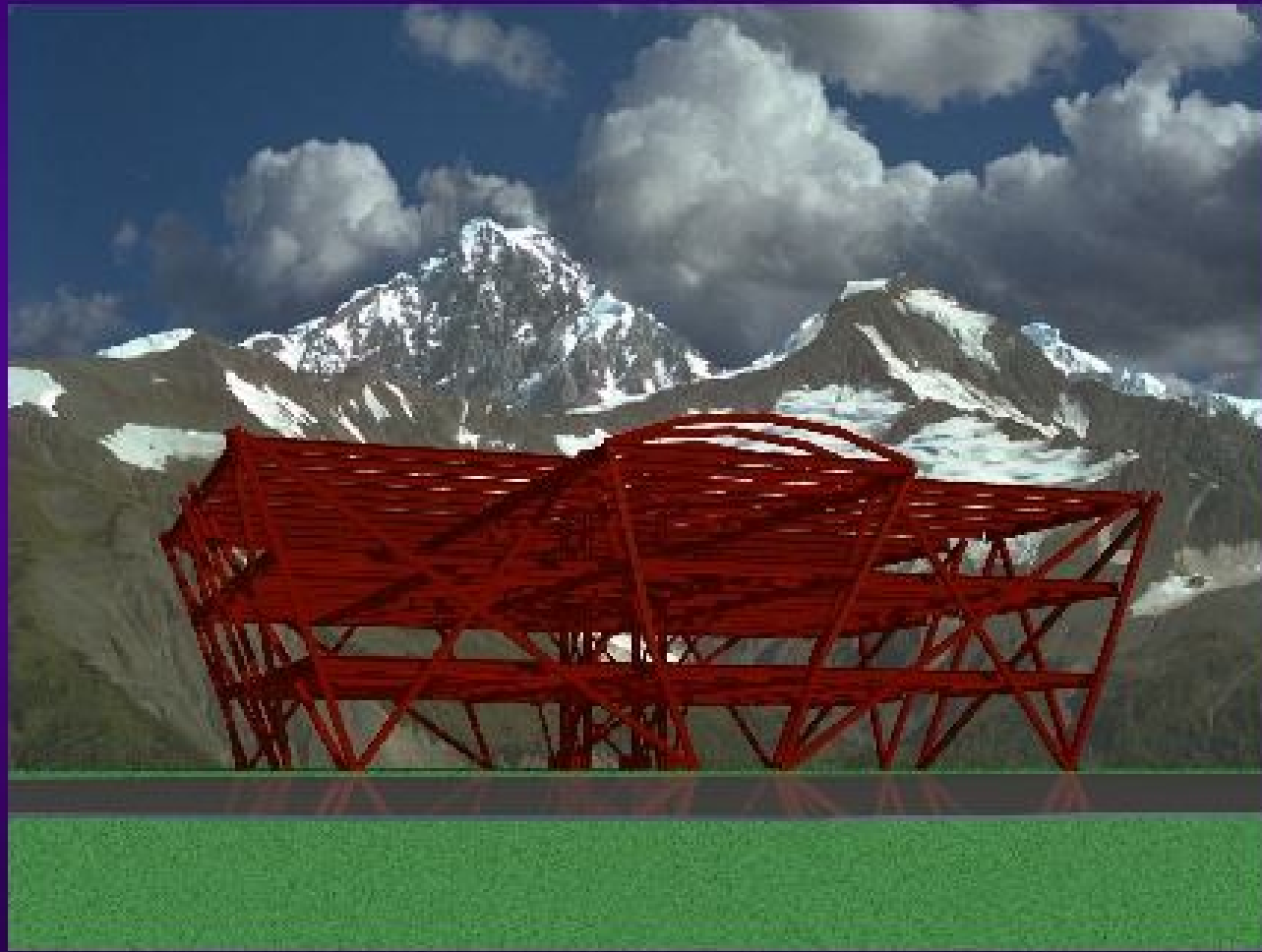
- ◆ System Choice: Water-Air Heat Pump
  - ◆ Heat Exchanger: Ground Water
- ◆ Heating Coils in Window Louvers

