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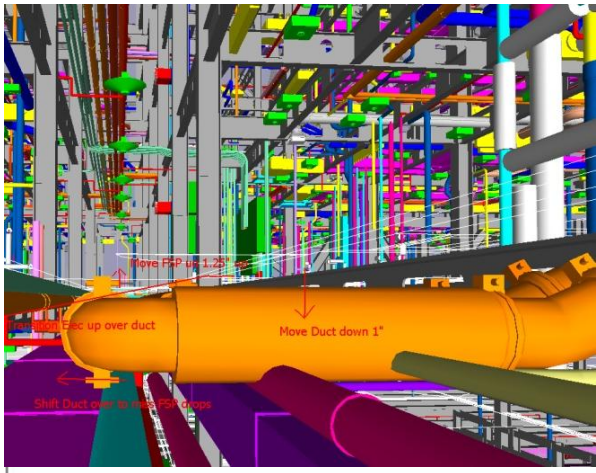
# Design Management – A Lean Approach


Faster Forward – Technology in Architectural Practice November 17, 2011

# Bruce Cousins, AIA

- 30 + yrs. Architect & Technology Consultant, M Arch.UC Berkeley
- 2.5 Years Sr. Mgr. Virtual Design and Construction, Top 300 General Contractor
- $0.75B in Virtual Design and Construction (VDC)
- 41 construction professionals managing projects using virtual building models
- Used VDC at all operational levels as extension of employee skill set



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# Learning Objectives

1. 3D Building Information Modeling technology is changing the way Architects design and deliver a project.
2. Combining the “Lean” Process with BIM technology works to facilitate a collaborative design process.
3. New Roles and Responsibilities are evolving for Architects to lead and or collaborate with all project stakeholders throughout design and construction process.
4. The fundamental building blocks of the Lean Process that can be applied to managing the design process?

   Design Management, Target Value Design, Set Based Design, Rapid Prototyping, Co-Location, Shared risk & reward.
5. Path Forward for Lean, BIM and IPD projects?

Resetting the Operating System

# INTRODUCTION

# What is Not Working?

CALATRAVA'S EXIT

## Denver officials grapple with DIA designs after Santiago Calatrava's exit

By Eric Gorski
*The Denver Post*

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POSTED: 09/25/2011 01:00:00 AM MDT
UPDATED: 09/25/2011 09:21:36 AM MDT

Spanish architect Santiago Calatrava is shown with a model of the rail bridge he designed to span Peña Boulevard in July 2010. The bridge was eliminated from plans after the cost of the Denver International Airport South Terminal project was reduced by $150 million to $500 million. (THE DENVER POST | RJ SANGOSTI)

Calatrava has prepared a reduced design for South Terminal to save money, Day said. "He said 'Don't tell me what to cut. Tell me your budget.'"

The result is a new design for the hotel-train-station-plaza complex that is 25 percent reduced in area, and 30 percent reduced in volume, from the original design, she said.

Financial Constraints, unnecessary time delays, deep divisions between the design team and the Program Managers.
Robertina Calatrava - Letter

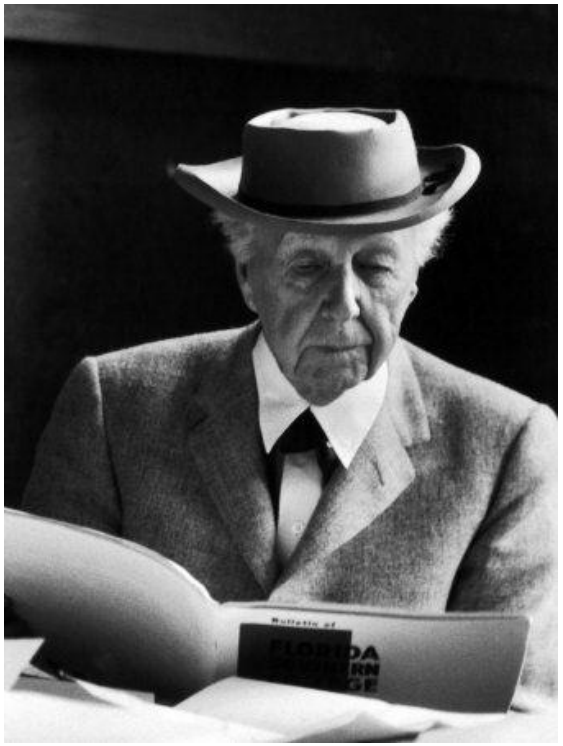
# What is Not Working?

- ✓ Unrealistic design & production schedules
- ✓ Incomplete documents push decisions downstream
- ✓ Lack of management discipline overwhelms even the most dedicated project team
- ✓ Lack of Accountability within the Team
- ✓ Quality suffers, employees work long hours to meet impossible deadlines
- ✓ Silos of work do not allow transparency & teamwork
- ✓ Lack of Coordinated Documents
- ✓ Frequent Rework to meet project goals

# Master Builder Era

HH Richardson

Le Corbusier



FLW

# The Virtual Building Era


Morphosis

Gehry Technologies

Ghafari Associates

# The Virtual Building Era

VDC-BIM Technology encourages & enhances collaborative design relationships… signaling the end of an era of America's construction industry that has been risk averse, conservative and confrontational…

**NO ONE KNOWS AS MUCH AS EVERYONE**

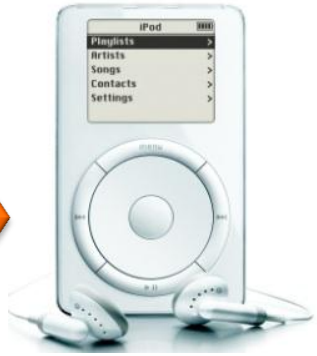
# Tradition Yields to Collaboration…

- ✓ Team agrees change is desired to the conventional design process
- ✓ Team members promise each other that they will work cooperatively to provide the most value to the Client
- ✓ They will commit to redesign the design process
- ✓ Share risk & reward – put profits at risk
- ✓ The Project Team become its own "company"
- ✓ Create a learning environment
- ✓ Everyone feels Vulnerable

# Response to Traditional OS Breakdowns



ITUNES NEW OPERATING SYSTEM




IPD – Integrated Project Delivery

Partnering

New OS

Design/Build

# Virtual Design & Construction
# the Dashboard for LEAN Processes

The “New” Operating System

# MANAGING DESIGN IN A COLLABORATIVE PROJECT ENVIRONMENT

# Beginning the Lean Journey…

By Nadine M. Post

Sutter Health Unlocks the Door to

# A New Process

Team contract, with shared risk and reward, fosters "all-for-one, one-for-all" spirit

In Sutter's brave new world of lean construction, the traditional "command and control" mentality of project management is gone. Gone are most lump sum, low-bid contracts. Gone are guaranteed maximum prices. Gone are inflated bids to cover risk. Gone are the adversaries. Gone are most requests for information. And, so far, gone are costly claims." — Nadine Post, Engineering News

# Meet or Exceed the Clients Expectations?

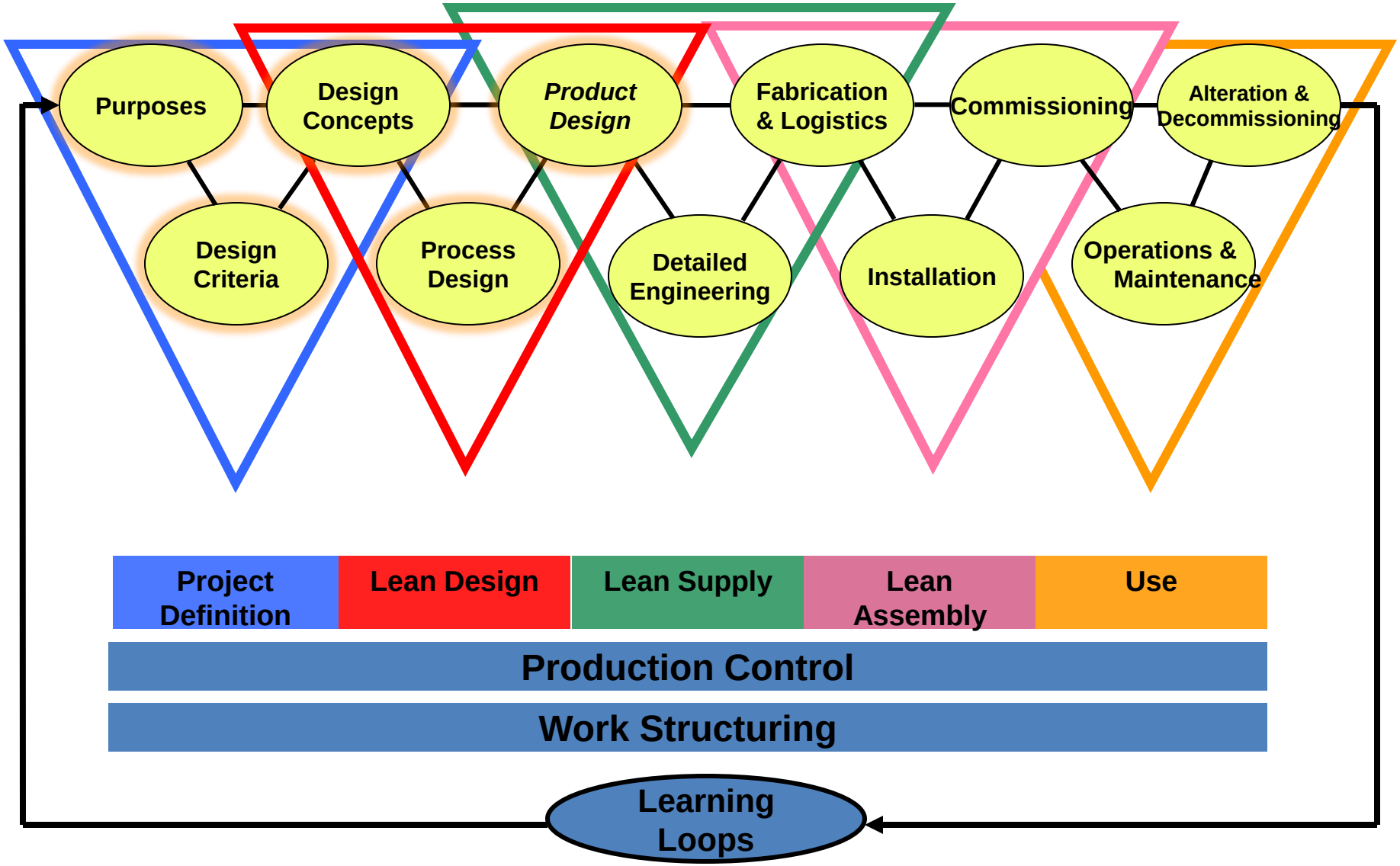
- Ideas - Fresh Thinking
- Iconic Imageable Forms
- Predictable Outcomes
- Meet the Project End Users Needs

Value is what a Client wants.

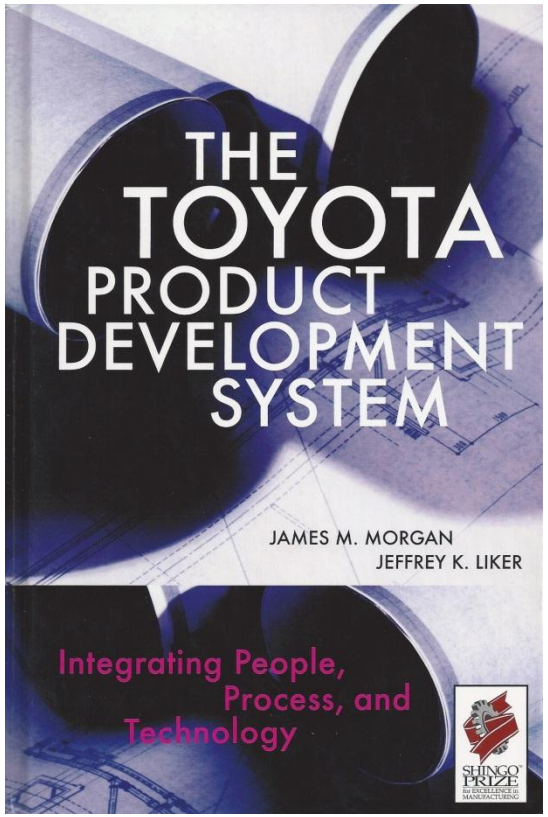
# Design is Messy & Not Sequential

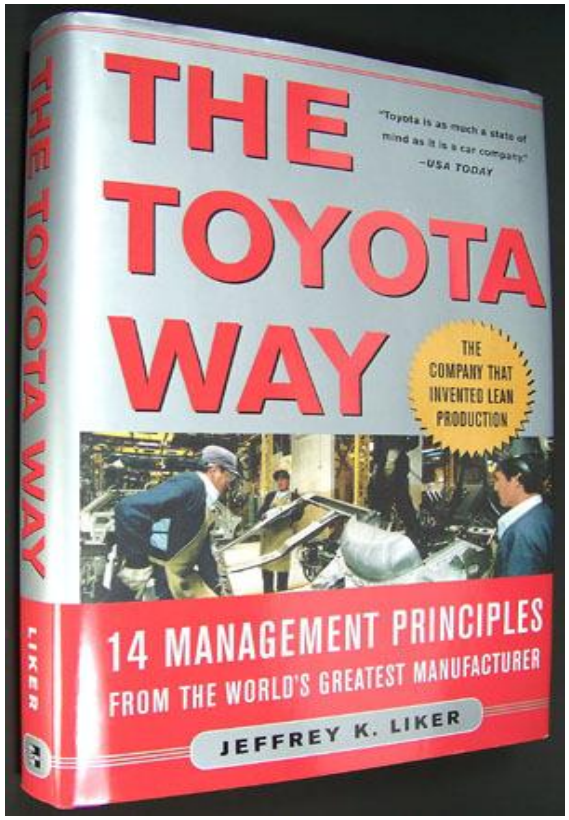
VS

A new design management paradigm must acknowledge this fundamental essence of design thinking. A Lean management approach acknowledges the essence design thinking the fuzzy, iterative, non sequential …


Purposes
Design Concepts
Product Design
Fabrication & Logistics
Commissioning
Alteration & Decommissioning
Design Criteria
Process Design
Detailed Engineering
Installation
Operations & Maintenance
Project Definition
Lean Design
Lean Supply
Lean Assembly
Use
Production Control
Work Structuring
Learning Loops

# Lean Management
# The OS for Successful Project Delivery




"Anything that does not add value is waste."

# Waste…In Planning & Design

- Lack of Accurate Owner Program
- Early Starts without complete info
- Discovery of the unknown – Lack of Sequence
- Waiting – Owner and other Review
- Predetermined design solutions that need rework to fit
- Lack of Direct Access to Supply Chain – Means & Methods

Source: The Toyota Product Development System

# Waste…In Construction

- Overproduction
- Waiting
- Unnecessary transport or conveyance
- Over processing or incorrect processing
- Excess inventory
- Unnecessary movement
- Defects
- Unused employee creativity

Source: The Toyota Way

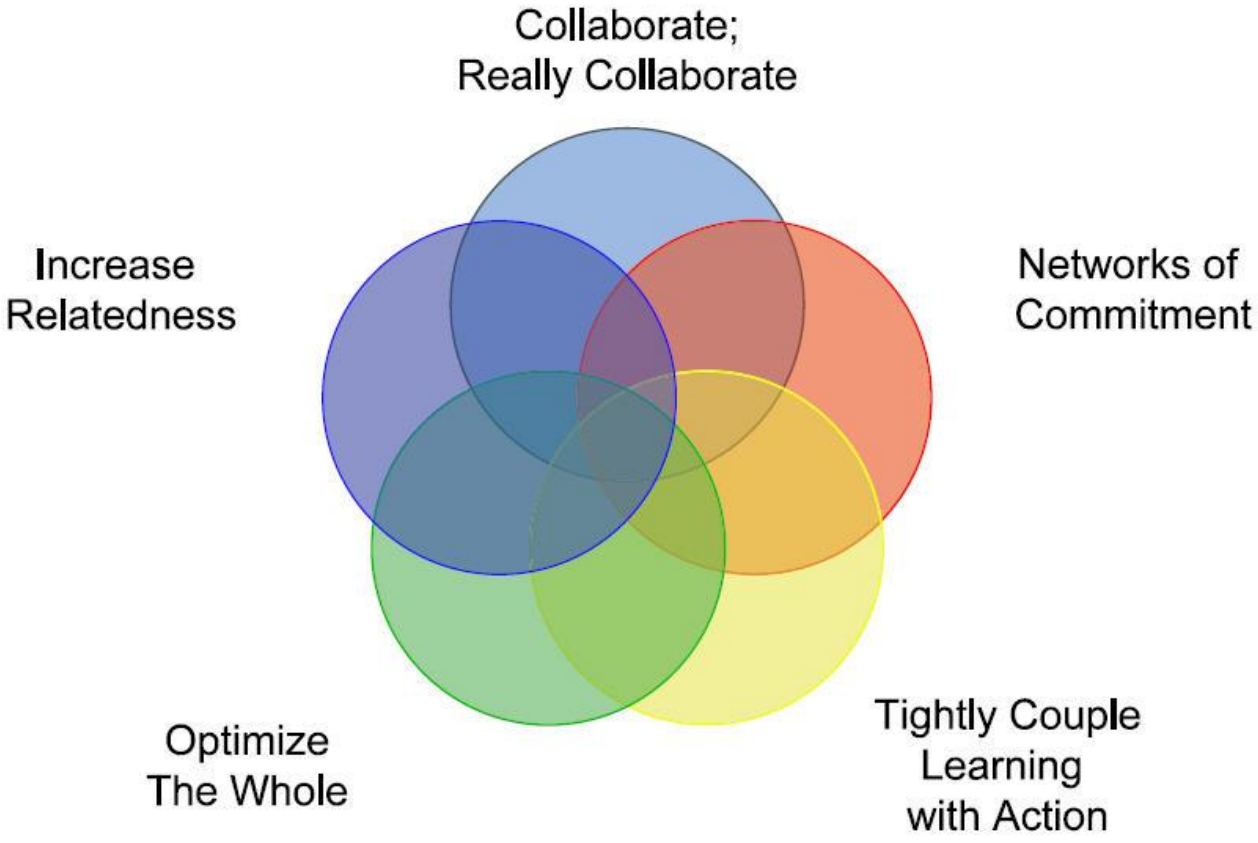
# BIM Technology's Contribution to Design Management

- *A 3D Picture is worth a Thousand Words or 2D Drawings*
- *Transforms ego-based conflict into fact-based conversations*
- *Increases the Speed of the Design Process Work Flow with less risk of missing key design issues*
- *Enables effective low cost Rapid Prototyping & Simulation of building performance*

Levit, Raymond & John Kunz, ***Design Your Project Organization as Engineers Design Bridges*** – **CIFE** Working Paper #73

# Integrated VDC-BIM & Lean

## FIVE BIG IDEAS OF LEAN PROJECT DELIVERY



Key Concepts

# COLLABORATIVE WORKFLOW & DESIGN MANAGEMENT

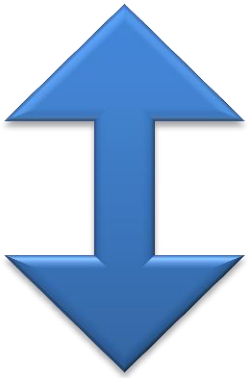
# Design Management

## CURRENT STATE

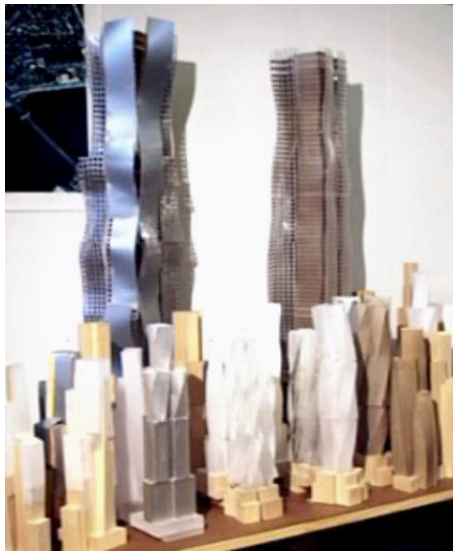
- Conventional Views – Design cannot be measured & understood
- Scope Budgets are a moving target
- Lack of design process transparency is expected
- Rework and back tracking are inevitable
- Direct participation in supply chain will be done later
- Undisciplined & non existent design management
- 3D Models used primarily for presentations
- Lack of Timely Owner Decisions

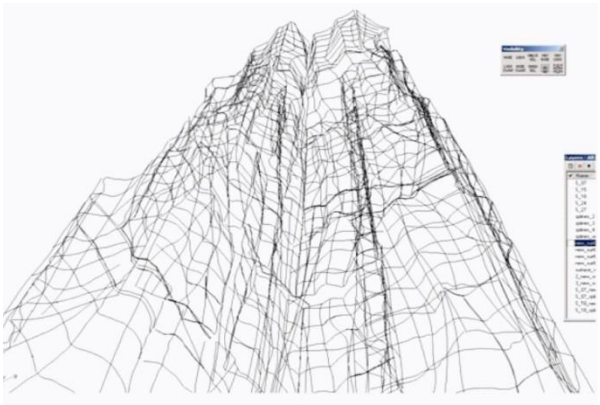
# Continuum of Design Management

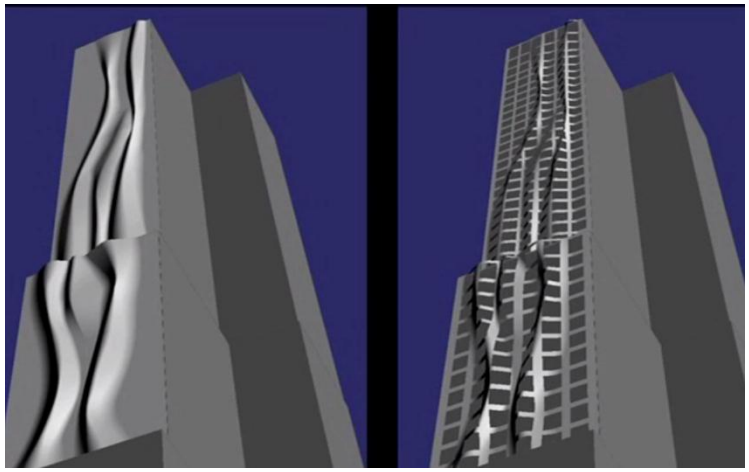
Design projects are unique & therefore cannot be planned or managed