# Engineering



THE CORE

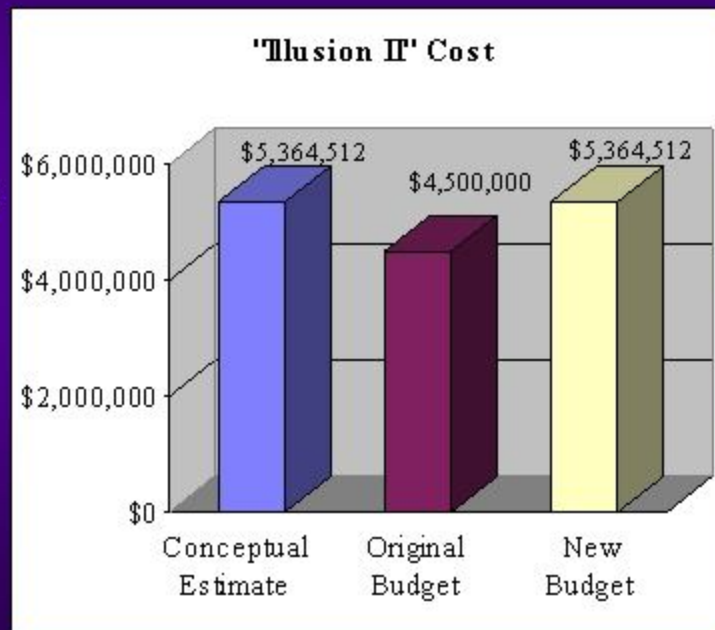
# Engineering



# Construction - Evolution

## Cost factors

- ◆ Means
- ◆ Limited Specifications
- ◆ Limited Detail



# Construction - Evolution

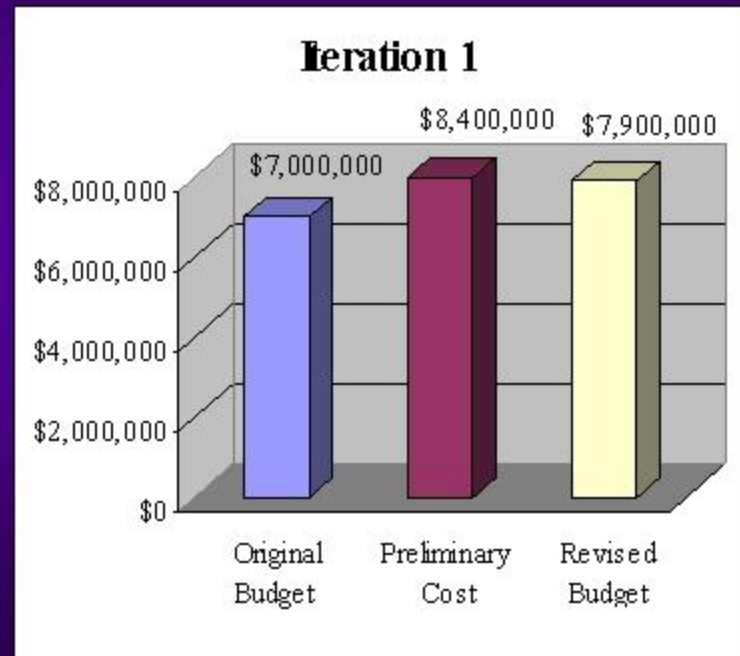
## Cost Data

### ◆ Mentors

- ◆ Structural System
- ◆ Exterior Closure
- ◆ Winter Construction

### ◆ Means

- ◆ Interior Construction

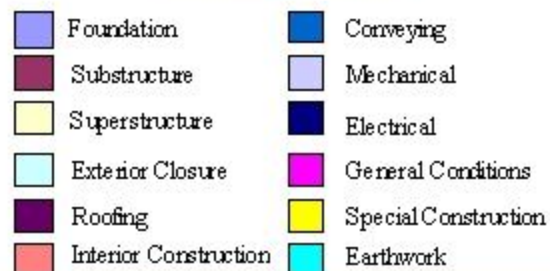
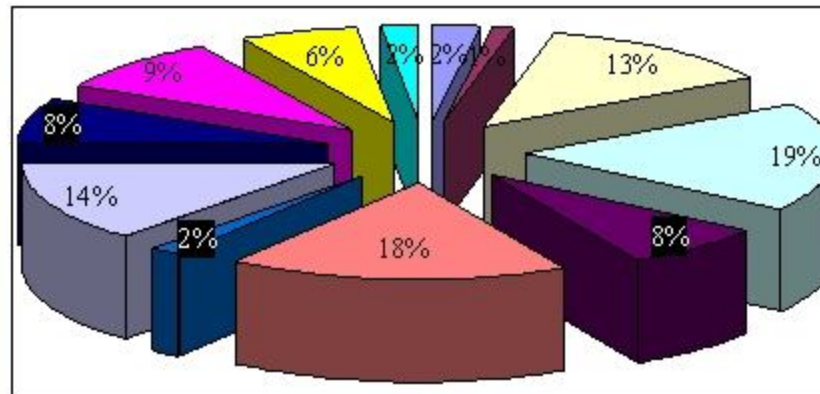


# Construction - Evolution

## Cost Impacts

- ◆ Roofing
- ◆ Structural System
- ◆ Exterior Walls
- ◆ Interior