Design is understandable and measurable…therefore can be managed







Translations from Model to Building

Michael Kilkelly, Gehry Partners KA Connect podcast 5/30/11

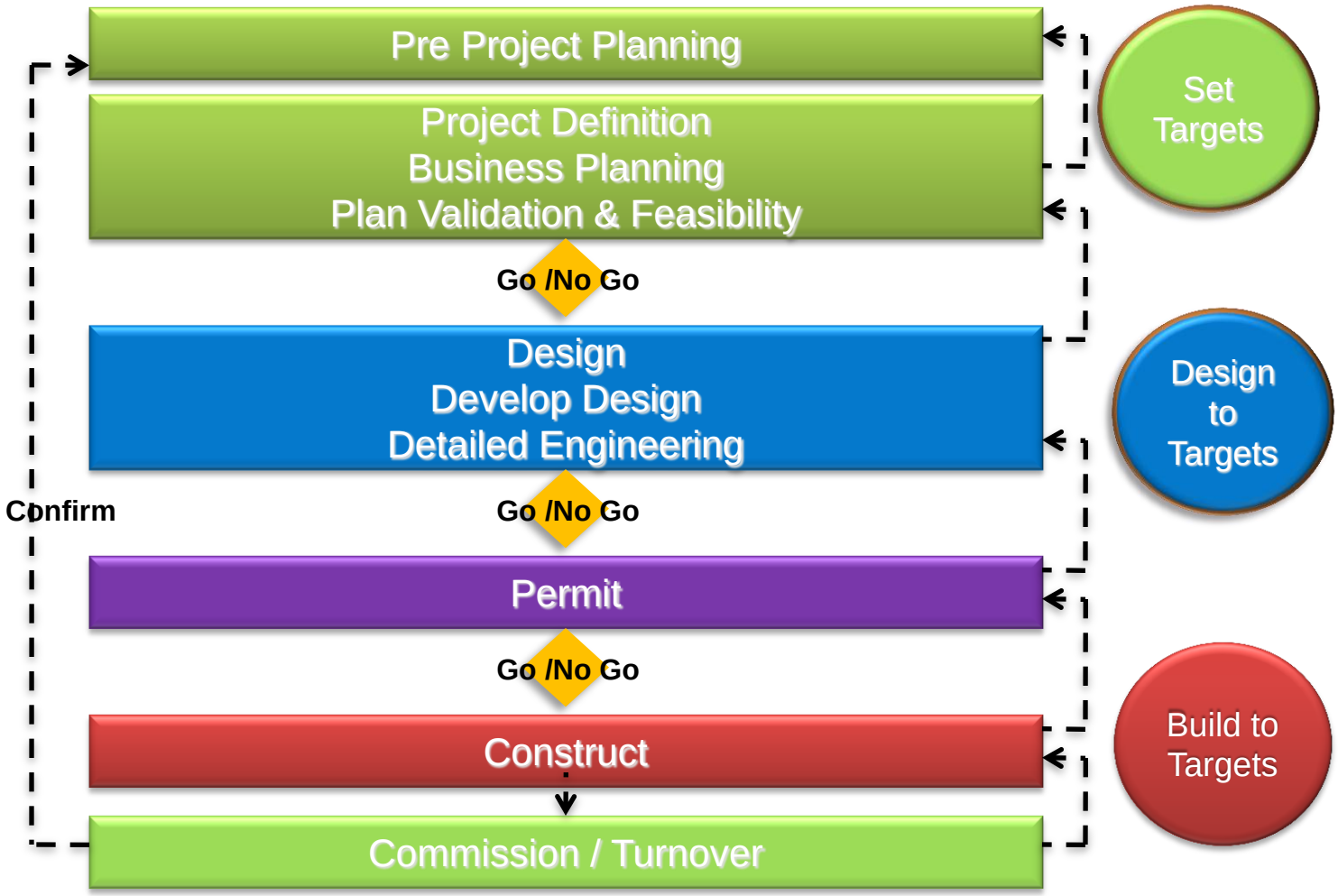
“Anything that does not add value is waste”

# KEY CONCEPTS OF LEAN PROCESS IN DESIGN MANAGEMENT

# The Objectives of a Collaborative OS

- ✓ Work together to define the issues and produce decisions then design to those decisions vs. Design alone and then come together for group reviews and decisions
- ✓ Work in pairs or a larger group, face to face vs. Work separately
- ✓ Design based on a detailed estimate vs. Estimate based on a detailed design.
- ✓ Carry design sets far into the design process vs. Narrow choices to proceed with one design
- ✓ Design for what is constructible vs. Evaluate the constructability of a design after it is designed

# Lean Project Work Flow




"Target Costing" Lean Construction Institute

# Establish “Client First” Spirit

Hold kickoff & alignment workshops

The Owner, Architect, Builder work as a team to solve the Client’s Problem

Define Perceived Risks and Constraints

Launch meeting schedule

Establish the BIG room and Co-located teams

# WORK TOGETHER FACE TO FACE

*“Design is principally a social activity.”*

*--Gregory Howell – Lean Construction Institute*

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# Eat Together & Give Prizes




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# Align Interests & Establish Trust

Expected Outcomes:

1. Agreement by the companies and individuals present concerning their collective appetite for delivering the project under an integrated agreement and using Lean project delivery principles.

2. Agreement on the path forward for developing the team's capabilities to deliver the project on a Lean, integrated basis and for negotiating an operating agreement to govern the team.

***Set Goals & Objectives***

***Team Building***

DISCOVERY WORKSHOP – WELLINGTON MUNICIPAL CENTER, SKY TRAIN PHOENIX

# Last Planner

- People doing the work are best qualified to schedule their Work
- Design and construction projects are a network of commitments.
- Teams must collaborate and make reliable promises to complete the project

# Make Team Communication Visual





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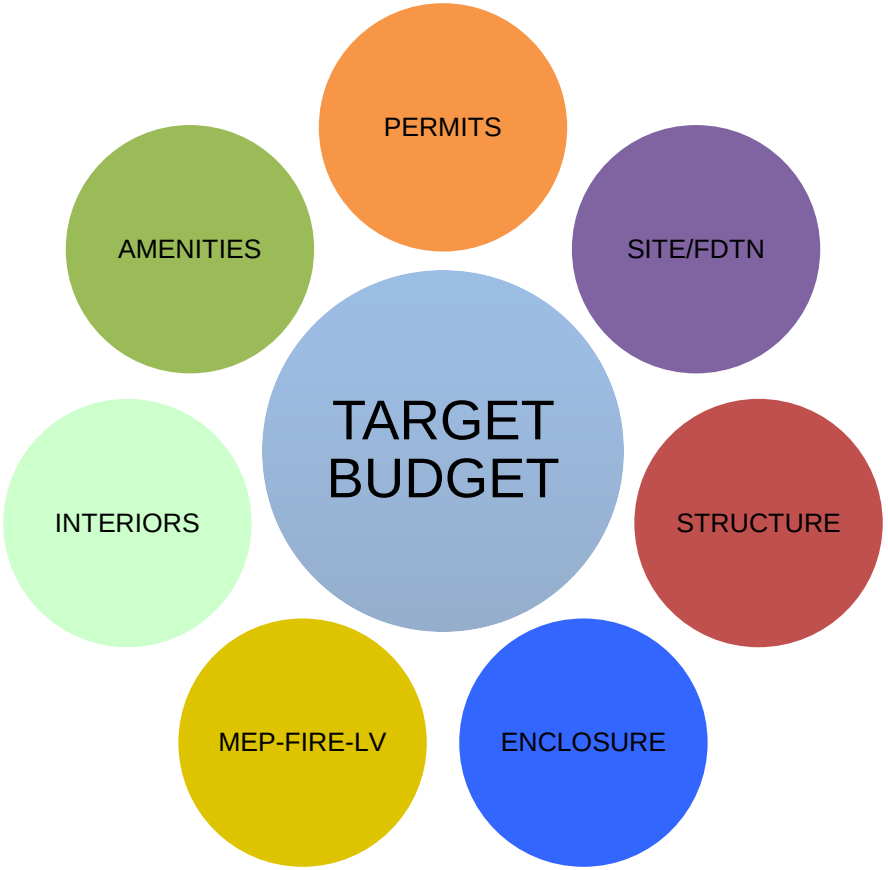
# Target Value Design - TVD


1. Set Target Cost – Typically lower than the budget that assumed current best practice
2. Form Target Value Design Teams by system and allocate the target cost to each team
3. Provide cost and performance standards for the Core Building Elements

# Target Value Design - TVD



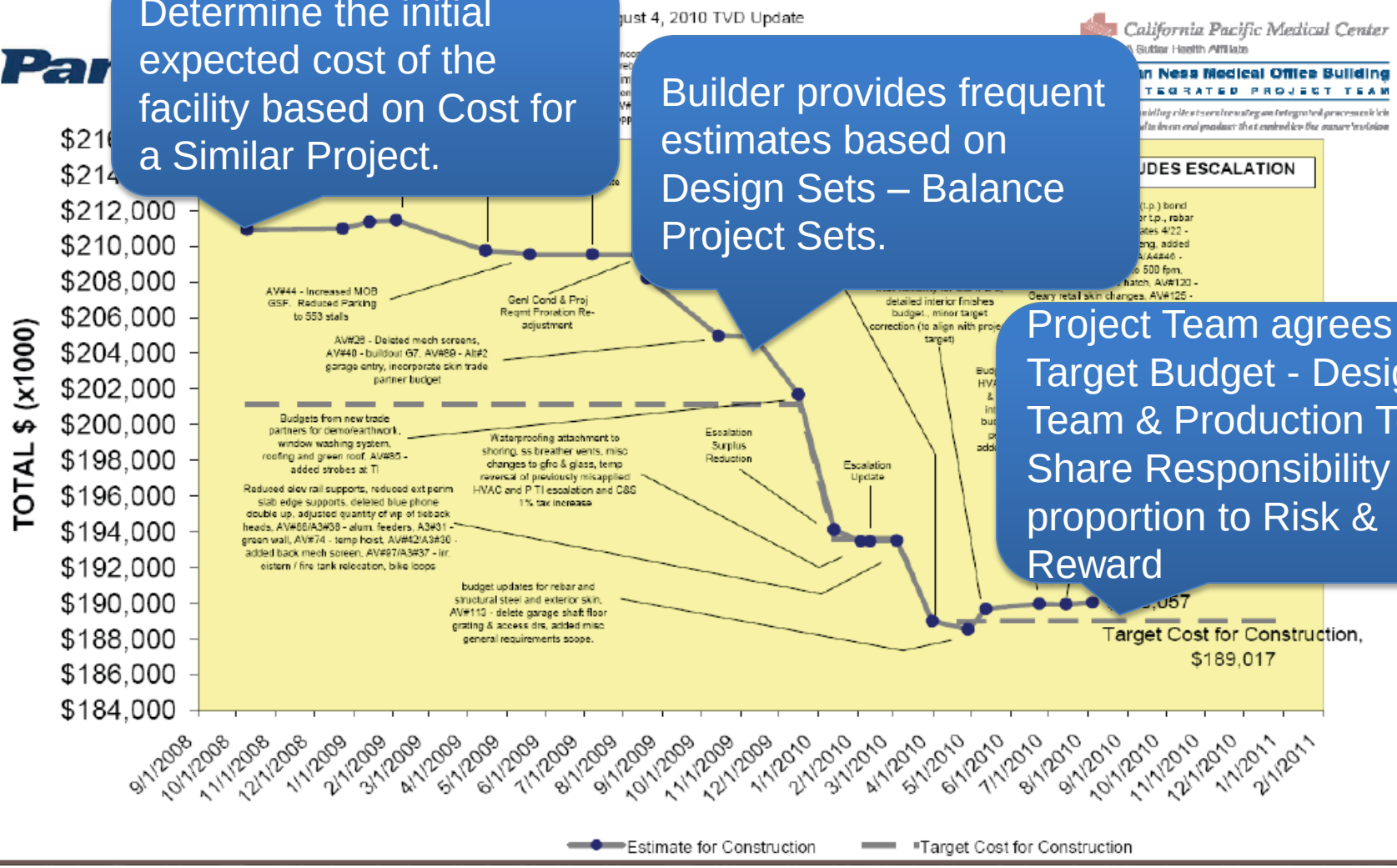

① Entitlements & Permit
② Site / Civil / Foundations
③ Structure
④ Enclosure
⑤ MEP Fire Low Voltage
⑥ Interiors
⑦ Amenities

# DESIGN BASED ON A DETAILED ESTIMATE

Determine the initial expected cost of the facility based on Cost for a Similar Project.

Builder provides frequent estimates based on Design Sets – Balance Project Sets.

Project Team agrees on Target Budget - Design Team & Production Team Share Responsibility in proportion to Risk & Reward



# “Real Time” Budget Reviews

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# SET BASED DESIGN

Use a “Set” based Design approach, evaluating Design ALTERNATIVES against target values

1. Embrace & Engage the Supply Chain
2. Design Build 3D prototypes of Concepts
3. Evaluate Sets including Target Budgets
4. Production Team must use & Understand BIM
5. Use A3 Documentation to generate Sets
6. Frequent Review of Sets with key production team members

# CARRY DESIGN SETS AS FAR AS POSSIBLE

## Set Based Design

Stanford Green Dorm

### Building System Matrix

| | | $CO^2$ Impact | | | Life Cycle Costs | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Embodied Energy | Mass | Insulation | First Costs | Construction Speed | EQ Losses | Maintenance / Durability | Research Value | Thermal Comfort | Deconstructability | Flexibility | Total (Weighted) | Life Cycle Costs | $CO^2$ Impact |
| **Dorms / Common Lab Space** | **weight (1-5)** | 3 | 1 | 1 | 5 | 1 | 3 | 2 | 4 | 2 | 1 | 1 | | | |
| 1. Wood Bearing Wall [1,2,3,4] | | 5 | 2 | 3 | 5 | 3 | 1 | 3 | 1 | 3 | 3 | 2 | 69 | 34 | 20 |
| 2. Steel Frame / Mtl Deck/Concrete Topping [7,8,9] | | 2 | 4 | 3 | 3 | 5 | 4 | 5 | 4 | 4 | 4 | 5 | 83 | 37 | 13 |
| 3. Wood Post and Beam [1,3,4,9] | | 5 | 2 | 3 | 3 | 3 | 2 | 3 | 1 | 3 | 4 | 4 | 65 | 27 | 20 |
| 4. Metal Stud Bearing Wall [3,4,10] | | 2 | 2 | 3 | 4 | 3 | 2 | 5 | 1 | 3 | 1 | 2 | 58 | 34 | 11 |
| 5. Concrete Slab and Walls [3,4,10] | | 1 | 5 | 3 | 1 | 2 | 4 | 5 | 4 | 5 | 1 | 4 | 66 | 24 | 11 |
| 6. CMU Bearing Wall/Wood Floor [1,2,3,10,11] | | 3 | 4 | 3 | 3 | 1 | 2 | 4 | 2 | 2 | 2 | 2 | 58 | 26 | 16 |
| 7. Straw-Bale / Wood Frame [1,2,3,4,13] | | 4 | 4 | 5 | 3 | 3 | 1 | 3 | 2 | 5 | 3 | 1 | 67 | 24 | 21 |

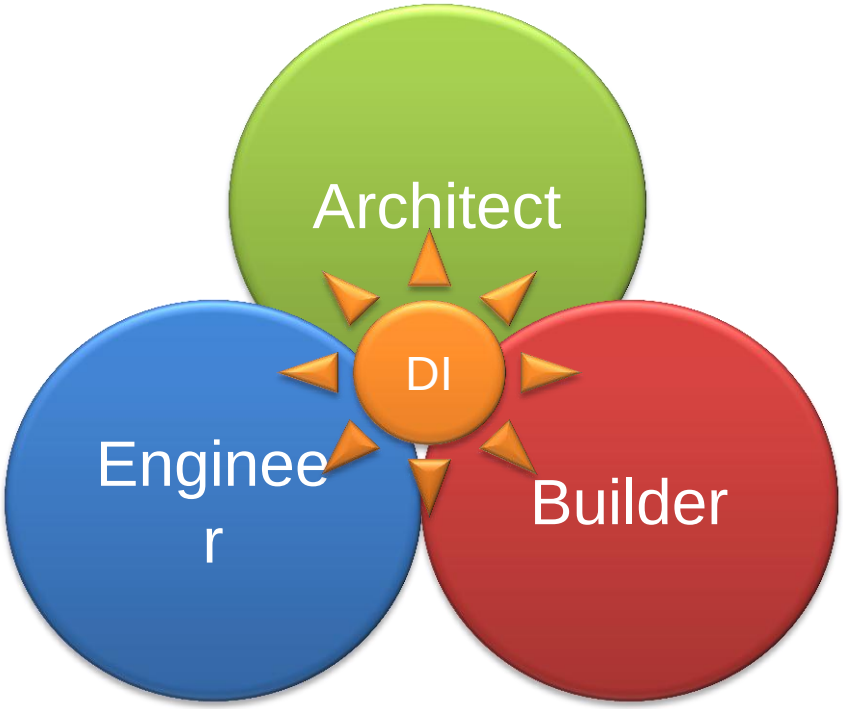
Notes

1. FSC Certified Wood
2. Resource Efficient Framing
3. Plywood Shearwalls
4. 1.5" Concrete or Gypcrete Topping
5. Steel Under Discontinuous Walls
6. Low Cement Concrete (70% Slog, 30% Cement)
7. Rocking & Restoring Systems w. Replaceable Fuses (FT Cable, Steel Fuses, ECC Fuses)
8. Moment Frames w. Dampers
9. Structural Insulated Panel (SIP) Skins
10. Plywood Floor Diaphragm
11. Rigid Insulation (3") on Exterior Walls
12. Rocking and Restoring Systems w. PT Cable Reinforcement
13. Lime Plaster Skins

**Architect: EHDD**
**Contractor: Pankow**
**Mechanical Engineer: Taylor**

TIPPING | MAR

# Who “Drives” Design Management?




## Design Integrator

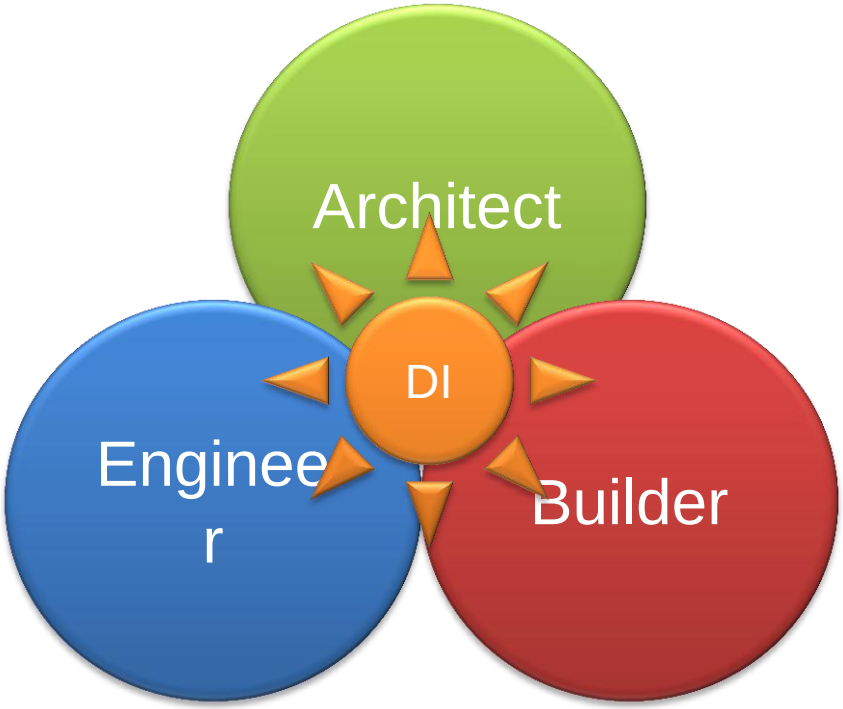
Design Integrator is a person whose primary task is to focus on facilitating the Design Management work flow based both on social coordination and technical integration.

# Characteristics of a Good Design Manager

- Empathy with and enthusiasm for the project goals and objectives
- Have a natural ability to direct creative professionals (both designers and builders) toward the project's objectives.
- Ability to make difficult choices – often at odds with some stakeholders
- Integrity, ethics, and a reputation for fair dealing
- Disciplined in maintaining project flow
- Level temperament and patience in working with others
- Willingness to give credit to co-workers when due
- Familiarity with project delivery methods
- Training and broad understanding in both design and construction
- Ability to gain & maintain respect of the Project Team


http://www.dbiabooks.com/shopexd.asp?id=8395

# Design Manger or Design Integrator




“Responsibility without Authority”

# Leveraging Lean Project Planning in Design Management

- *Define Design Work Flow* – Identify Risks
- *Manage the Design* – Use TVD to find the right solutions quickly – from months to days
- *Structure the Work* - Not the same old way
- *Manage the Supply Chain* – establish new strategic vendor relationships
- *Simulate Construction* – 3D,4D & 5D technology schedule, materials & methods
  - *Rapid Prototyping – What If's?*
  - *Really Collaborate* – Redefine Risk Reward

Lean Design Management

# THE PATH FORWARD

# Design Management

## FUTURE STATE

- Design Team Understands that Design is manageable
- Rework and back tracking are inevitable – Built into Design Schedule and Process
- A collaborative environment is established & supports an integrated and transparent decision-making process
- Shared obligations, risks and rewards are agreed upon
- A "Learning Environment" for best practices is in place
- VDC-BIM is used to plan by simulations and rapid prototyping
- Project is designed to budget (TVD & cluster estimates)
- Easily understood metrics Planned Percent Complete (PPC) used to track Design teams progress and Project Budget
- Project teams practice continuous improvement with process change and technological innovation

# LEAN Design ……..

## “Shared Obligations, Risks and Rewards”

- ✓ Mutual Respect & Trust
- ✓ Intensive Planning Early
- ✓ Shared Compensation
- ✓ Shared Risk & Reward
- ✓ Early Participation
- ✓ Co Located Design
- ✓ Not Design/Build!!

# Adopting Innovative ways of Project Mgt …

- Create a Learning Environment
- Devote Time and Resources
- Carefully Plan, Manage & Measure
- Invest in Training
- Use Social Media to Communicate
- Allow for Failure – “Failure is not the end of a conversation but the beginning of another one.”