Cost Breakdown by Type of Work



# **C**onstruction - Evolution

## **Resolution**

- ◆ **Owner Preferred Glass Roof**
- ◆ **Willing to pay up front for Life-Cycle Savings**
- ◆ **Owner Preferred Braced Frame**
- ◆ **Structural Engineer Optimized Repetition**
- ◆ **Less Expensive Exterior Wall System**

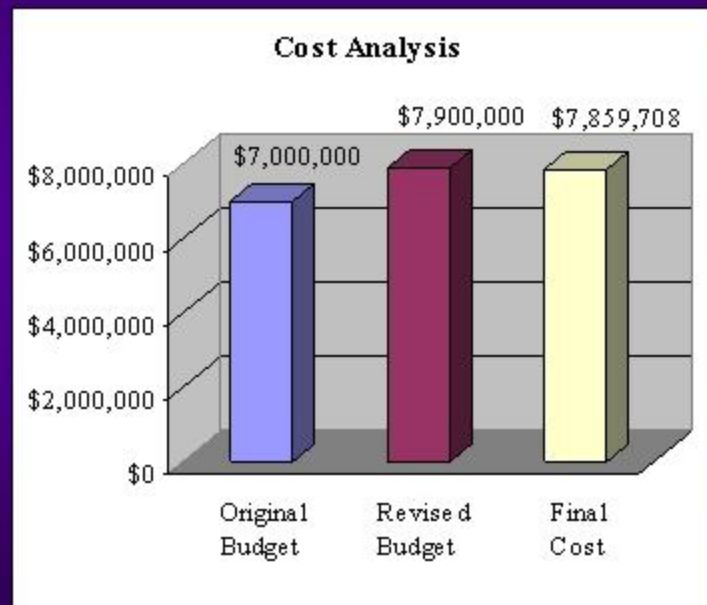
# **C**onstruction - Evolution

## **Resolution**

- ◆ **Owner Preferred Glass Roof**
- ◆ **Willing to pay up front for Life-Cycle Savings**
- ◆ **Owner Preferred Braced Frame**
- ◆ **Structural Engineer Optimized Repetition**
- ◆ **Less Expensive Exterior Wall System**