# PLAN YOUR LEAN JOURNEY – START SMALL

Focus: Lean Transformation

**Performance, gaps, and targets**

| Goal | Possible metrics |
|---|---|
| Become a learning organization | # of adopted improvements |
| Do projects in a lean way | # of projects on LPS<br>PPC - by business unit, region, project |

**Reflection on last 12 month's activities**

| Activity | Rating | Key results / Issues |
|---|---|---|
| Implement LPS on Beattitudes | | |
| Implement LPS on Sagewood | | |
| SAT with leadership group | | |
| | | |

**Rationale for next 12 month's activities**

Start Portico Place project

**Signatures**

**This year's action plan (milestone chart)**

| Goals | Activities | 5/1 | 5/8 | 5/15 | 5/22 | 5/29 | 6/5 | 6/12 | 6/19 | 6/26 | 7/3 | 7/10 | 7/17 | 7/24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Become a learning organization | | | | | | | | | | | | | | |
| | Project #1 | x | x | x | x | x | x | x | | | | | | |
| | Project #2 | x | x | x | x | x | x | x | | | | | | |
| Do projects in a lean way | | | | | | | | | | | | | | |
| | Project #3 | | | | | | | | x | x | x | x | | |
| | Project #4 | | | | | | | | | | x | x | x | x |
| | Project #5 | | | | | | | | | | x | x | x | x |
| | Project #6 | | | | | | | | | | | | x | x |

**Followup / Unresolved Issues**

Author:
Version and Date:



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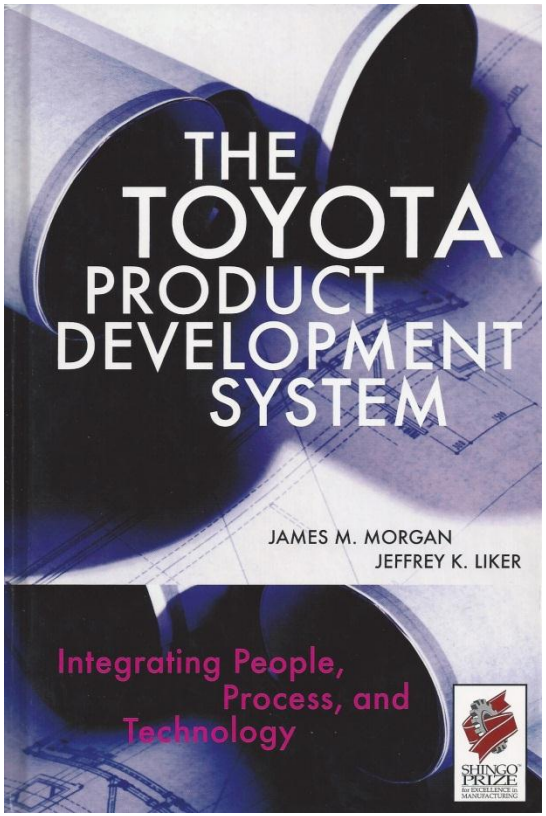
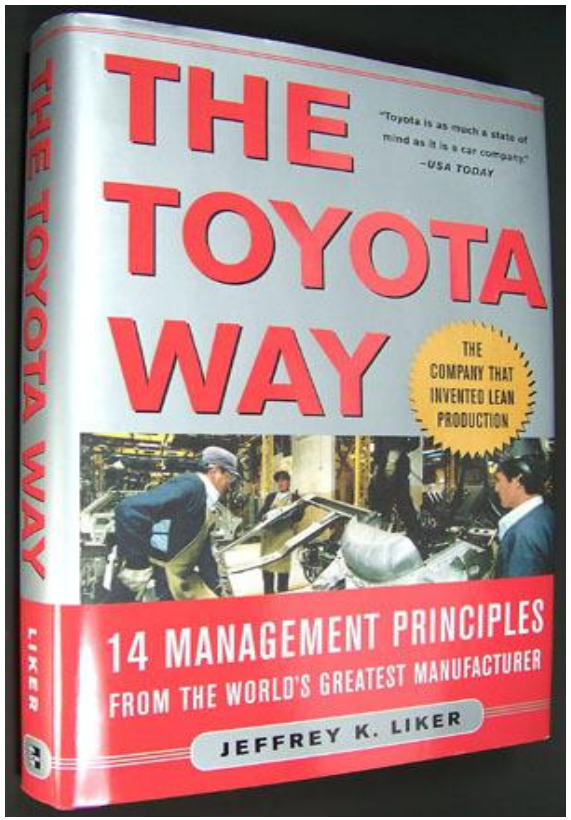
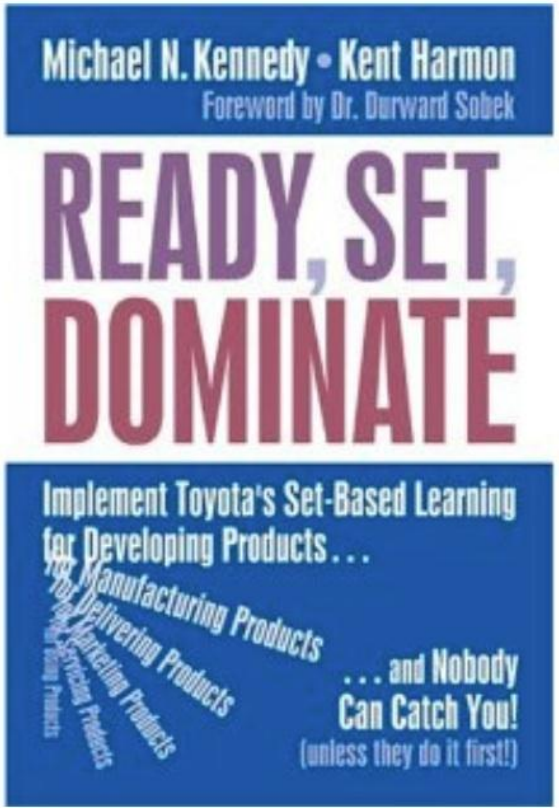
# Lean Resources & References



# VDC-BIM Resources & References

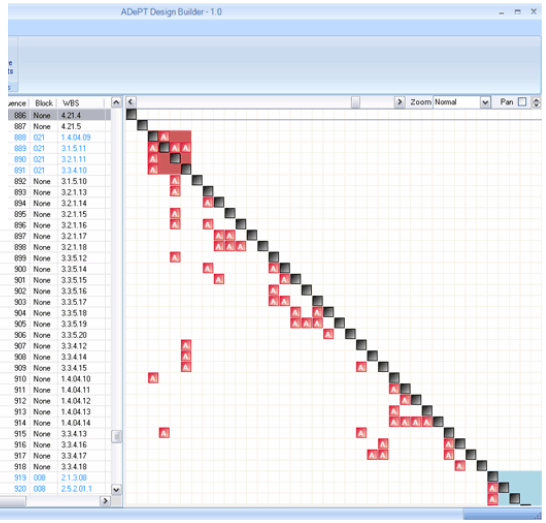

2011 BIM Guidelines, Templates & Contracts

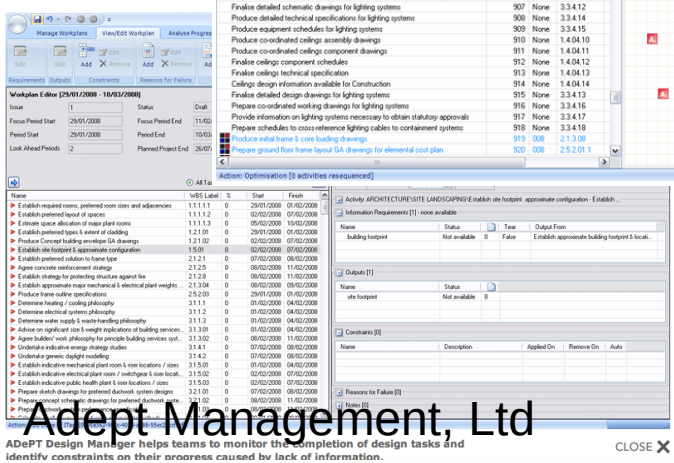
# Design Mgt. Resources & References

The ADePT Design software suite lets you plan and control complex, iterative, and information driven project processes.

ADePT design software suite


Figure 1: Adept Management's Design Management Framework™




Adept Management, Ltd

Lean Construction Institute
Building Knowledge in Design and Construction

www.leanconstruction.org
Lean Design Forum


http://www.dbiabooks.com/shopexd.asp?id=8395

KA Connect 2011 Podcast
Romano Nickerson,
Boulder Associates
"Learning How to be Lean"



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# Thoughts to change by

“Don’t let great be the enemy of good.”

“Keep everything simple, make it visible, trust your people to do the the right thing.”

To accomplish great things we must not only act, but also dream; not only plan, but also believe.

# “Design Management – A Lean Approach”

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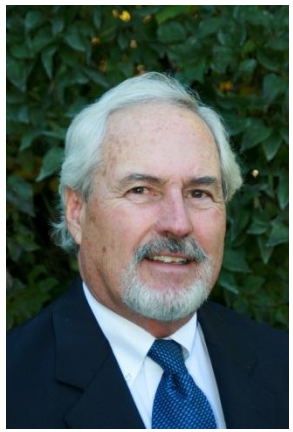


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## Aggressive Performance Goals Met through

# Integrated Project Delivery

GSA

ZGF
ZIMMER GUNSUL FRASCA ARCHITECTS LLP

Sellen

Good design
makes a difference™

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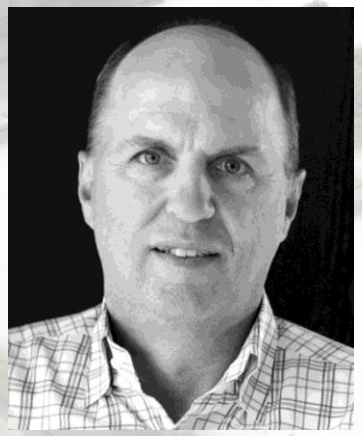
TAP FASTER FORWARD 2011



## Jack Avery

**Integrated Project Delivery/Design Project Manager**

Sellen

## Todd Stine

**Design Project Manager**

ZGF
ZIMMER GUNSUL FRASCA ARCHITECTS LLP

## Chris Chatto

**High Performance Green Building Consultant**

ZGF
ZIMMER GUNSUL FRASCA ARCHITECTS LLP

# Learning Objectives

Understand the heightened level of **team integration** and new models of knowledge sharing, **through the accelerated design-build competition and project delivery process**.

Identify best practices for achieving aggressive **building performance, cost** and **project delivery objectives**.

Discover how an integrated building weaves **interdependent systems** to achieve a net result greater than the sum of individual systems.

Learn to apply a rigorous technical, analytic and research-based approach to design and decision making to **arrive at best value solutions**.

# Project Overview

*Theme: Architect, contractor, owner all have design aspirations that exceed performance incentive*

Recovery Act Design Build Process

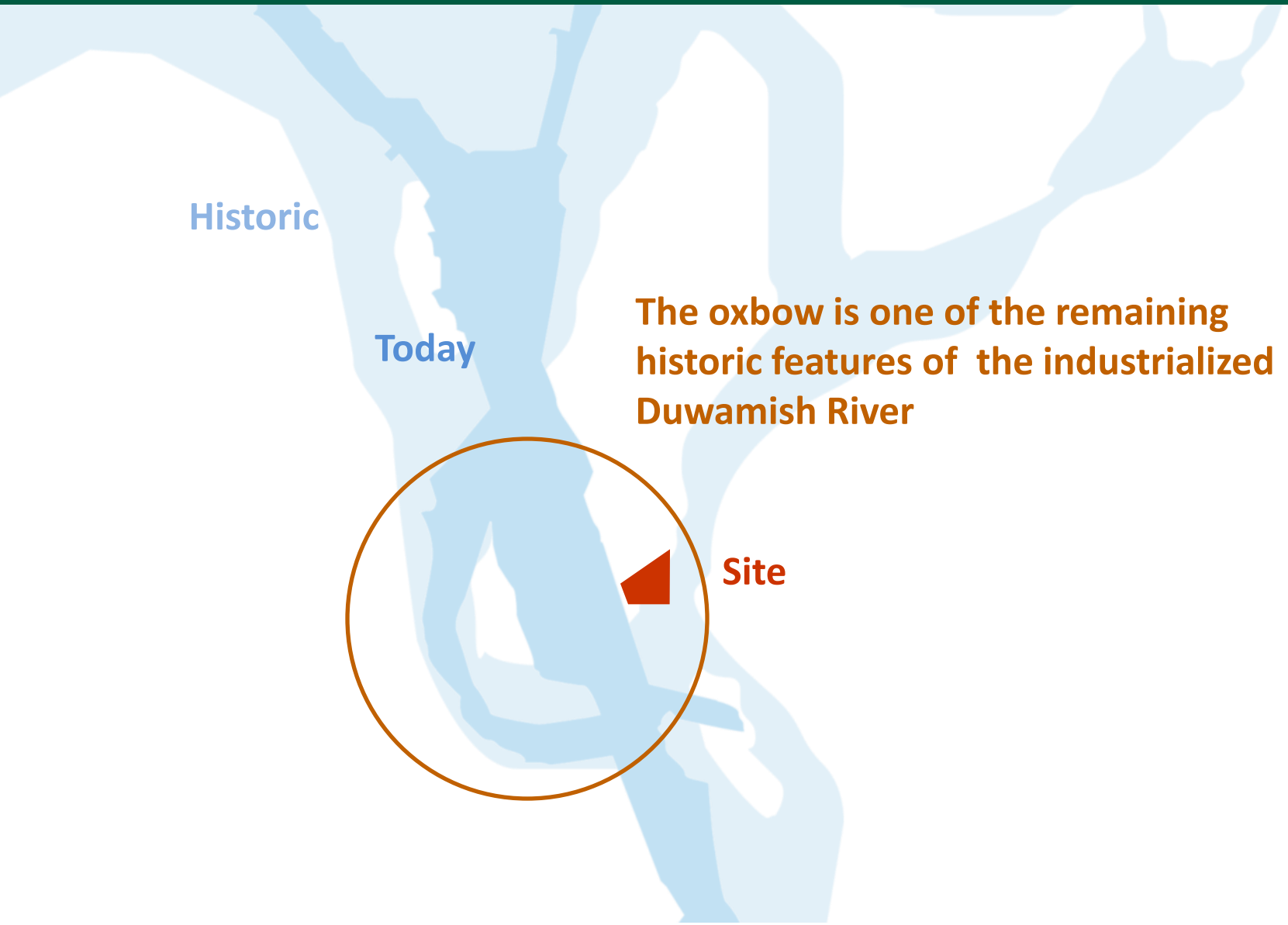
Site and Design Objectives

Meet Schedule, Price, and Performance

# Project Team

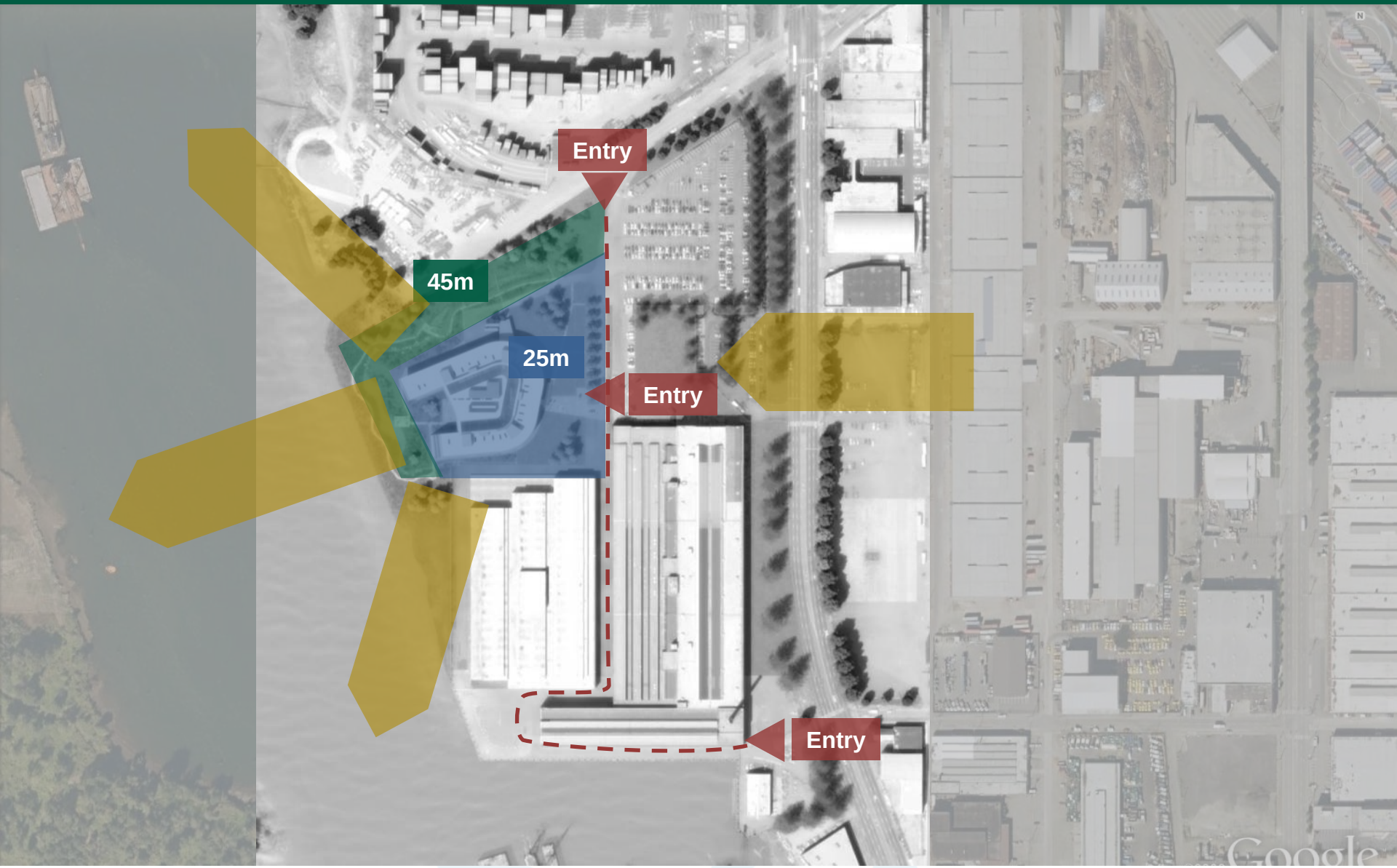
# Project Team


# Duwamish River Bed



# Federal Center South B1202 Redevelopment

# Site Context



# Site Context

View to North West Seattle Bridge

River View Northwest

River View Southwest

Natural
Face and Views

Formal Face

# Key Design Objectives

Reflect USACE mission

Optimize site amenities

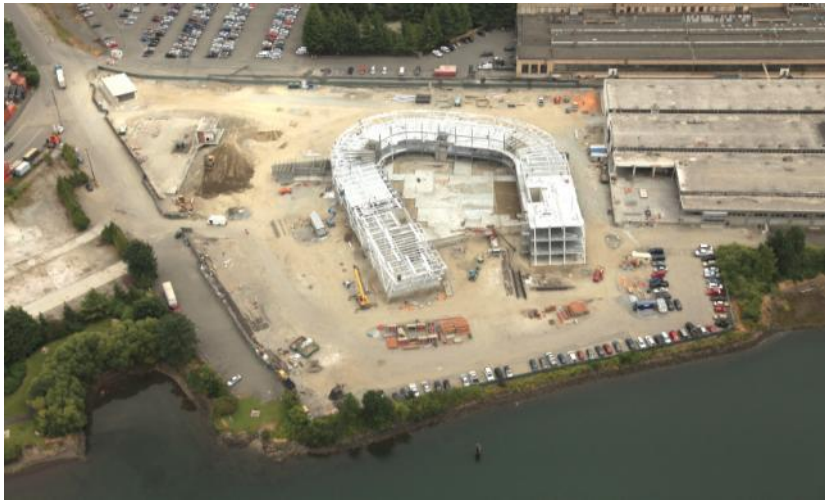
Solidify site and soil conditions

Assure air quality

Create a modern 21st century workplace

Achieve 30%  energy reduction

Re-use 1202 materials

# 21st Century Workplace

Create a sense of place

Enhance collaboration and identity

Reduce silos

Provide connectivity

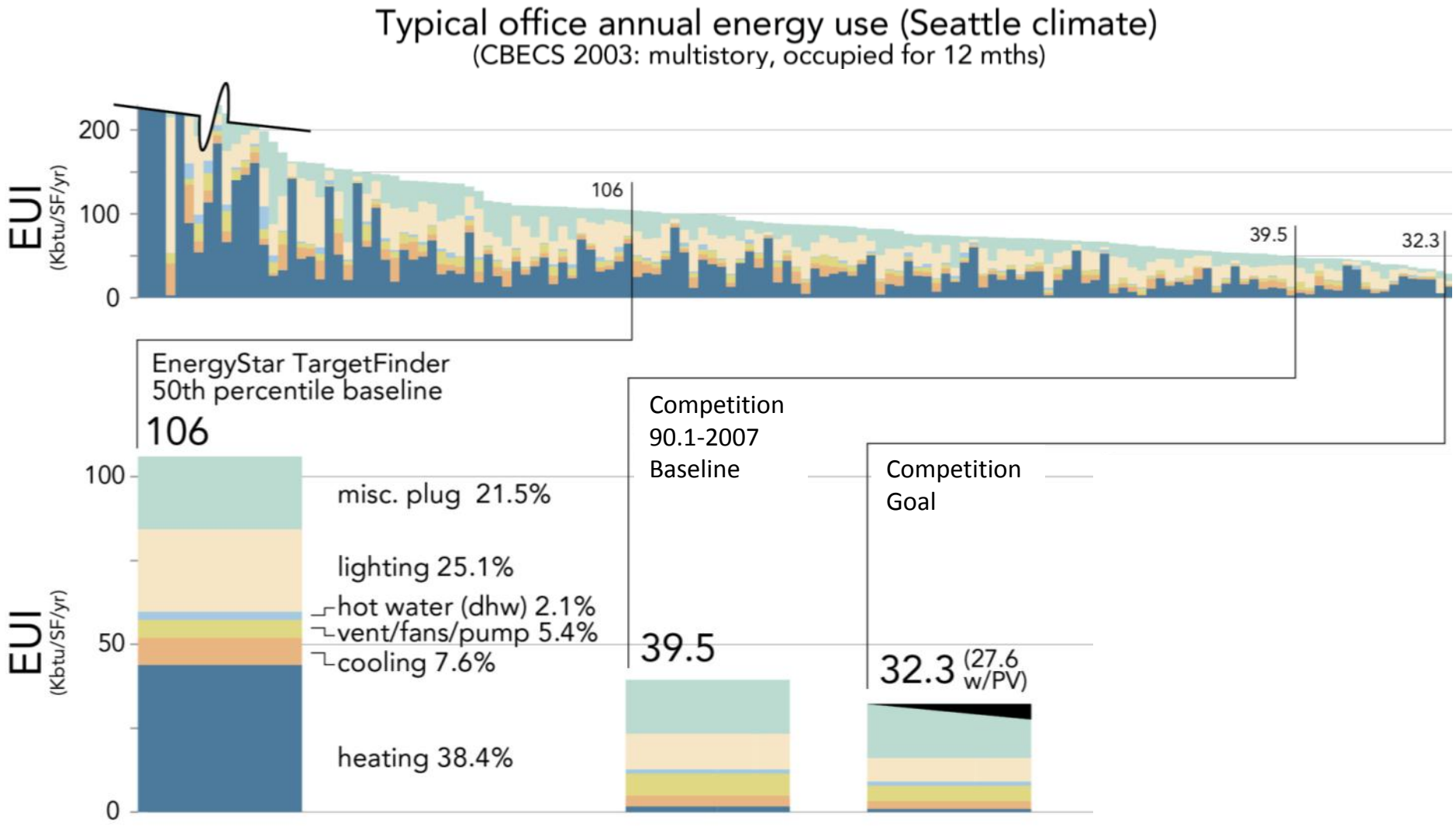
Support generational work styles

Air quality

Daylight and connection to nature

Thermal comfort

# Overall Energy Goals



# High Performance Green Building

**LEED Gold minimum**

Employ **integrated approach** to meet sustainability goals

**30% reduction in energy usage** compared to ASHRAE 90.1-2007

**Install advanced meters** for electricity, natural gas, and water

Install **solar thermal hot water system** (integrated approach determined not cost effective)

Plan for **on-site renewable energy** systems

Reduce **indoor potable water** use by at least 20%

Reduce **outdoor potable water** use by at least 50%

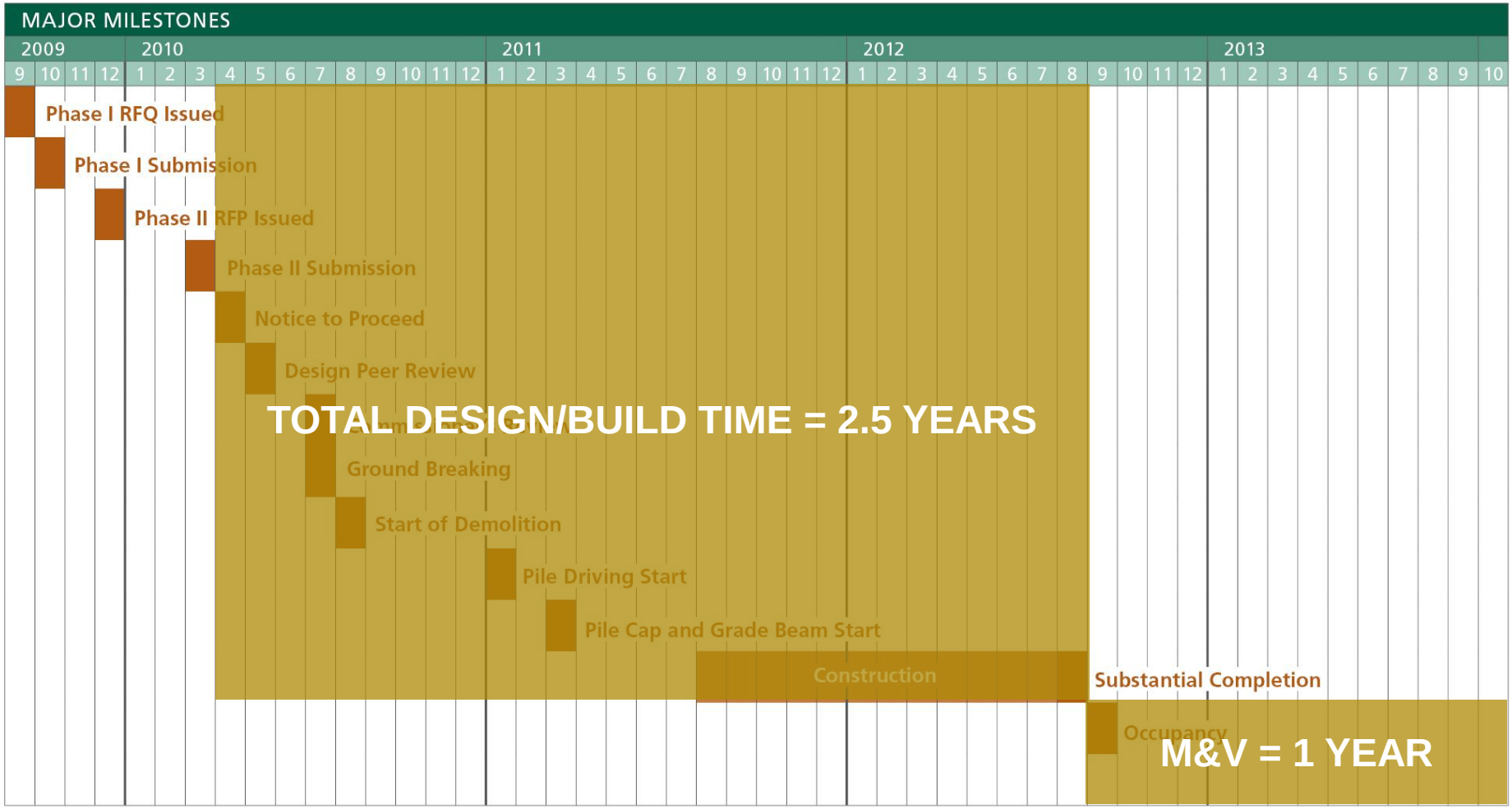
Manage 95$^{th}$ **percentile rain event** onsite through infiltration

Provide occupancy and **daylight sensors**

**Pre-occupancy flush-out**

**Salvage, recycle, or reuse at least 50% of construction and demolition waste**

# Scheduled Completion by June 2012



# Performance Guides the Design

Goal Setting *understanding 30% better than ASHRAE*

Abstraction of performance *Building width / daylight , Orientation / massing*

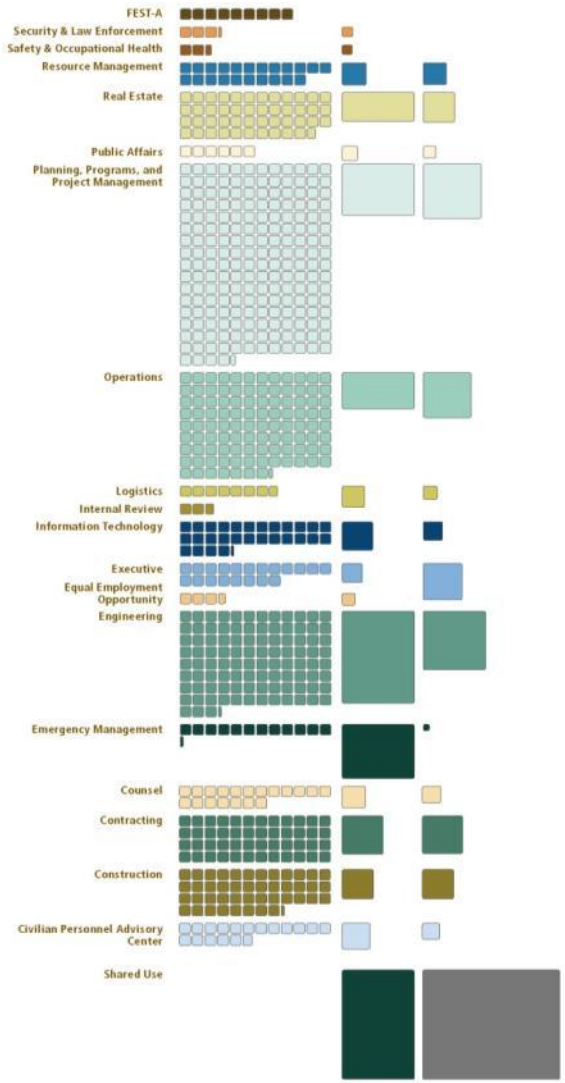
Office *flexibility and efficiency*

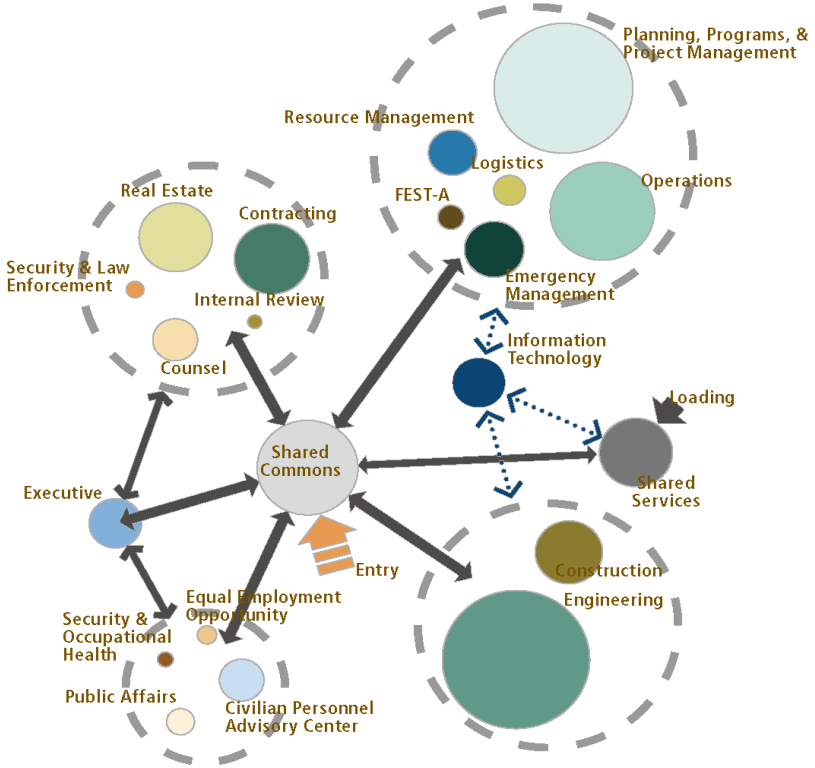
Competition Process, Goals and Integrated Team

*Twofers:* *Diagrid: Structural efficiency, Progressive collapse, Support piles*
*Building re-use: Timbers and atrium, Composite beams*
*Atrium: Daylight, Thermal efficiency*

# USACE Program Analysis

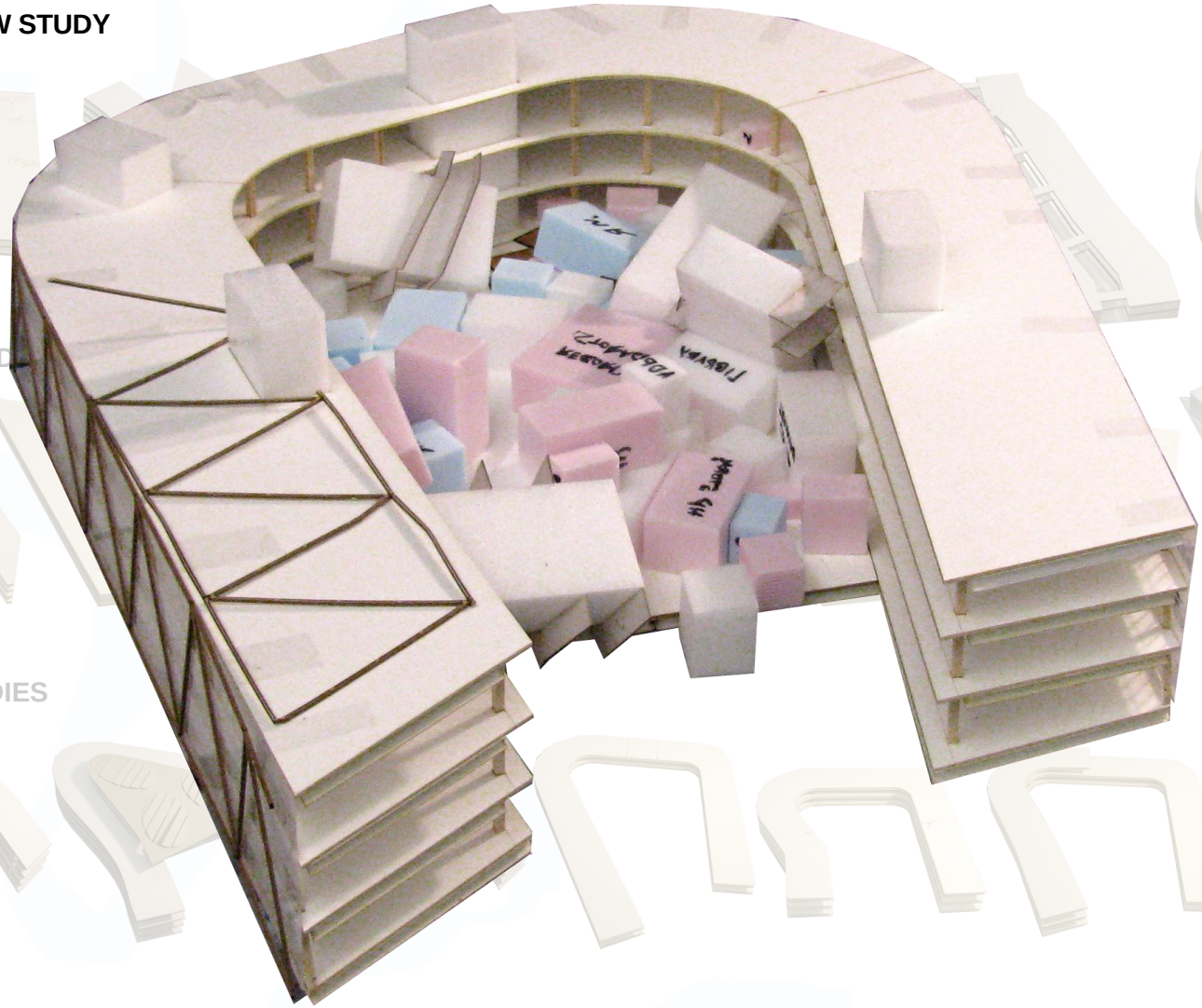
**PROGRAM BY DEPARTMENT**



# Performance Guiding Building Shape

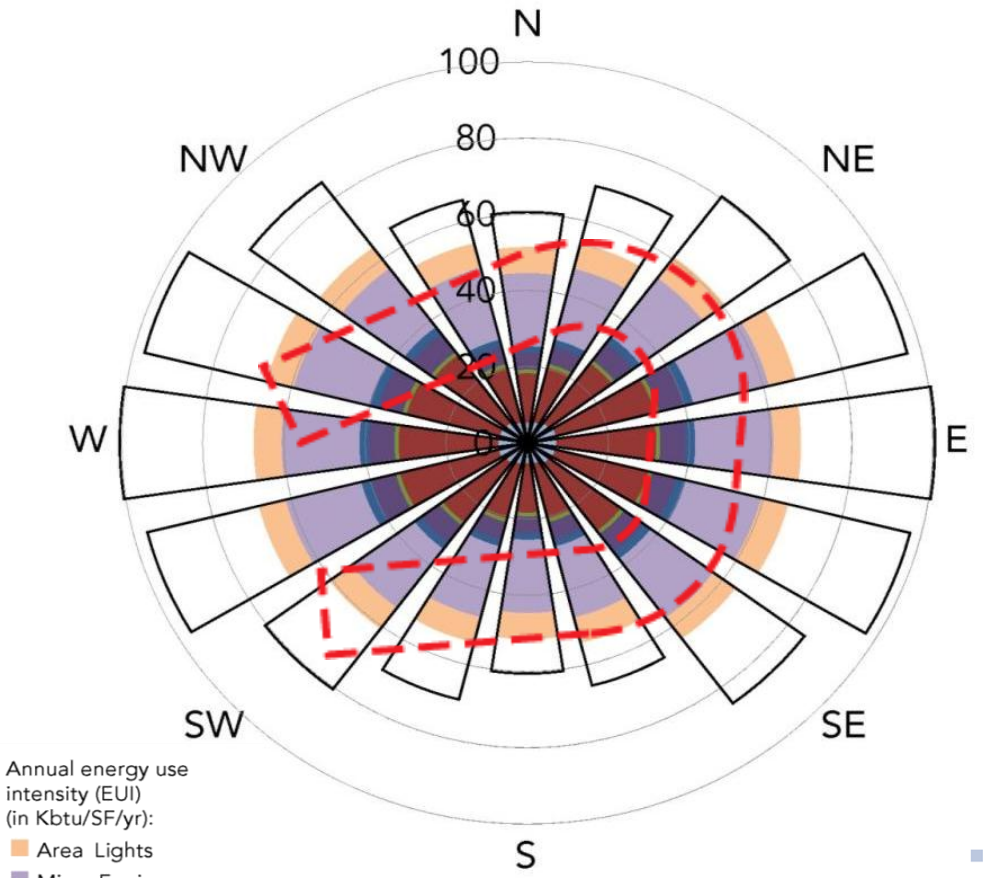
**FINAL OXBOW STUDY**



3 STORY STUDY

OXBOW STUDIES

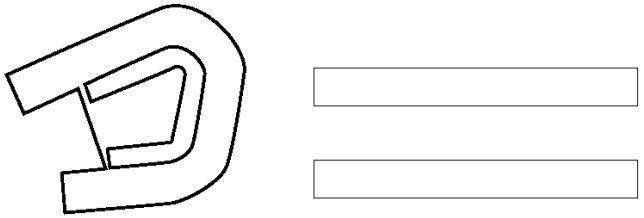
# Orientation

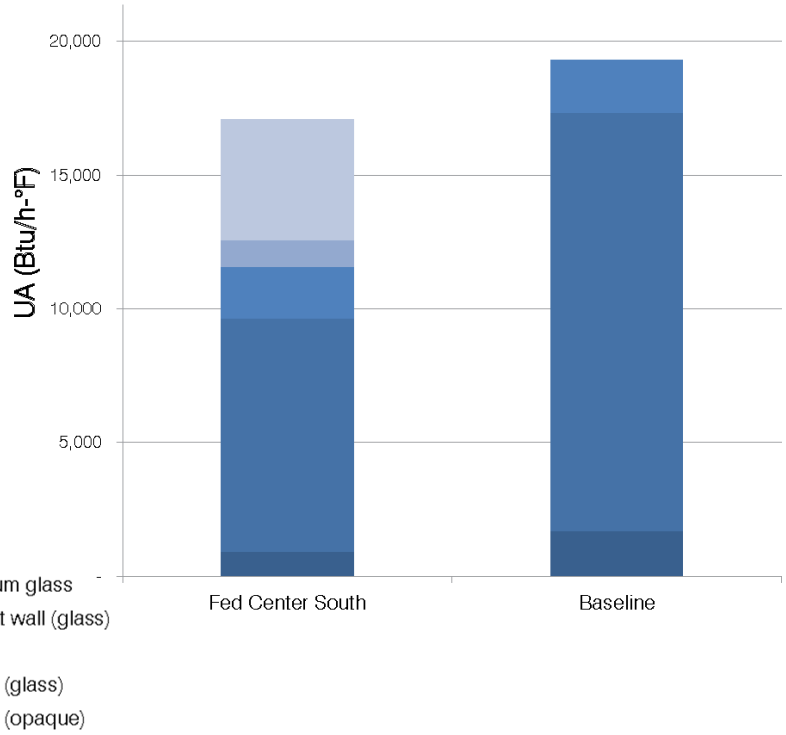



Annual energy use intensity (EUI) (in Kbtu/SF/yr):

- Area Lights
- Misc. Equip.
- Pumps & Aux.
- Vent. Fans
- Hot Water
- Space Heat
- Space Cool

☐ Relative peak hour energy use





# 3 Story Configuration

Optimizes site available for security setbacks

Maximizes open campus green space

Provides storm water management opportunities

# The Collaborative Workplace

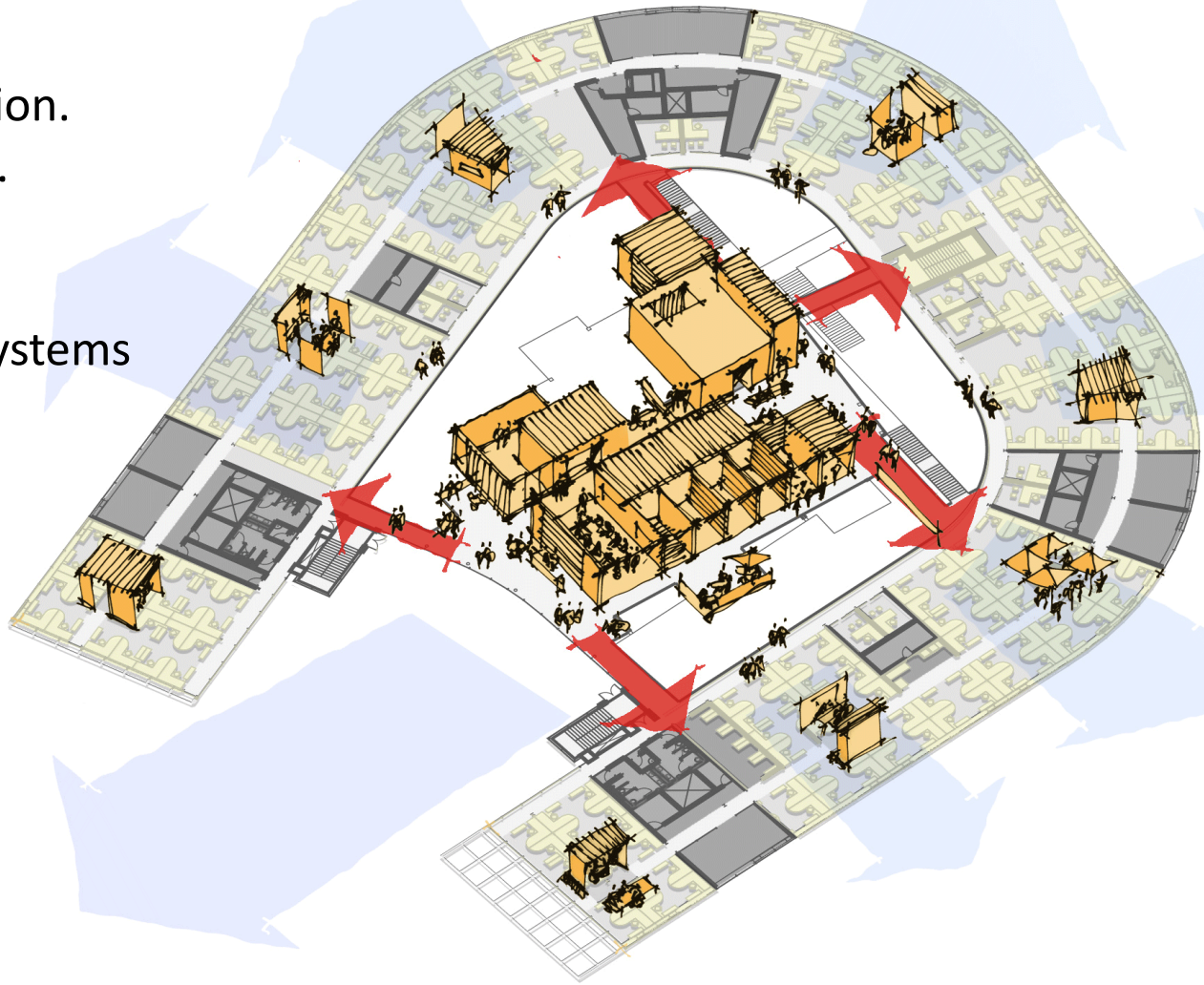
Flexibility. Efficiency. Daylight.
Unified. Open.

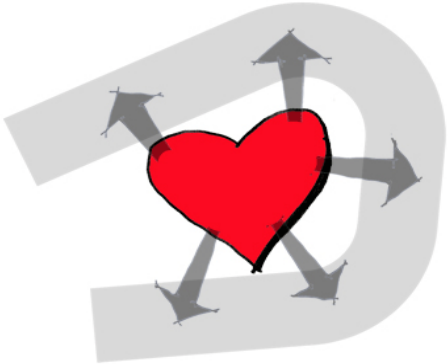
Interaction.  Collaboration.
Central and convenient.

No “Silos”.