# Construction - Final Costs



# Construction - Schedule

## Issues

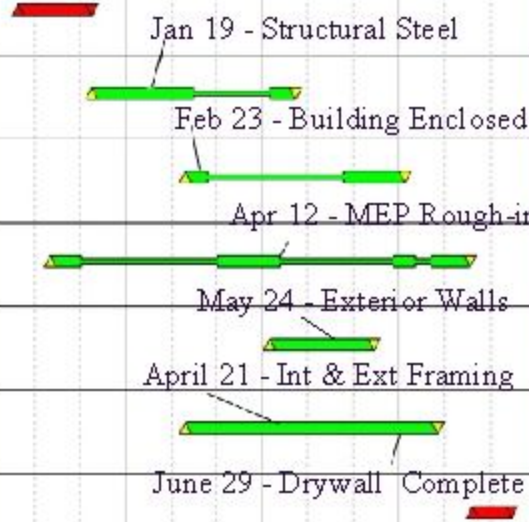
- ◆ Winter Construction
- ◆ Enclosing Building
- ◆ Congestion

## Durations & Sequencing

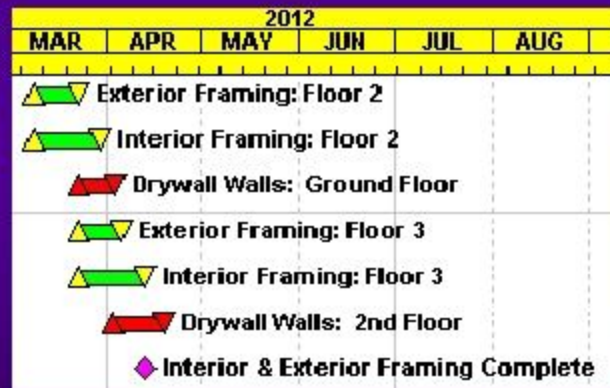
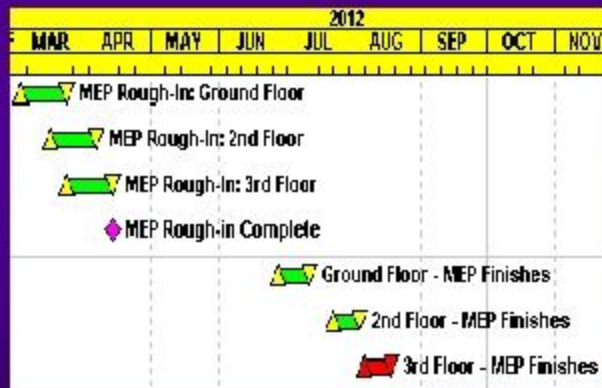
- ◆ Mentors
- ◆ Looking at Schedules Similar buildings

# Construction - Schedule

Activity Description	Orig Dur	Early Start	Early Finish	2011				2012								
				S	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
<b>+ Site Work</b>																
	15	30SEP11	20OCT11													
<b>+ Substructure</b>																
	35	21OCT11	08DEC11													
<b>+ Superstructure</b>																
	97	09DEC11	23APR12													
<b>+ Roofing</b>																
	105	10FEB12	05JUL12													
<b>+ Mechanical, Electrical &amp; Plumbing</b>																
	201	11NOV11	17AUG12													
<b>+ Exterior Closure</b>																
	50	06APR12	14JUN12													
<b>+ Interior Construction</b>																
	121	10FEB12	27JUL12													
<b>+ Occupancy Requirements</b>																
	20	20AUG12	14SEP12													