Optimize Mechanical Systems

Builds Community





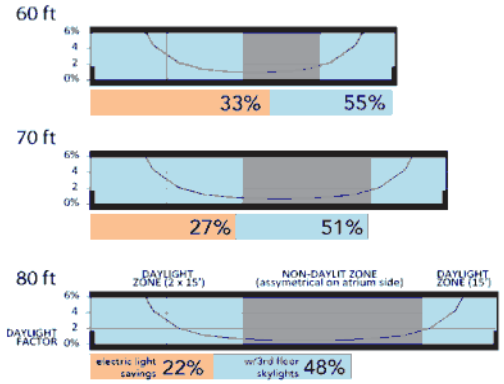
# Building Block of Workplace Design

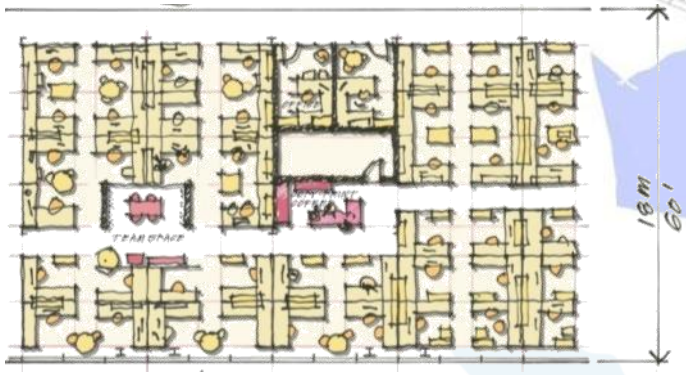
Allows Various Tenant Layouts

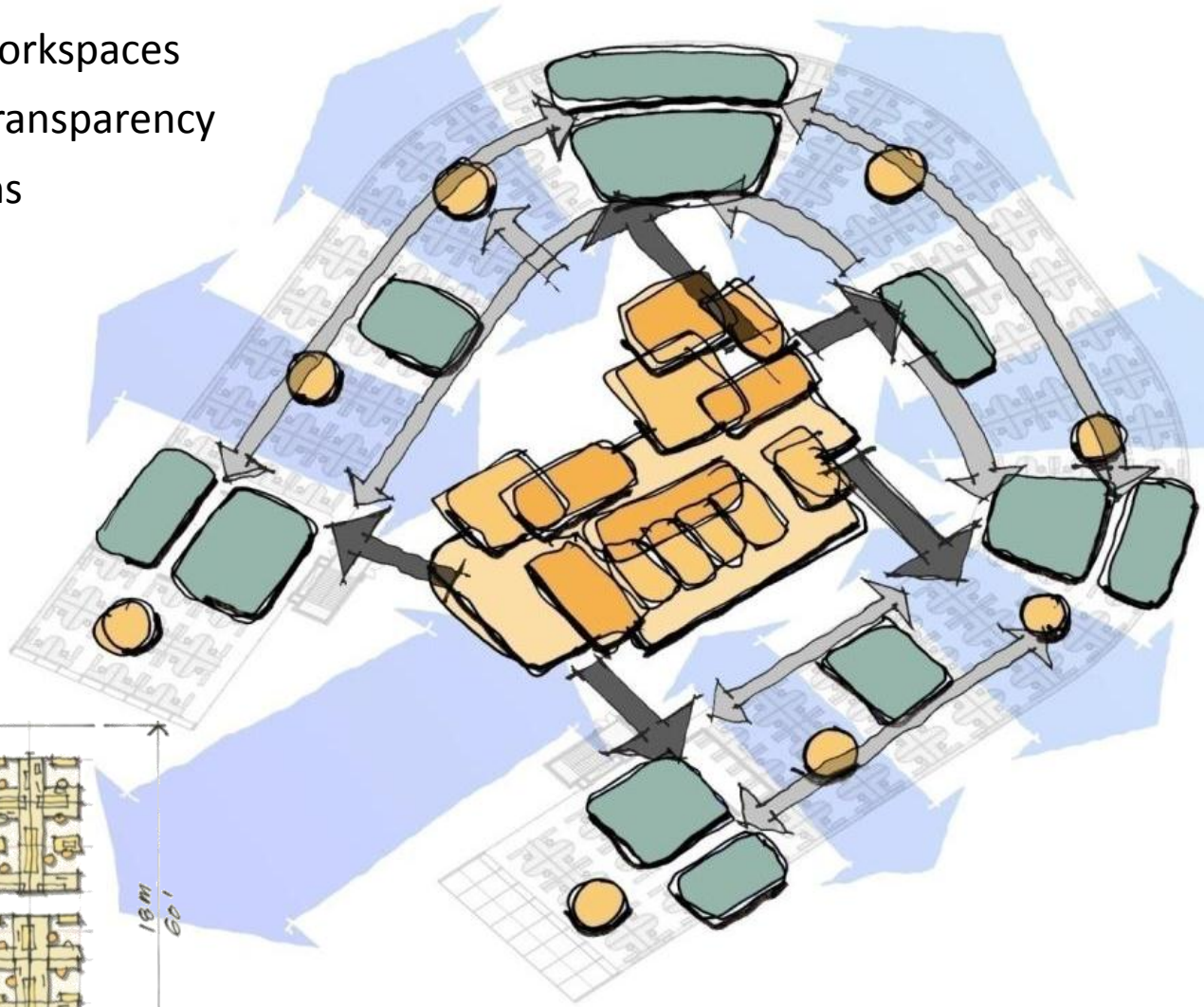
Maximizes Efficient 8 x 9 Workspaces

Optimize Daylighting and Transparency

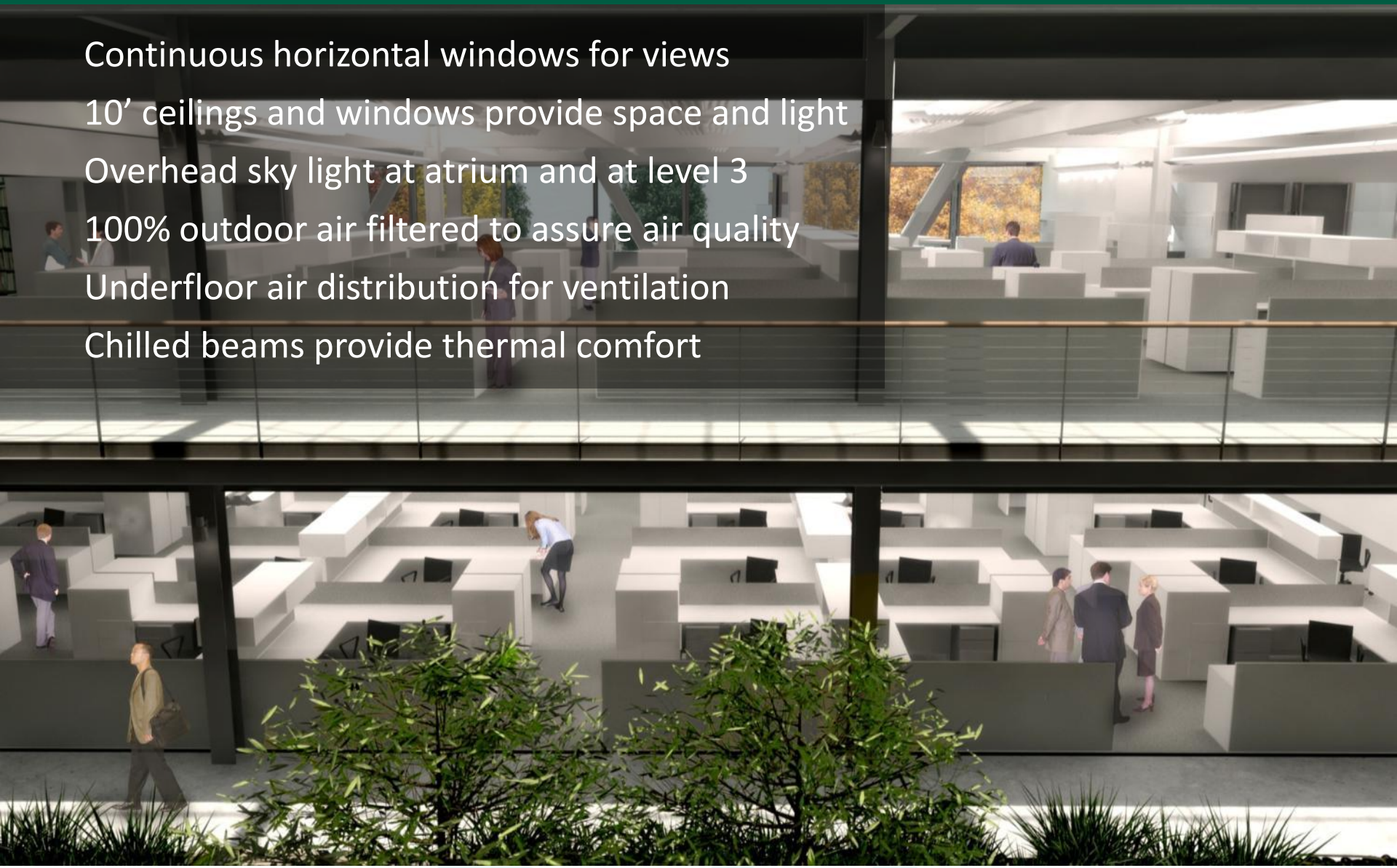
Optimize Visual Connections



# Workplace Amenities



Continuous horizontal windows for views

10’ ceilings and windows provide space and light

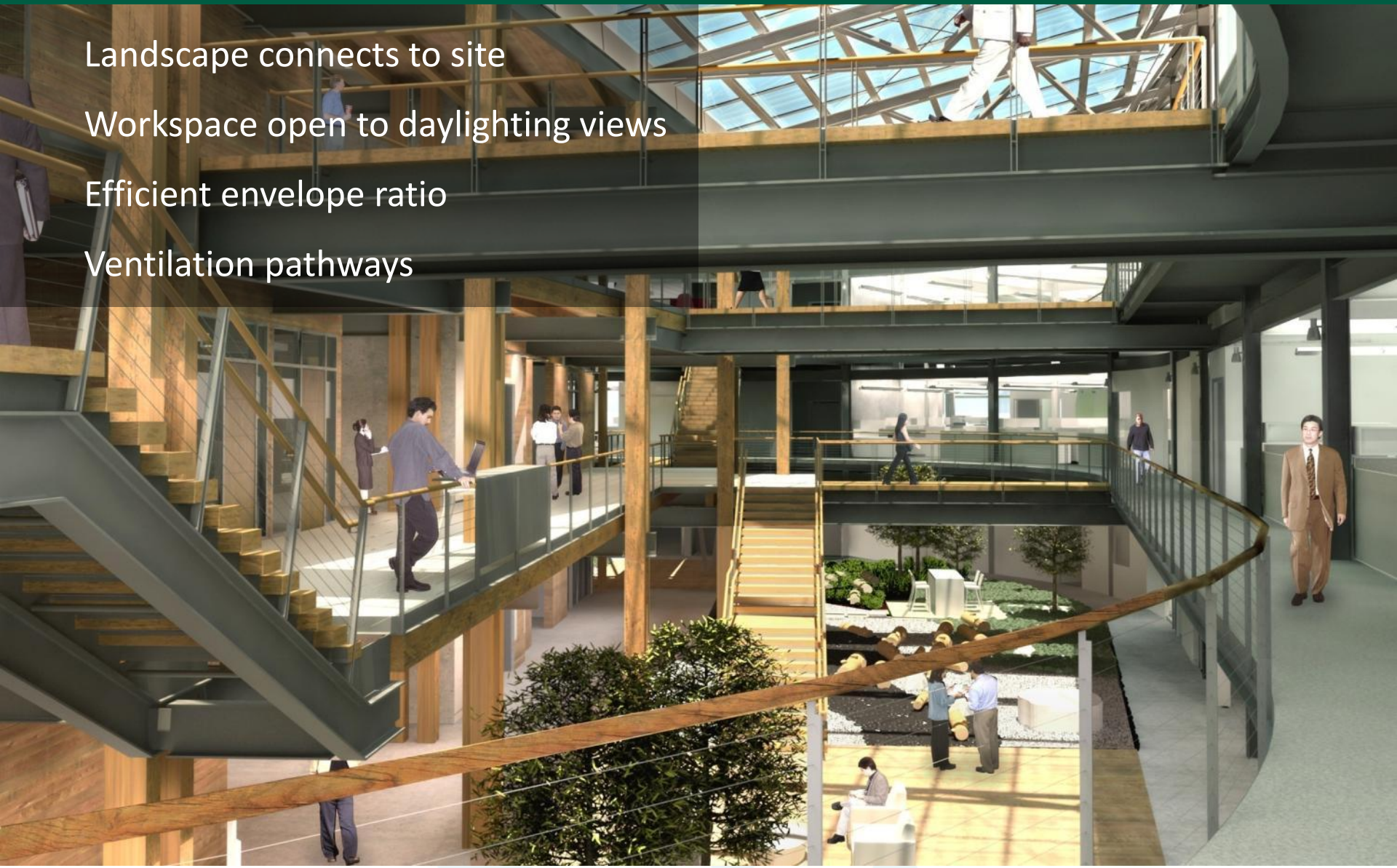
Overhead sky light at atrium and at level 3

100% outdoor air filtered to assure air quality

Underfloor air distribution for ventilation

Chilled beams provide thermal comfort

# Atrium Strategies



Landscape connects to site

Workspace open to daylighting views

Efficient envelope ratio

Ventilation pathways

# Structural Design

## Diagrid System

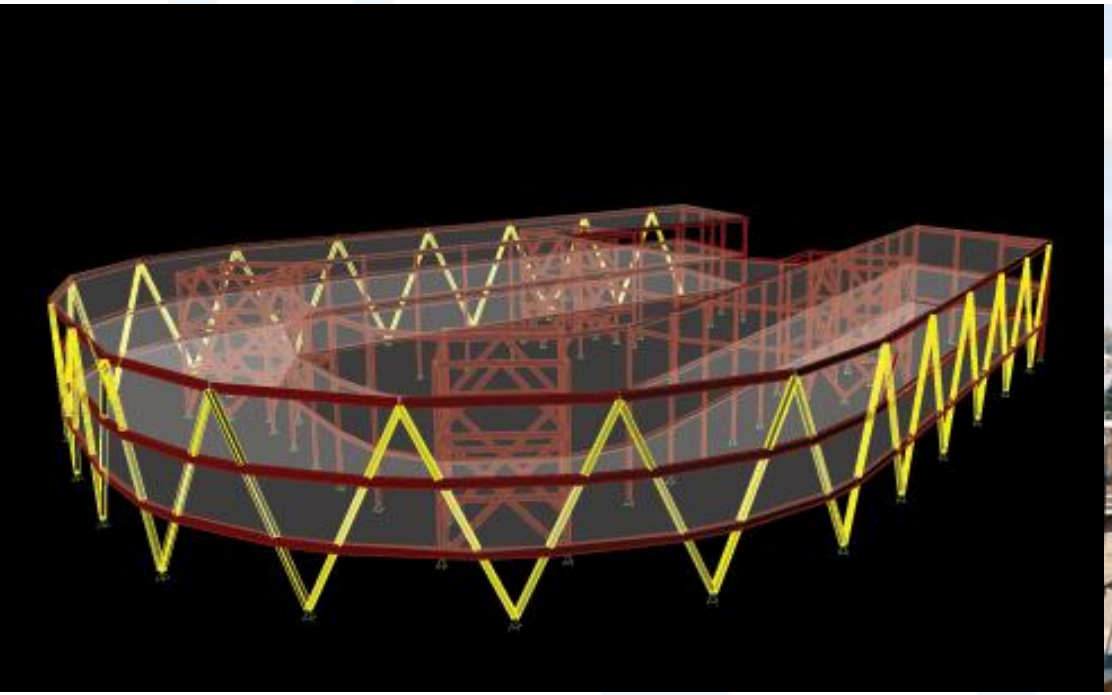
Carries gravity loads

Contributes to the lateral force resisting system

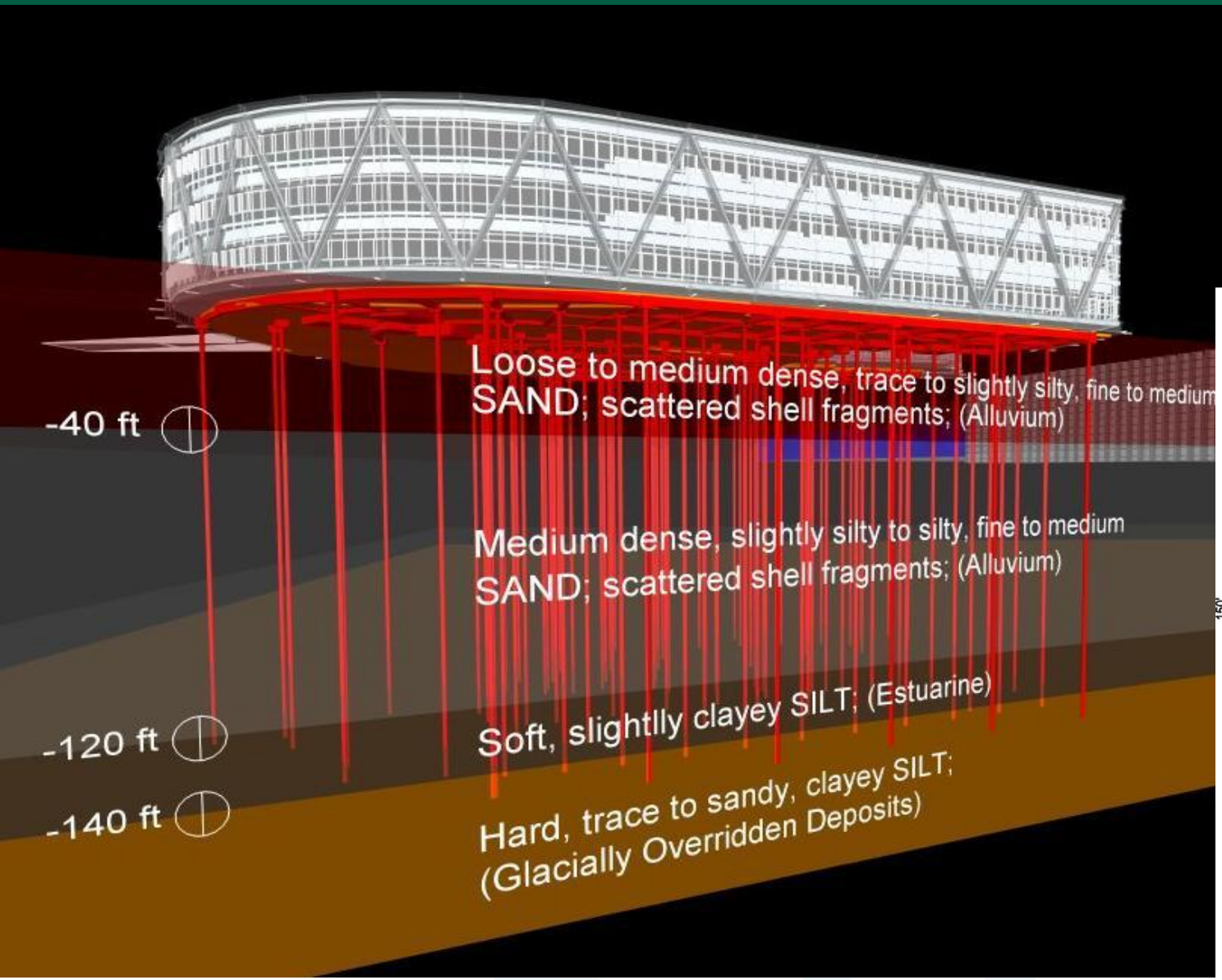
Serves as progressive collapse system → truss action