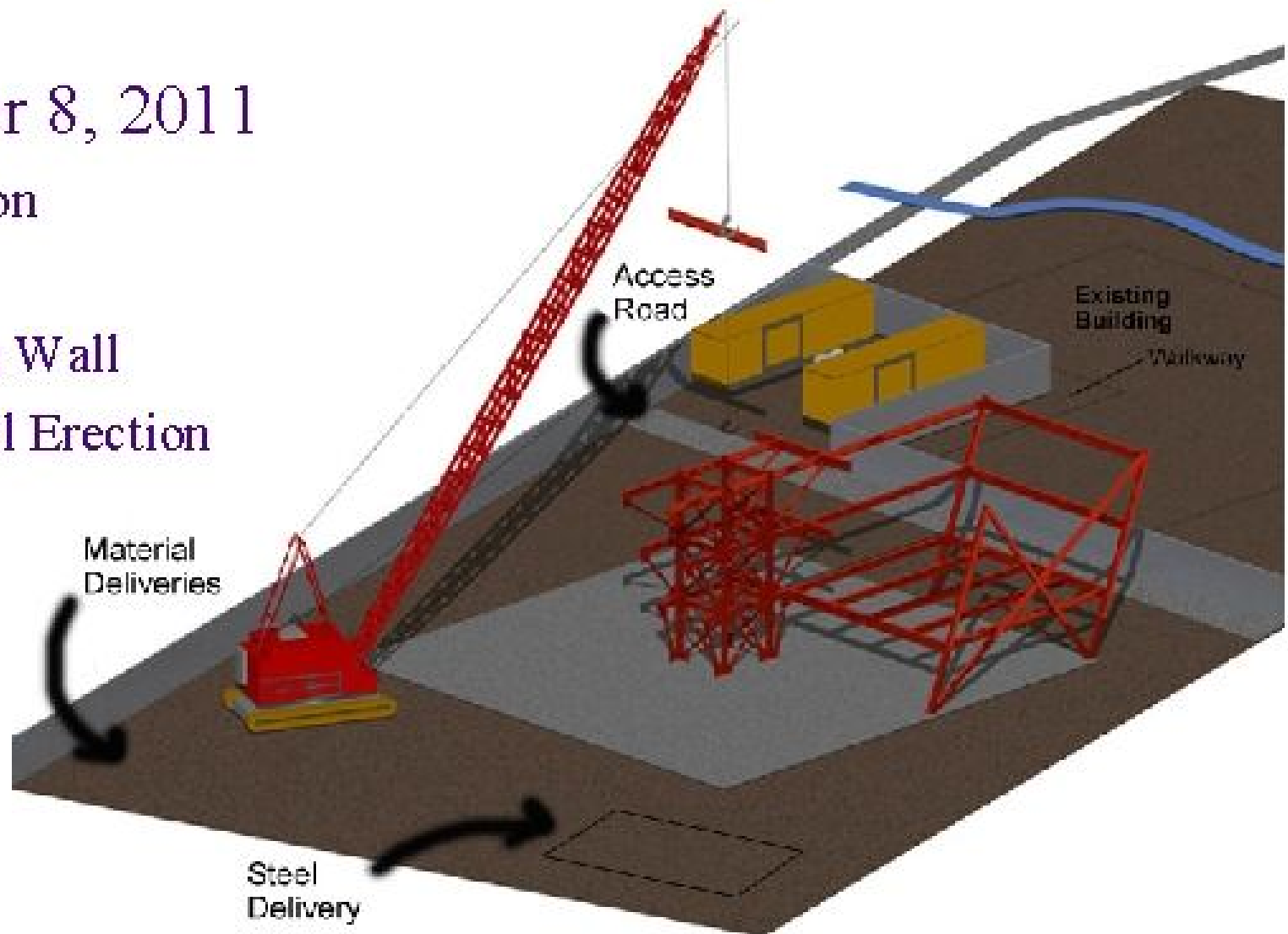
# Construction - Schedule Details



# Construction - 4D Sequence I

December 8, 2011