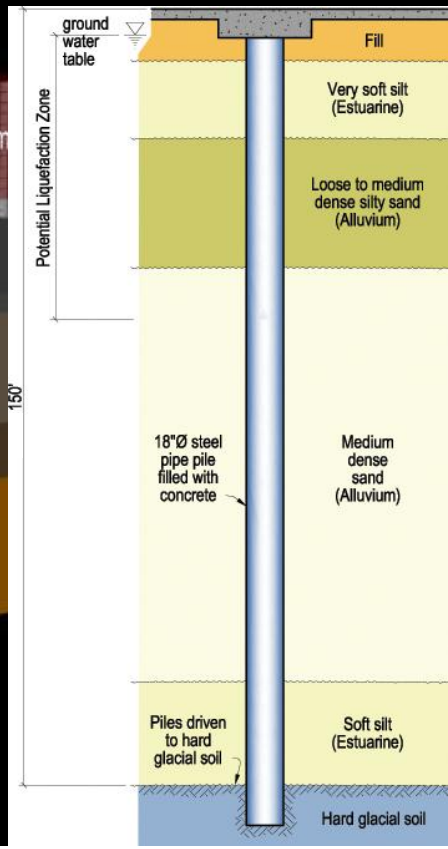
## Level One Floor System

Grade Beams supported by piles assure stability in any soils condition

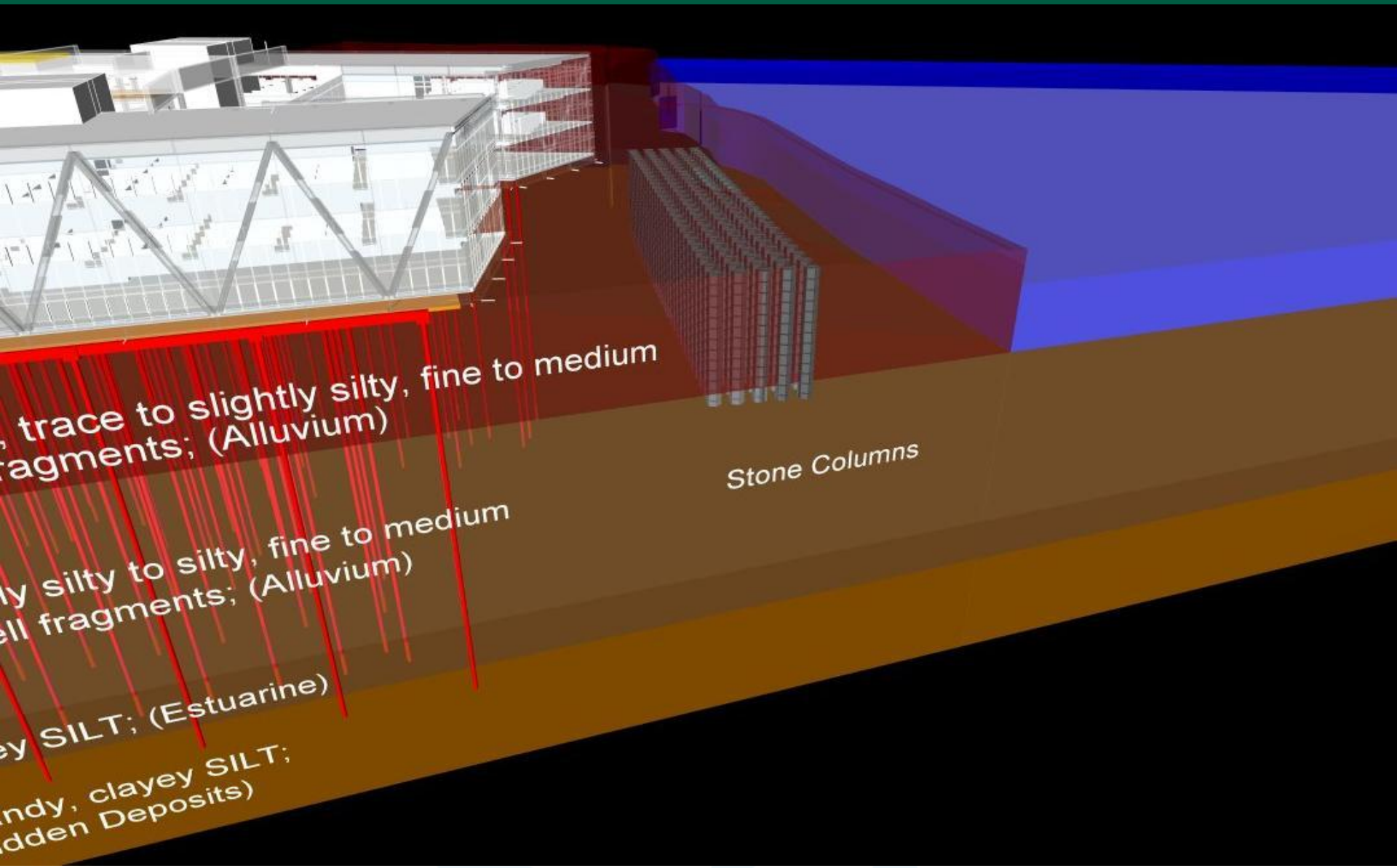


# Geotechnical Design



# Geotechnical Design

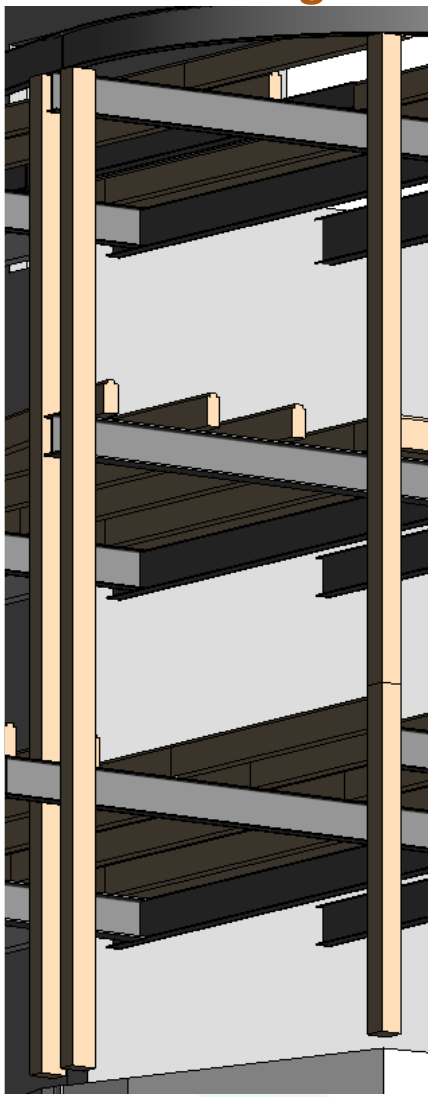


# Energy Piles


# Materials Reuse Timber

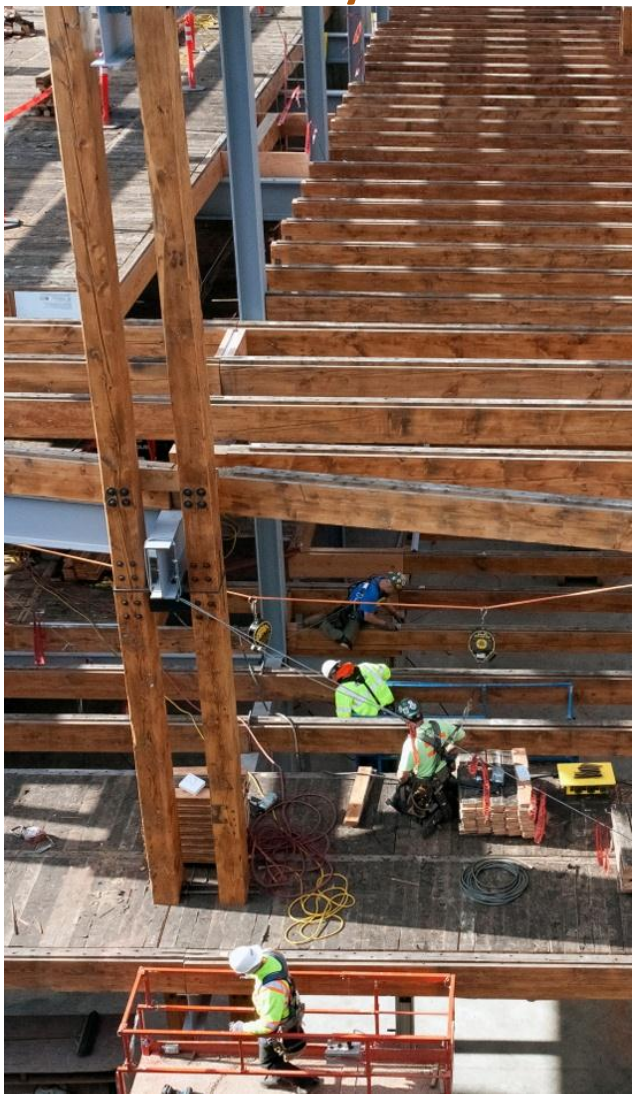
**Warehouse**

**Modeling**

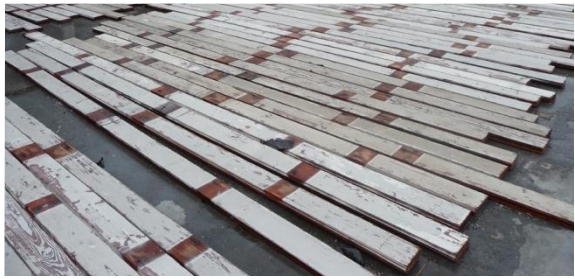


**Mock-up**

**Today**

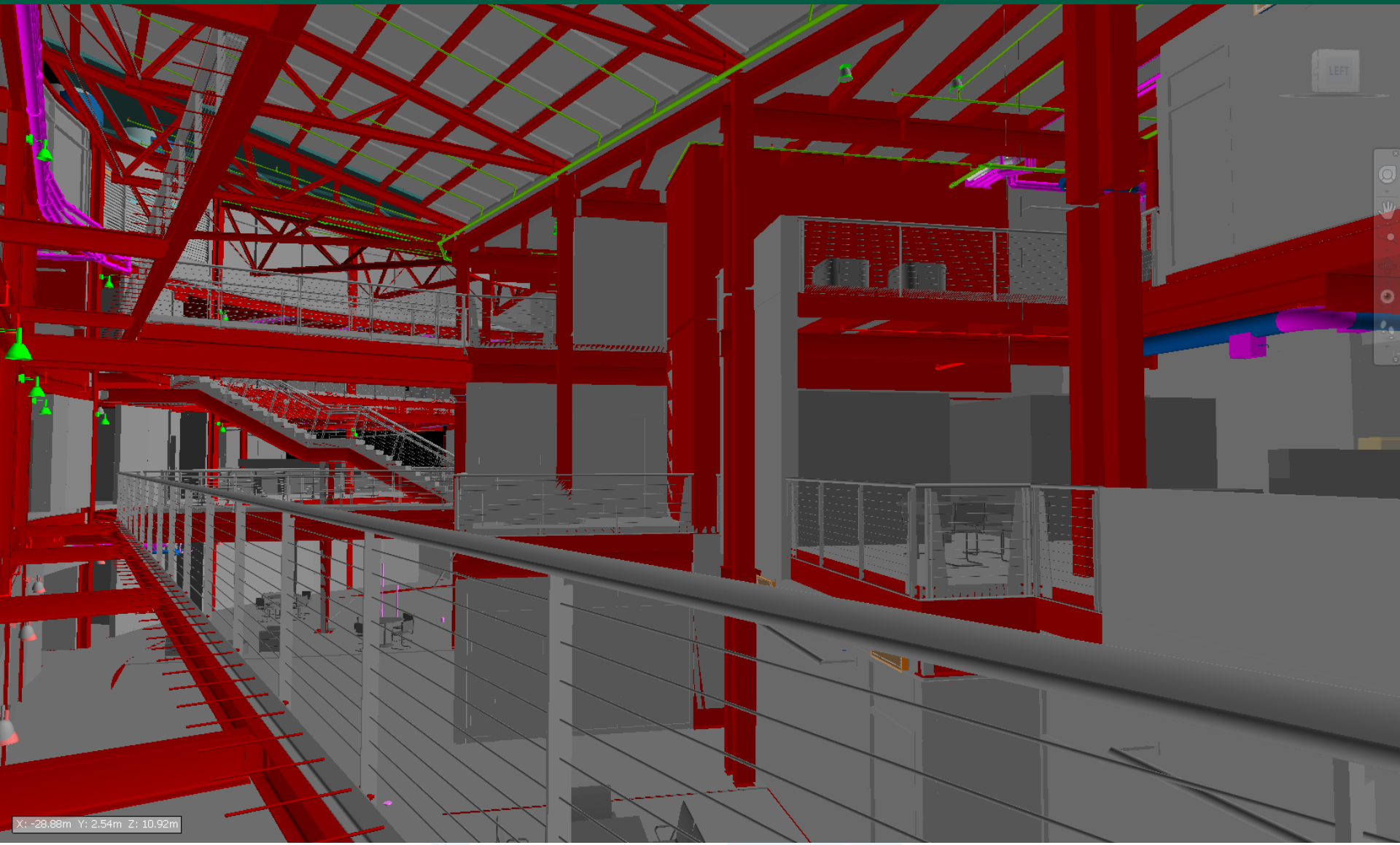


# Reclamation Process



# Materials Reuse

# Materials Reuse



# Materials Reuse

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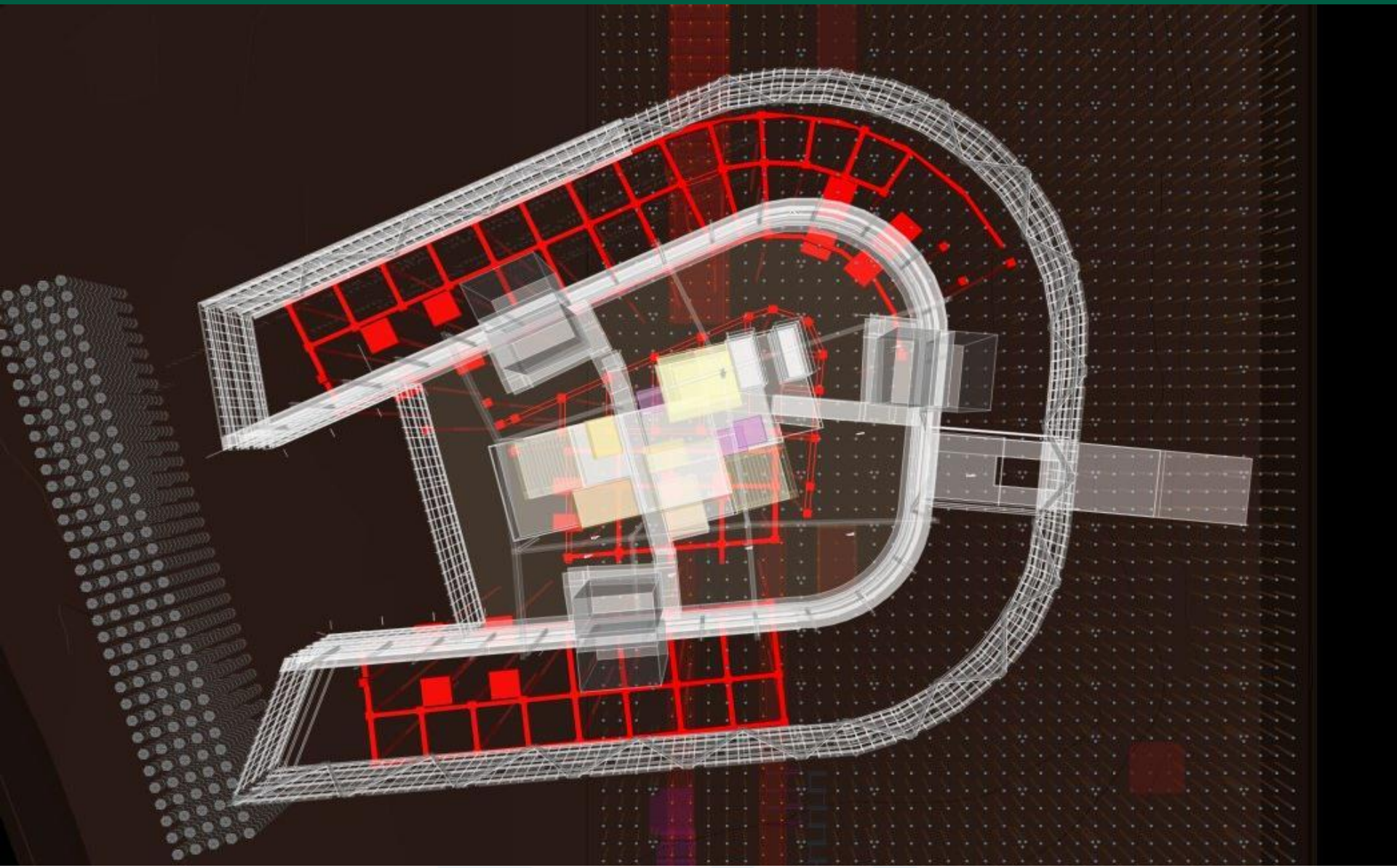


# Systems Modeling

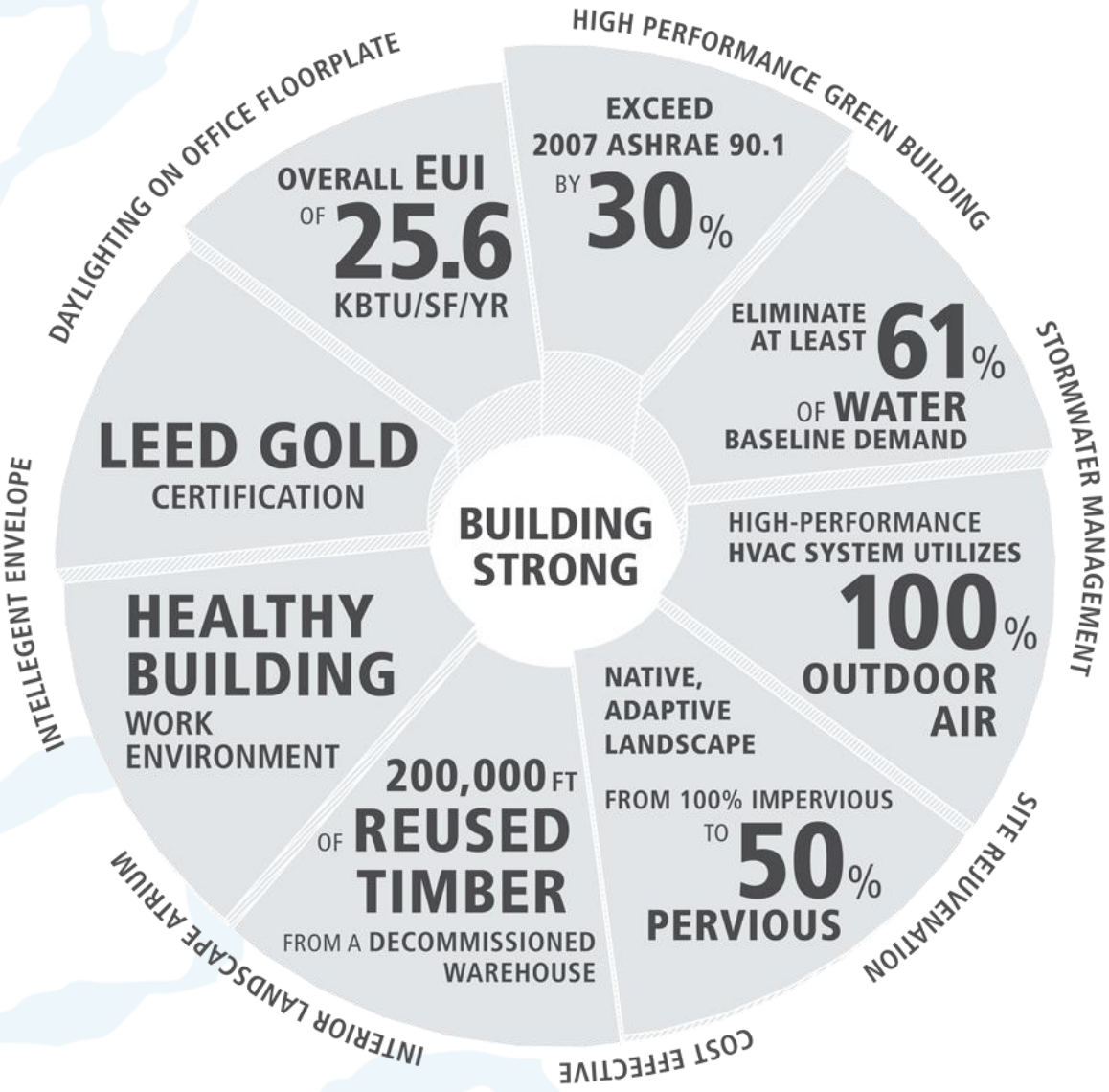
HVAC and envelope *Triple glazing, Exterior shading*

Phase Change, Ground Source and Cooling Tower

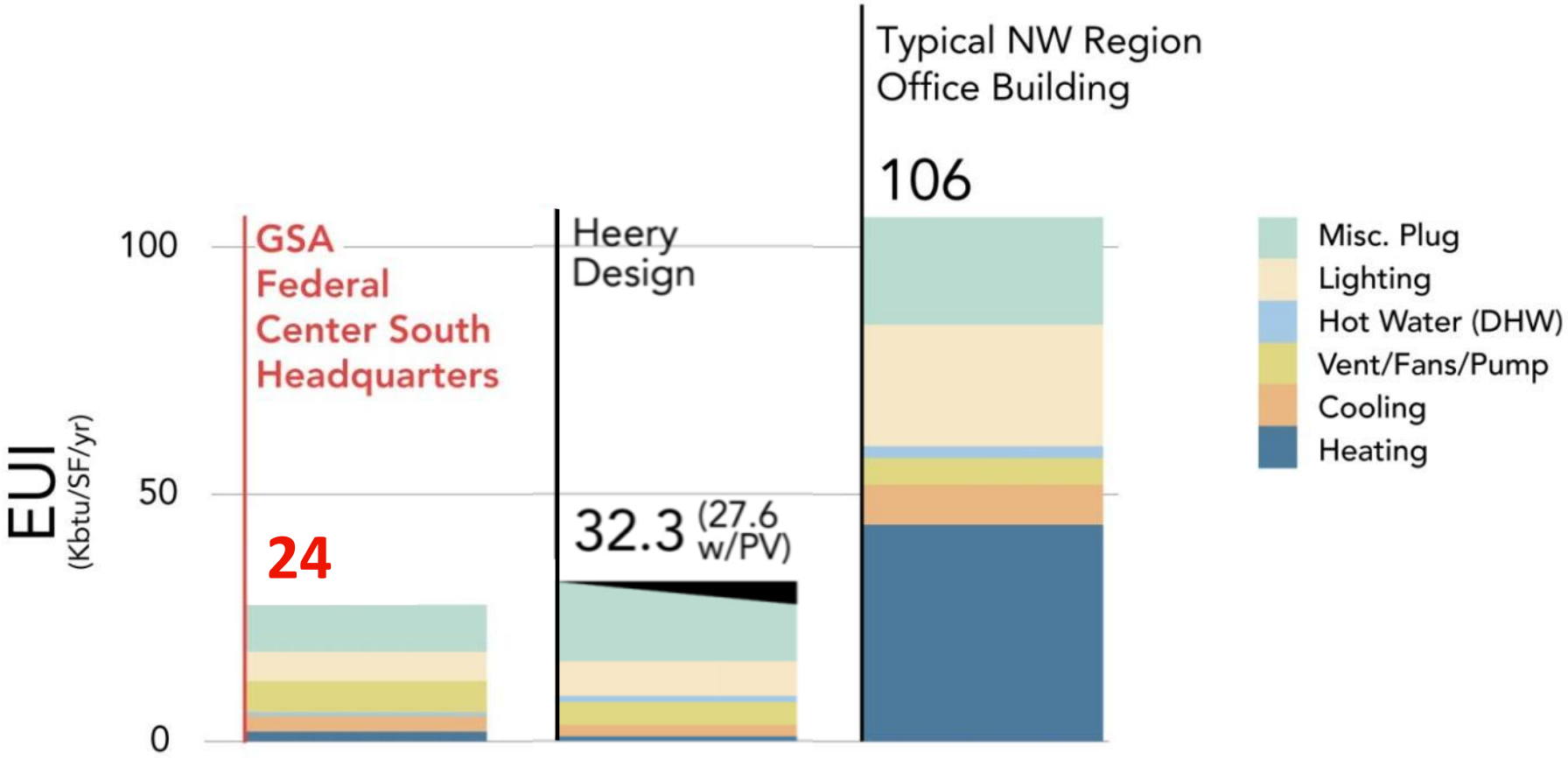
Daylight and Electrical Lighting

# Integrated Performance

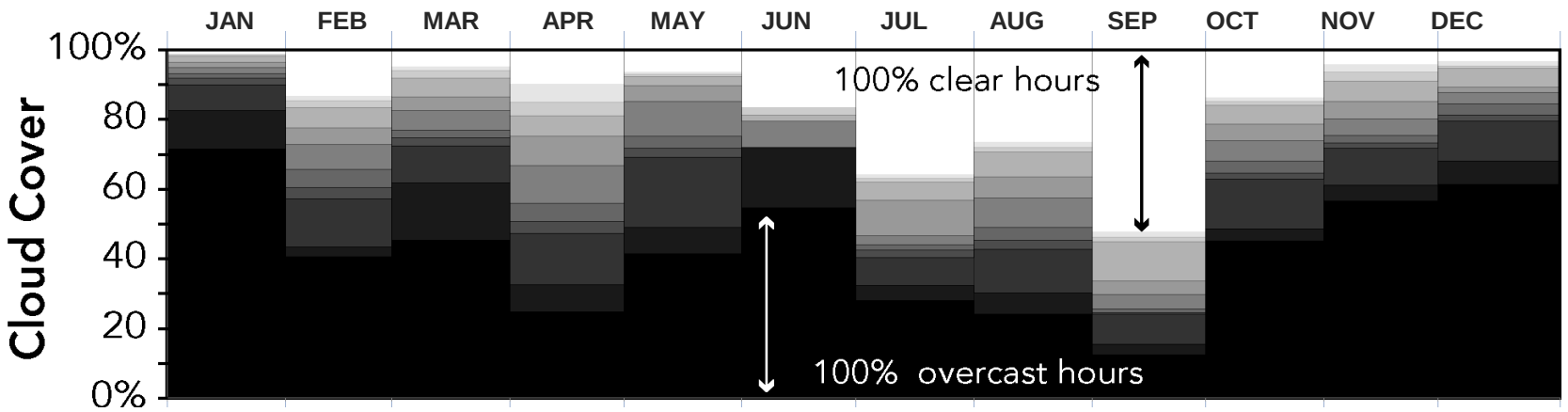
- Conservation first
- Reduce loads
- Passive systems
- Efficient active systems
- On-site renewable energy generation

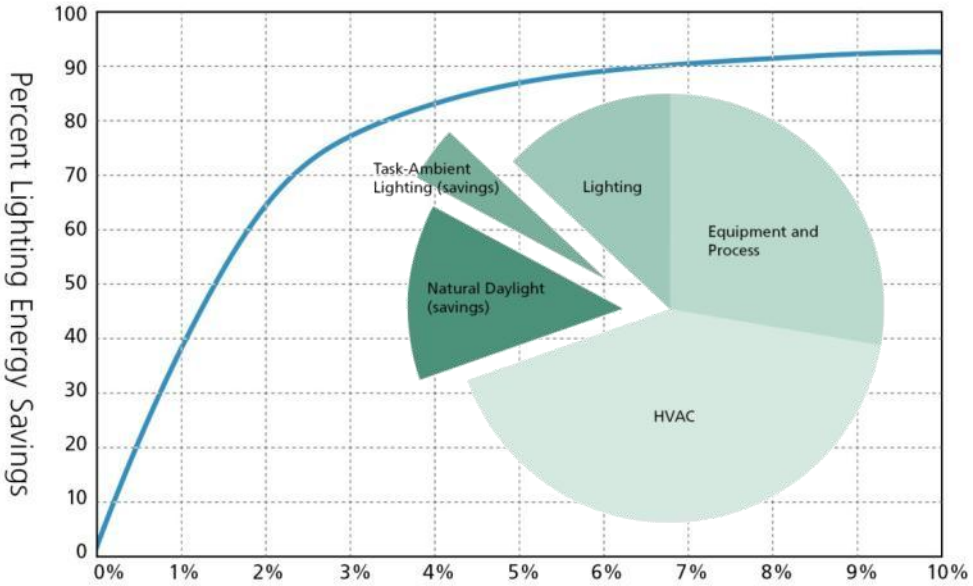


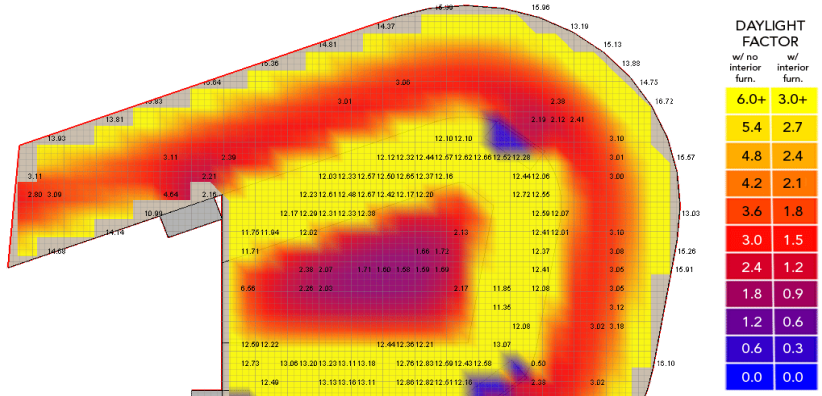
# Current Energy Model Performance



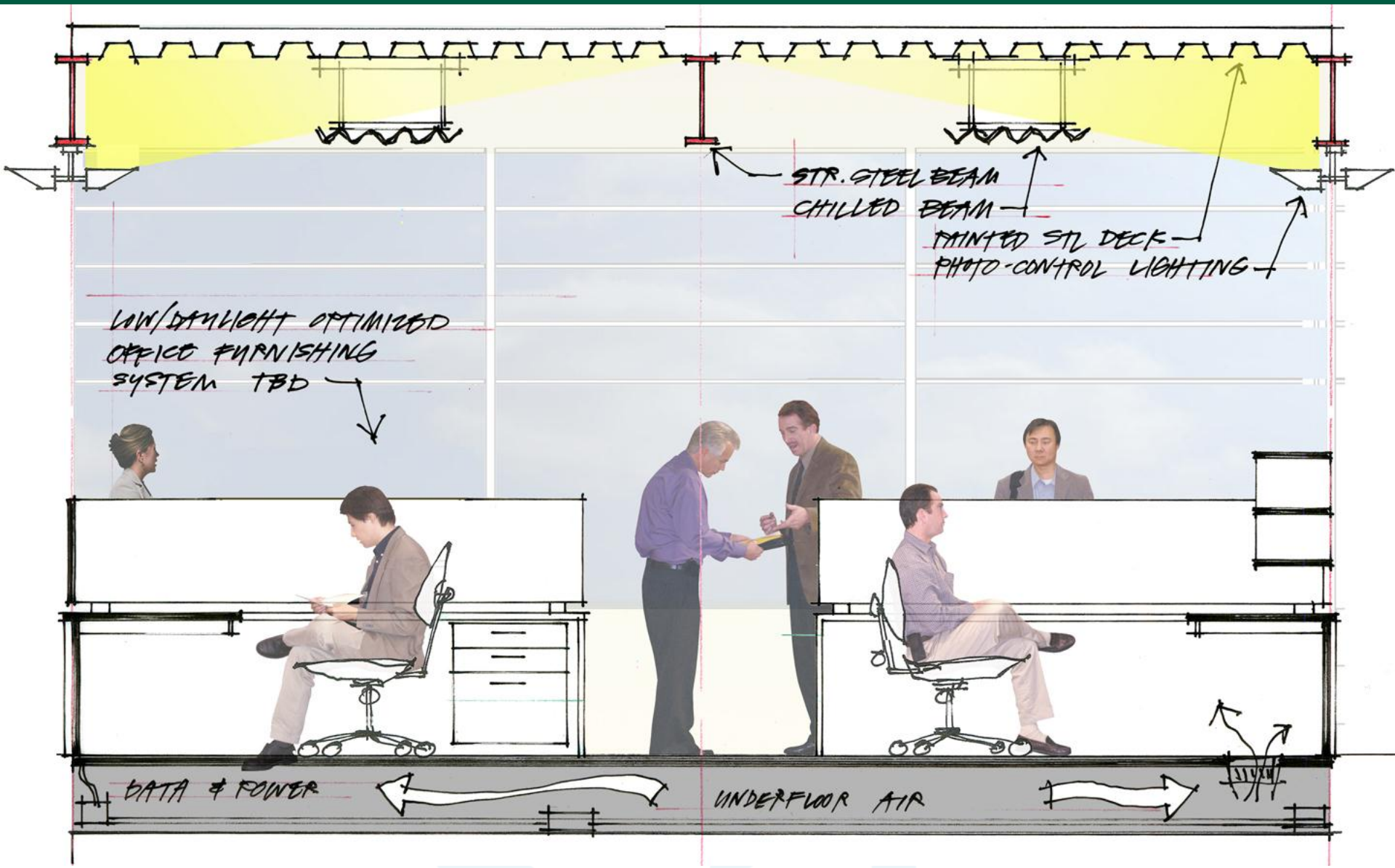
# Daylight Performance



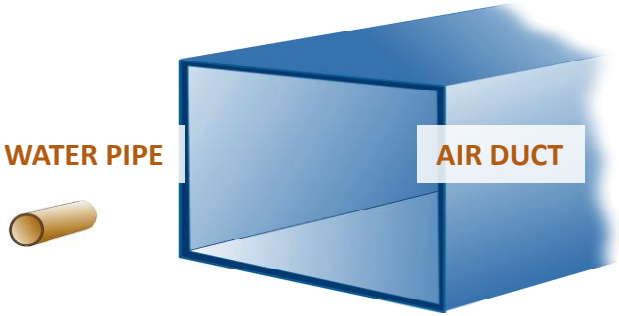



# Workplace Lighting



# Chilled Sails



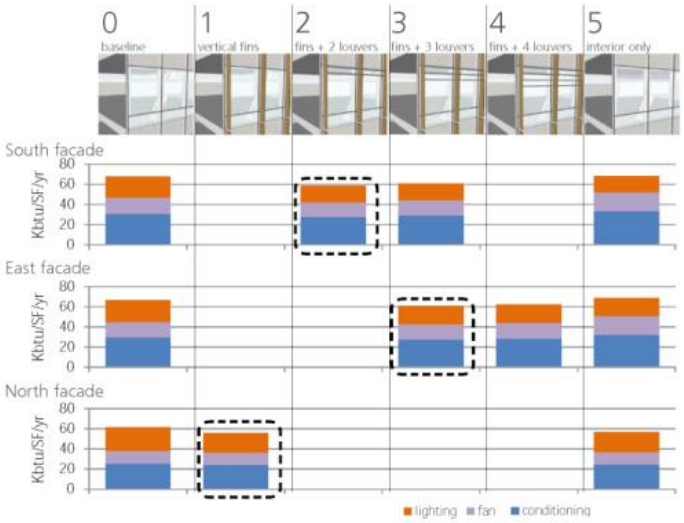


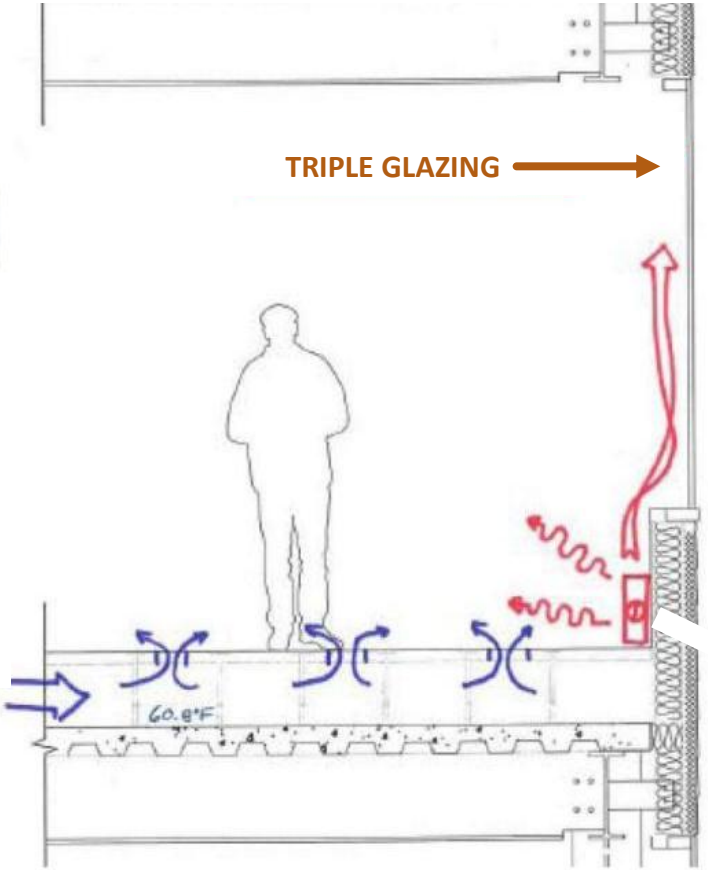

# Orientation-Specific Envelope

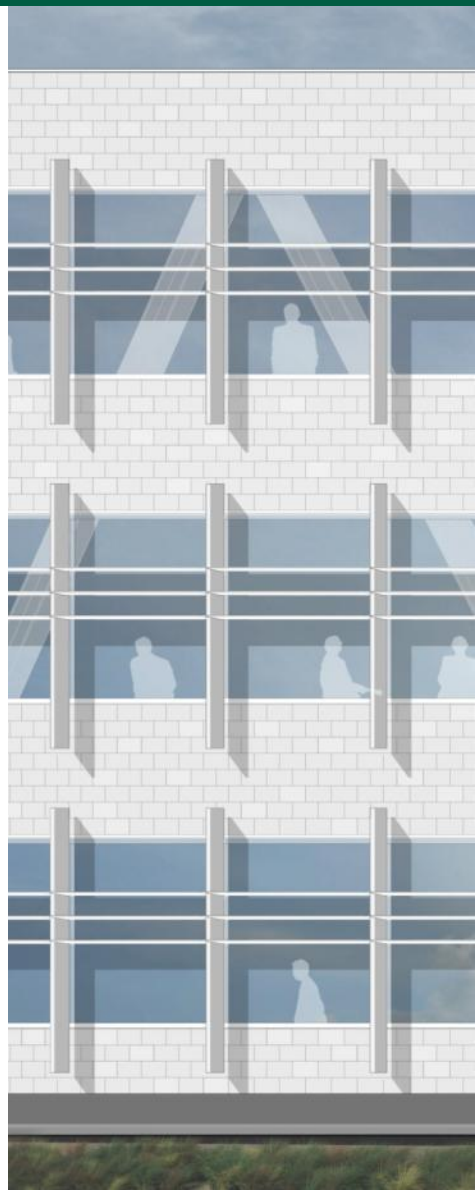
Daylight orientation

River orientation: natural

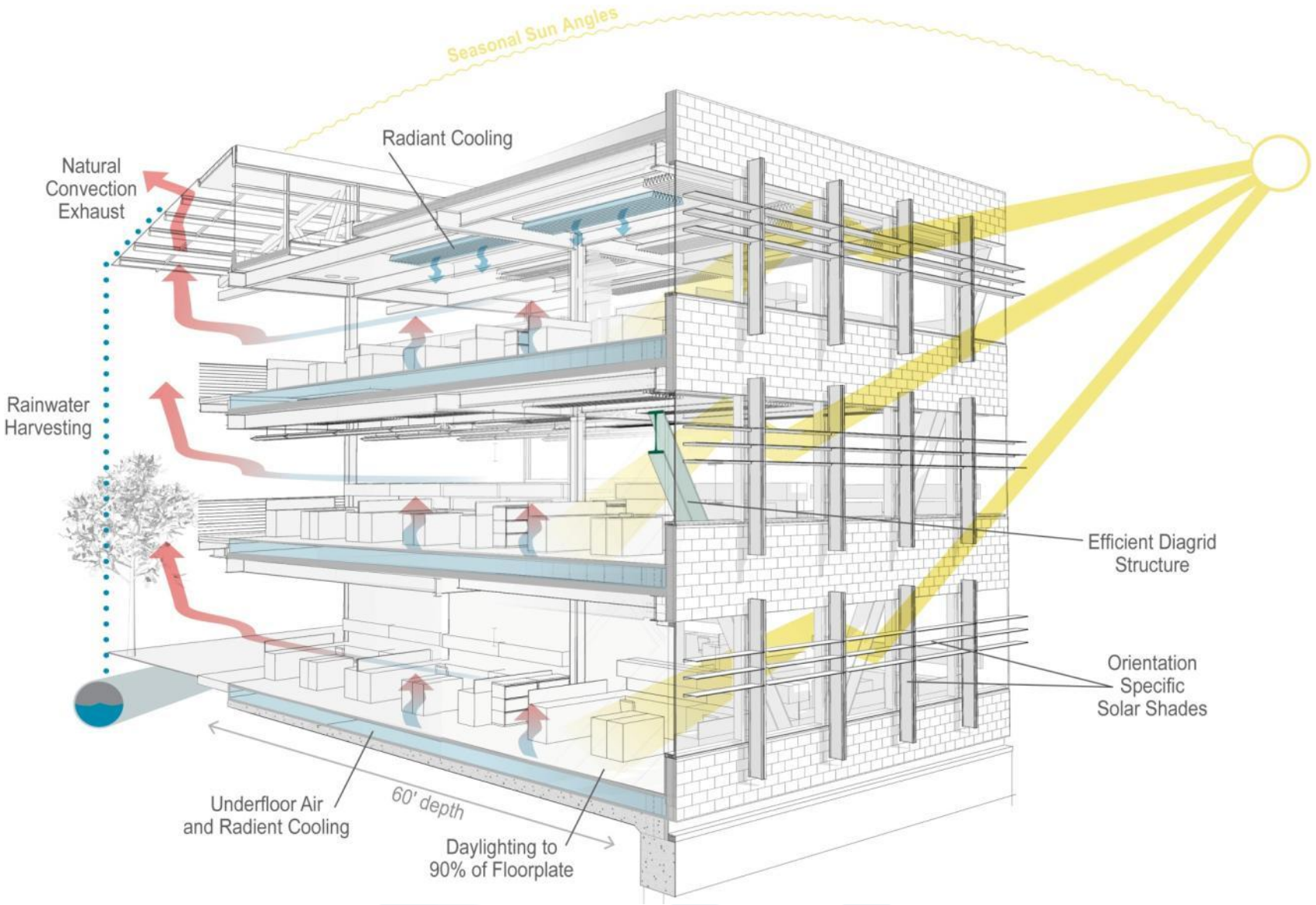
Campus orientation: formal



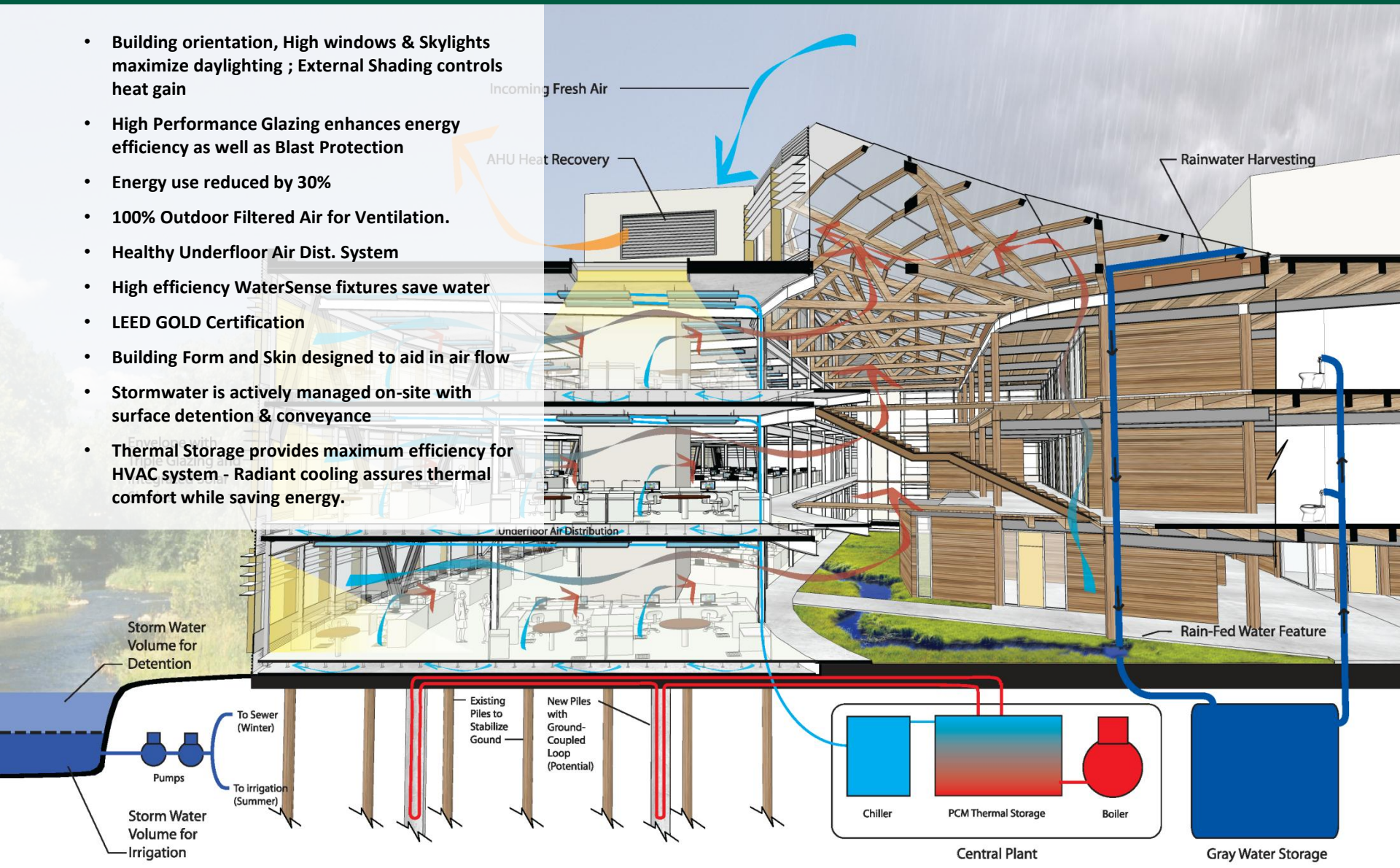



# High Performance Green Building

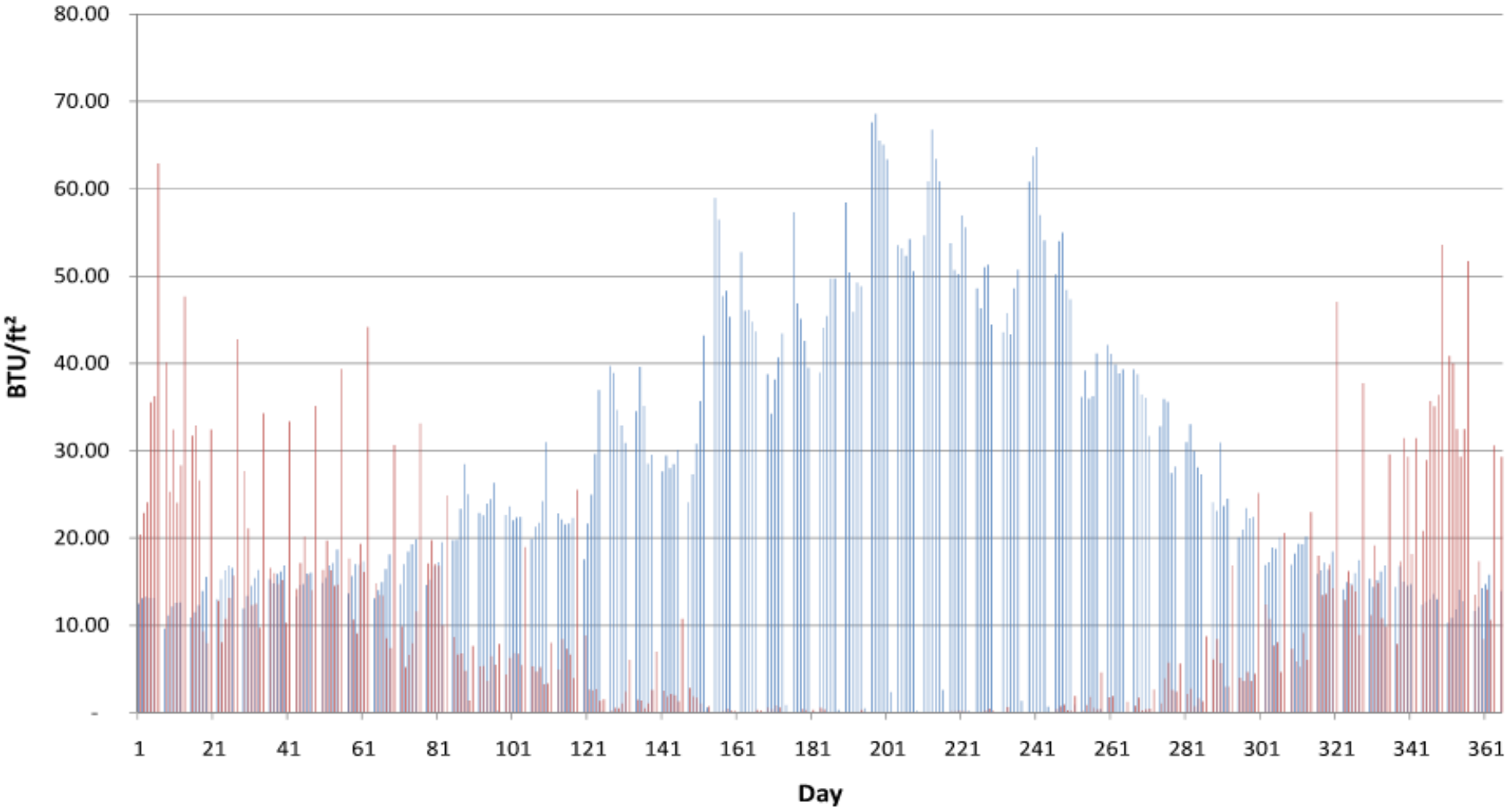


# High Performance Green Building

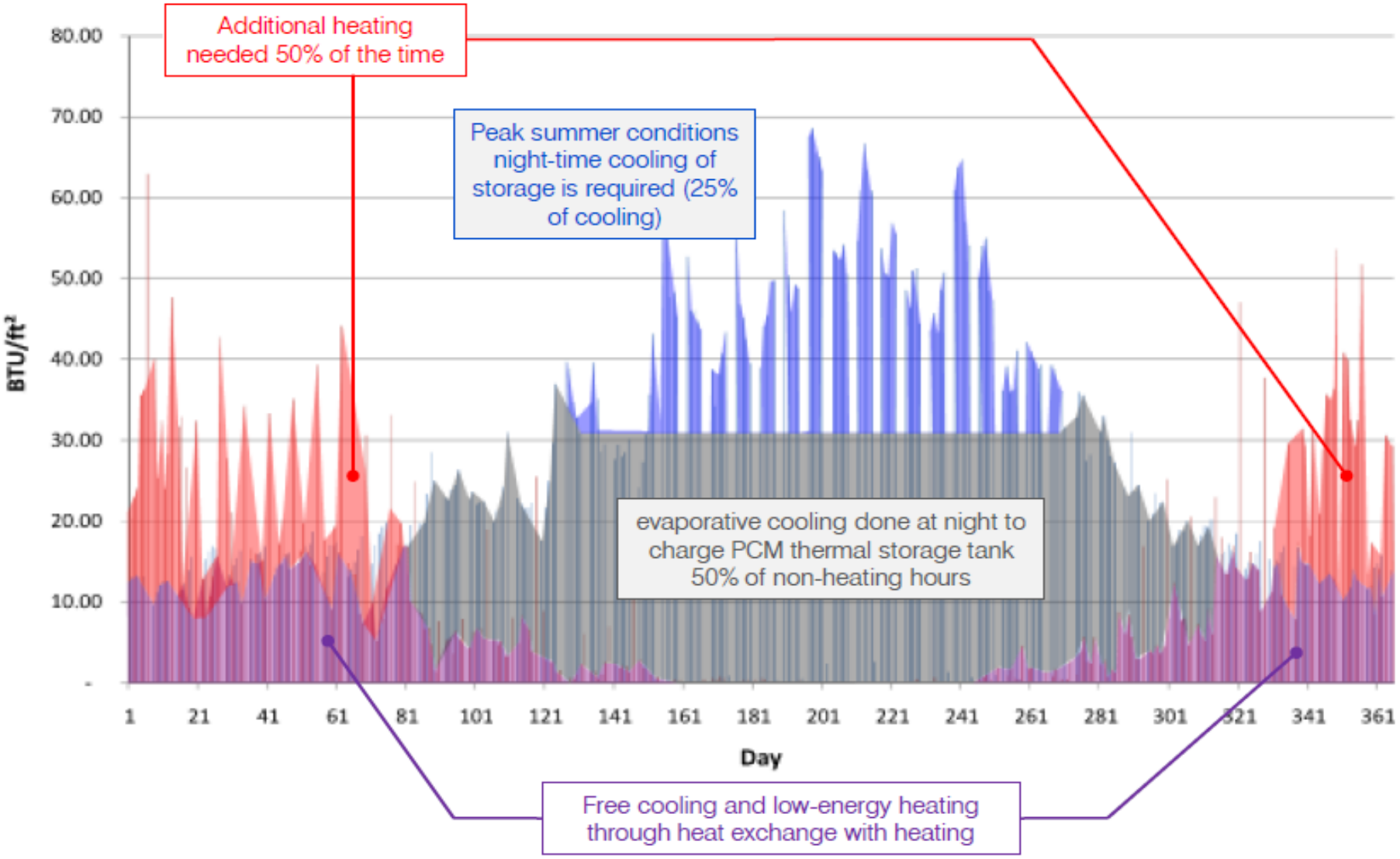
- **Building orientation, High windows & Skylights maximize daylighting ; External Shading controls heat gain**
- **High Performance Glazing enhances energy efficiency as well as Blast Protection**
- **Energy use reduced by 30%**
- **100% Outdoor Filtered Air for Ventilation.**
- **Healthy Underfloor Air Dist. System**
- **High efficiency WaterSense fixtures save water**
- **LEED GOLD Certification**
- **Building Form and Skin designed to aid in air flow**