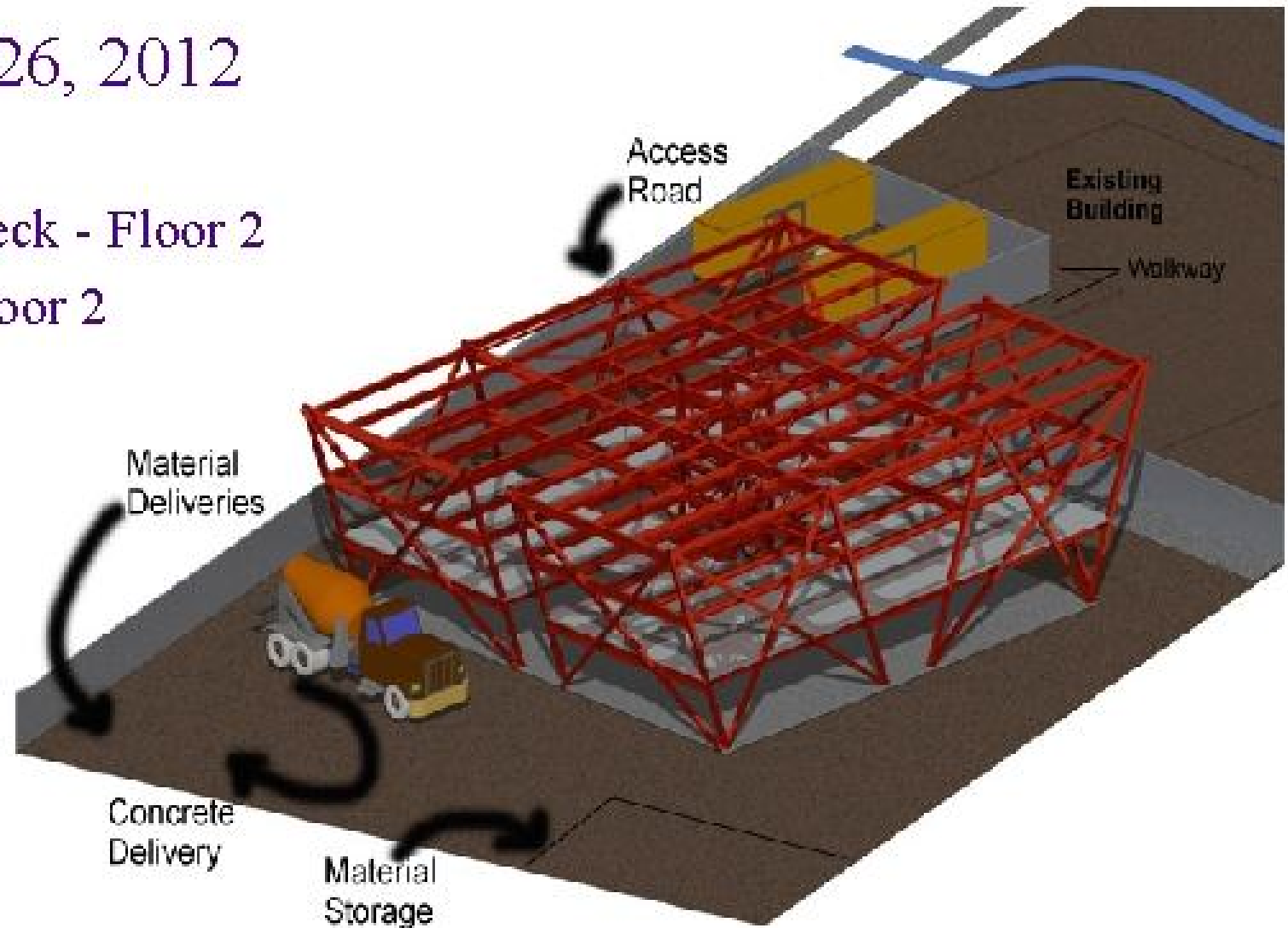
- ◆ Foundation
- ◆ Slab
- ◆ Retaining Wall
- ◆ Start Steel Erection



# Construction - 4D Sequence II

January 26, 2012

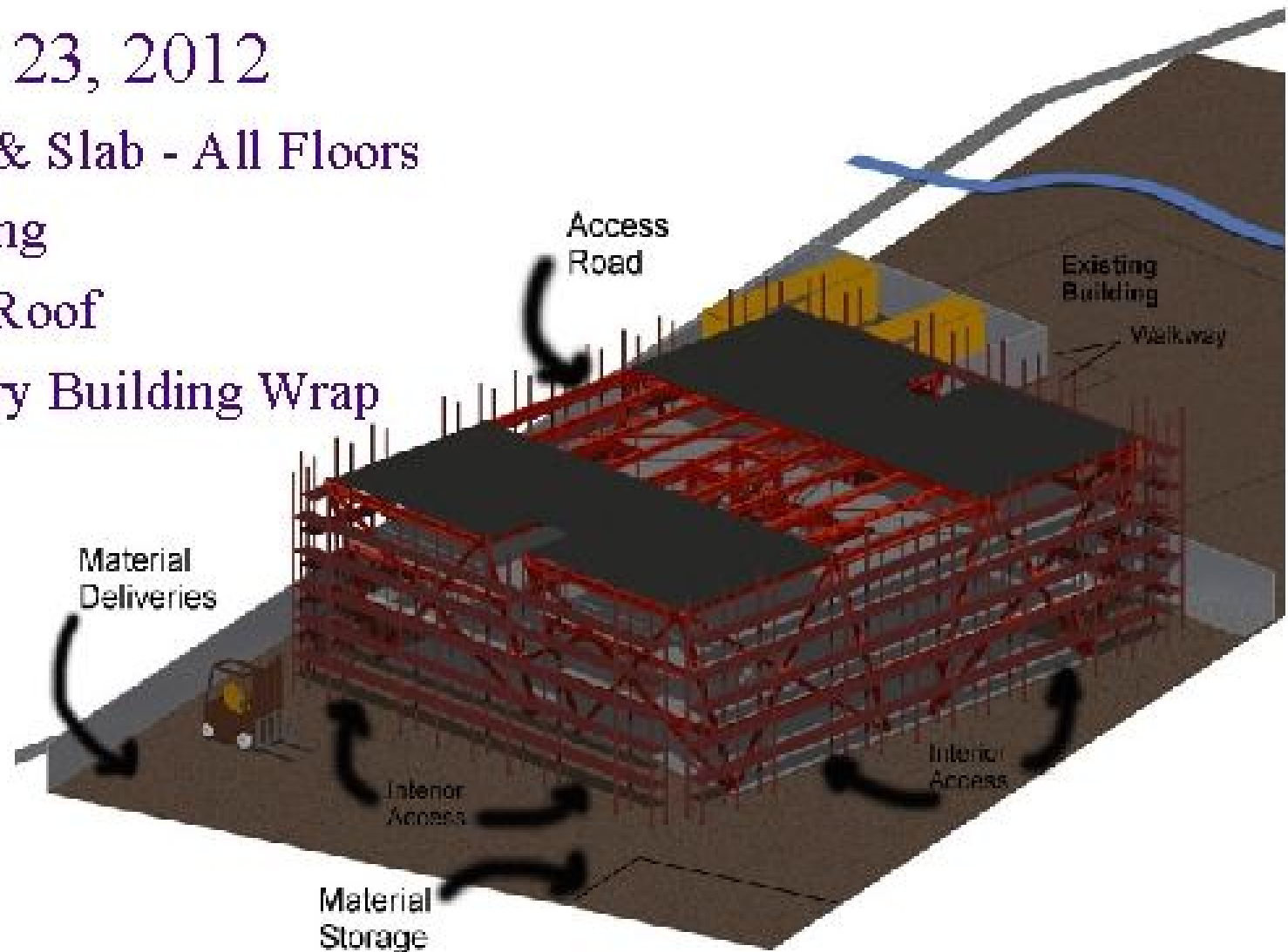
- ◆ Steel
- ◆ Metal Deck - Floor 2
- ◆ Slab - Floor 2



# Construction - 4D Sequence III

February 23, 2012

- ◆ Decking & Slab - All Floors
- ◆ Scaffolding
- ◆ Built-up Roof
- ◆ Temporary Building Wrap



# Technology Page

WWW



VRML



# Collaboration Issues

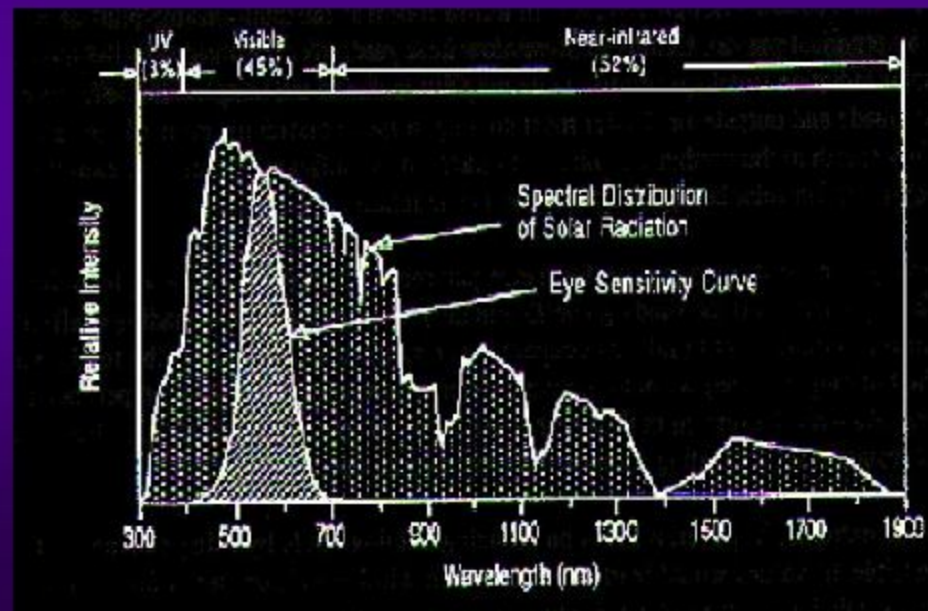
- ◆ Exterior Braced Frame vs. SMRF
- ◆ Column Locations
- ◆ Architectural Elevator Core
- ◆ Slanting Columns
- ◆ Envelope Materials
- ◆ The Waterfall
- ◆ The Roof

## Lighting

- ◆ Goal: Minimize solar heat gain while transmitting adequate daylight to avoid cooling loads
- ◆ Shading devices on office windows
- ◆ Roof & Atrium Glass
  - ◆ Double-Paned vs. Spectrally Selective Glass

## Features of Spectrally Selective Glass

- ◆ Transmits 70%
- ◆ More transparent



## Roof - Life Cycle Cost Analysis

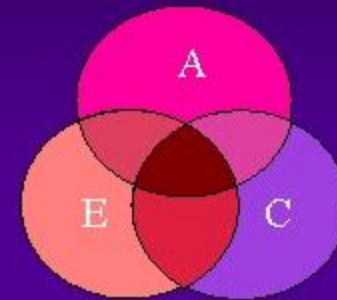
- ◆ Double Paned glass vs. Spectrally Selective Low-E glass
- ◆ Savings per year: approx. \$7,000
- ◆ Simple Pay-Back Period: 3.7 years

## Apprentice Experience

- ◆ Team worked well together which lead to the engineering complementing the architecture
- ◆ Collaboration leads to a better and richer building
- ◆ Entire process brought this building to life

# Lessons Learned

- ◆ Discipline Understanding
  - ◆ what is space
  - ◆ what is budget
  - ◆ what is torsion
- ◆ Art of Negotiation
  - ◆ the sale “it won’t be expensive”
  - ◆ the battle “sparring”
- ◆ “Team” Concept
  - ◆ No “T” in AEC
- ◆ Cyclical Rather than Linear



## Project Summary

- ◆ Real product, real space
- ◆ Collaboration can lead to better products and efficient design

*Thank You  
to  
The Mentors*