- **Stormwater is actively managed on-site with surface detention & conveyance**
- **Thermal Storage provides maximum efficiency for HVAC system - Radiant cooling assures thermal comfort while saving energy.**



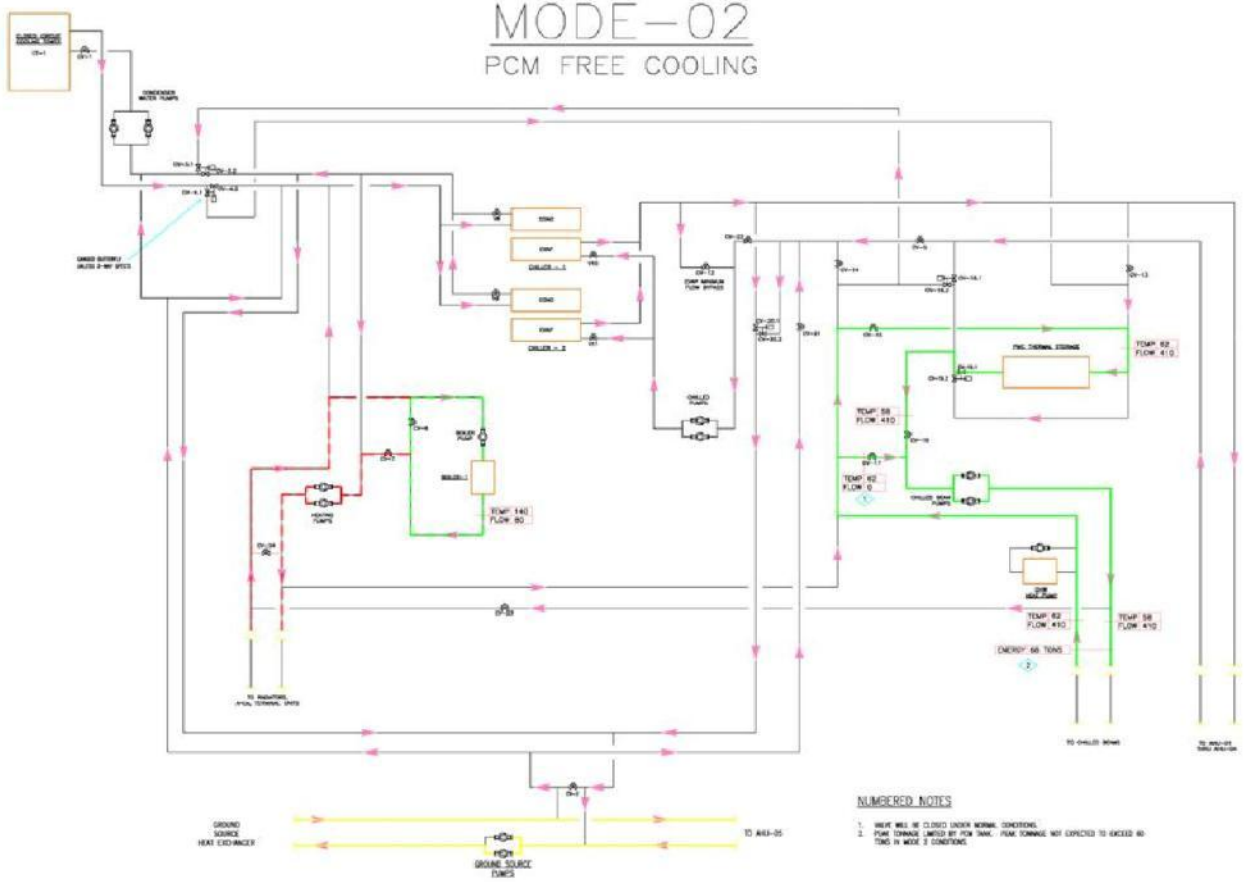
# Energy

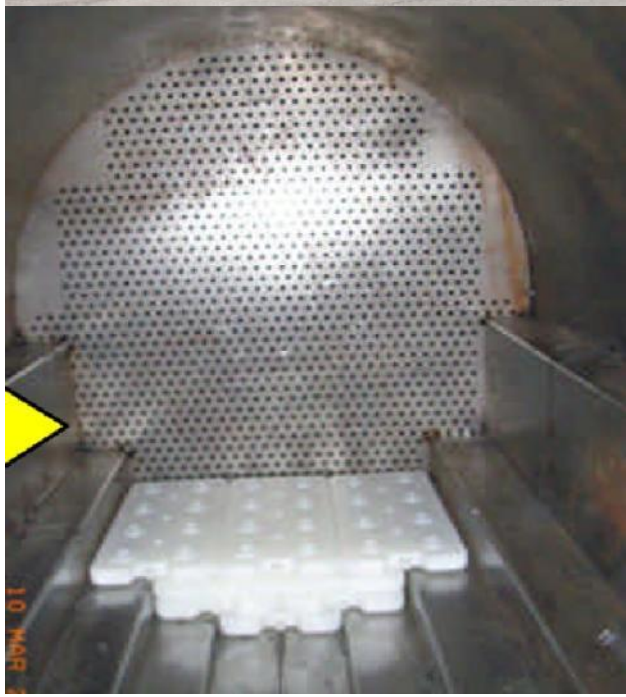

80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
-
BTU/ft²
1
21
41
61
81
101
121
141
161
181
201
221
241
261
281
301
321
341
361
Day

# Energy

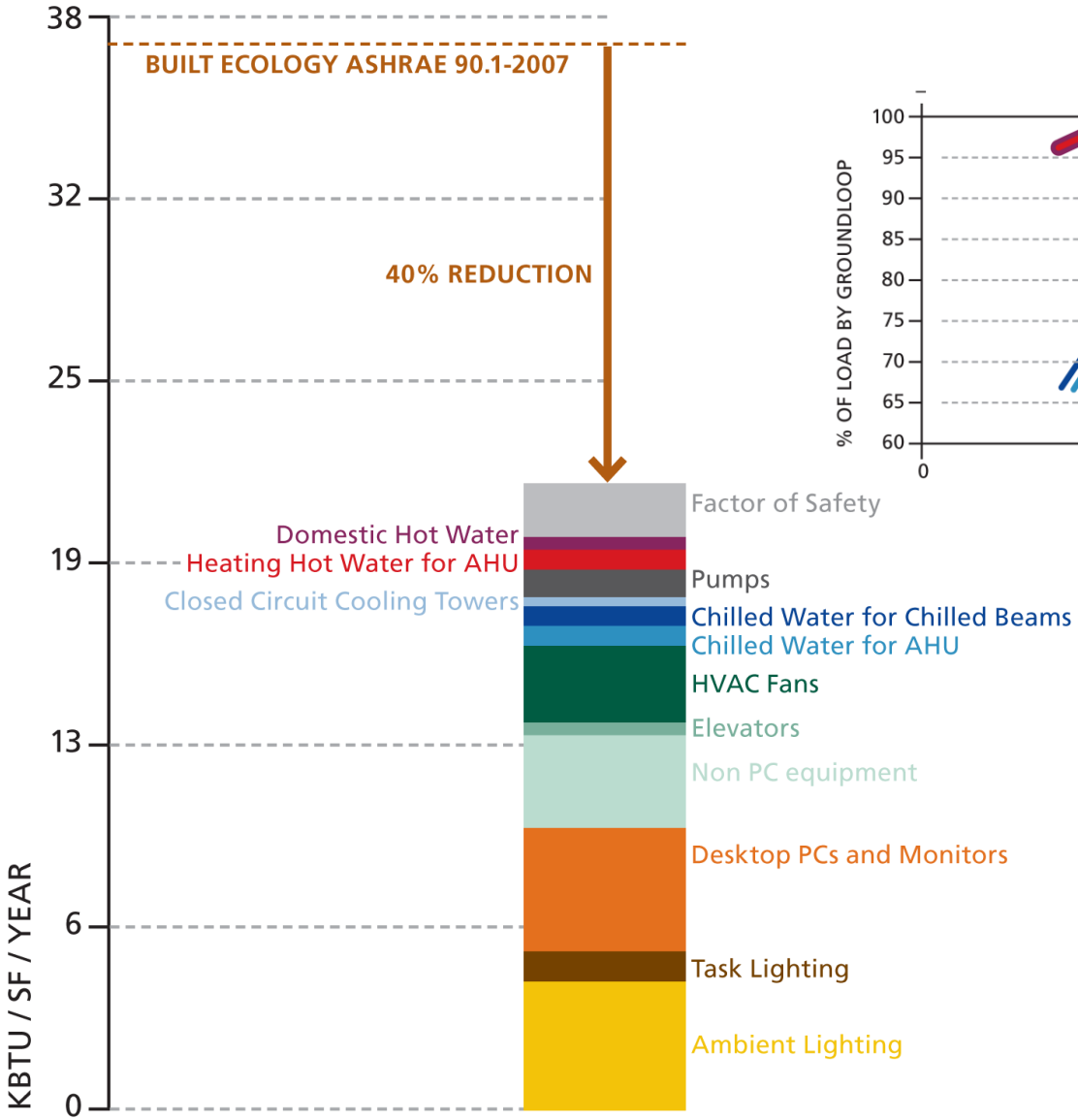

Additional heating needed 50% of the time
Peak summer conditions night-time cooling of storage is required (25% of cooling)
evaporative cooling done at night to charge PCM thermal storage tank 50% of non-heating hours
Free cooling and low-energy heating through heat exchange with heating
BTU/ft²
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
-
1
21
41
61
81
101
121
141
161
181
201
221
241
261
281
301
321
341
361
Day

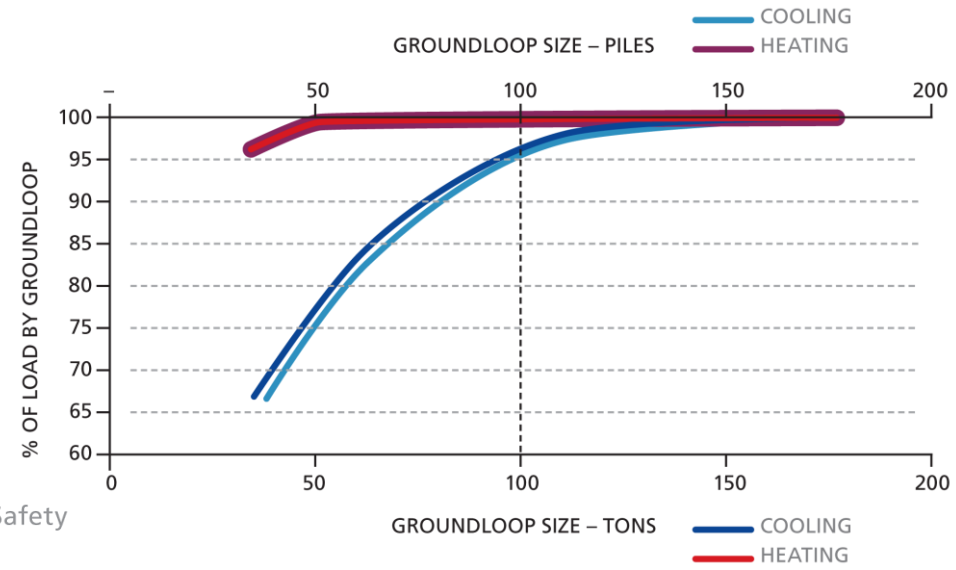
# Thermal Storage



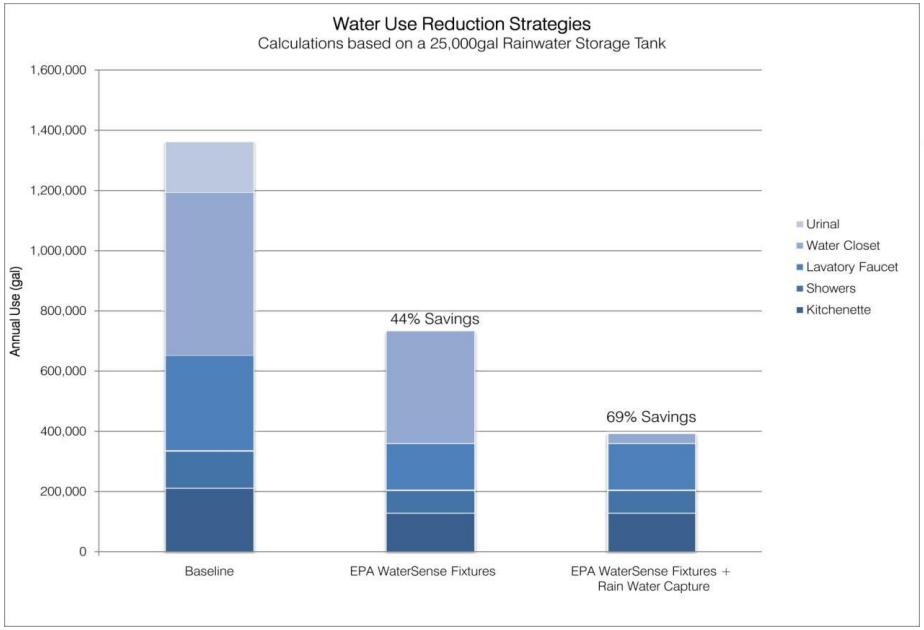



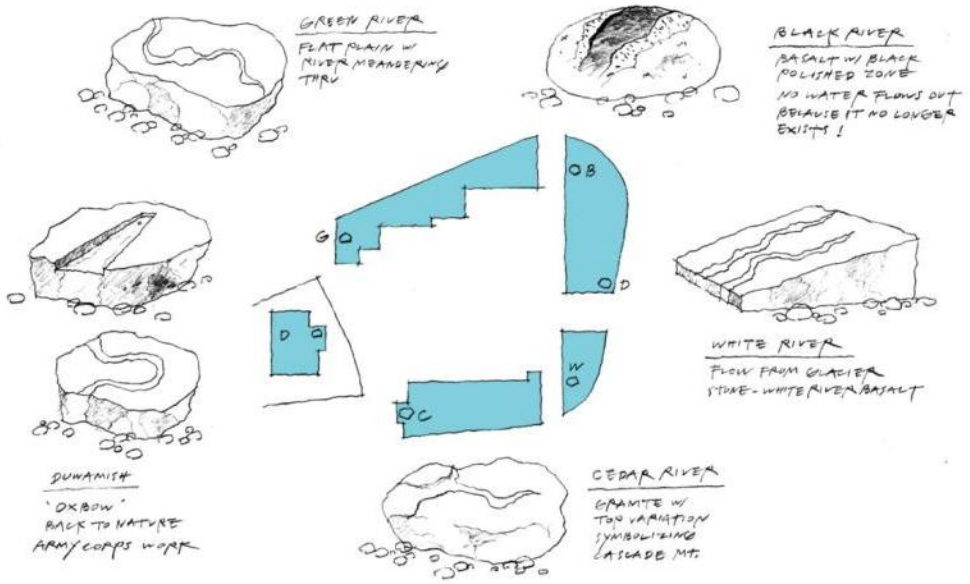
# Ground Source

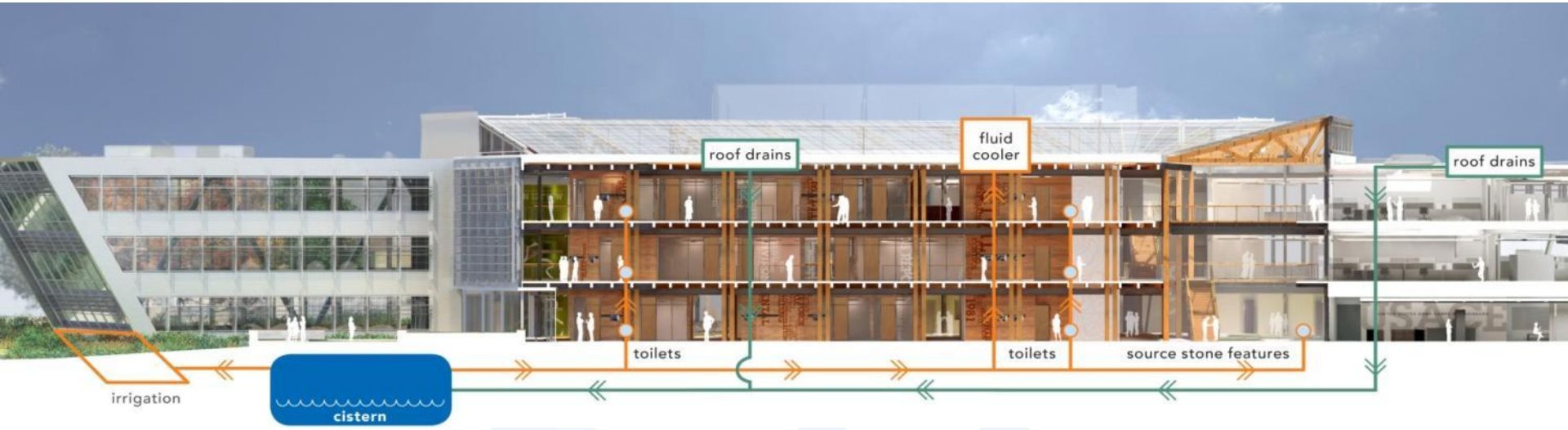


# Water Harvesting



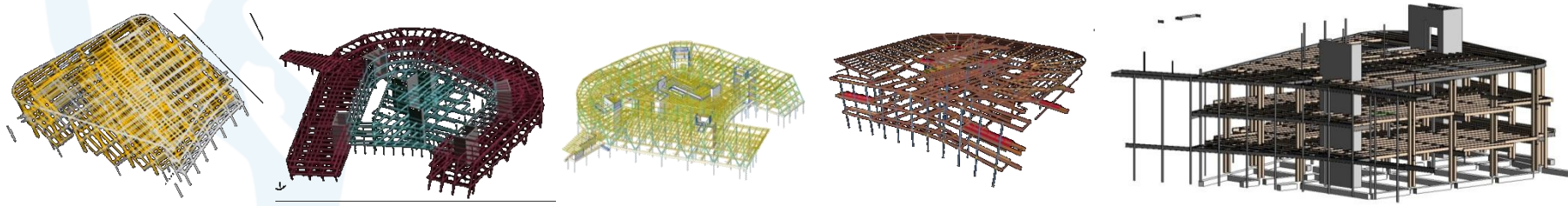



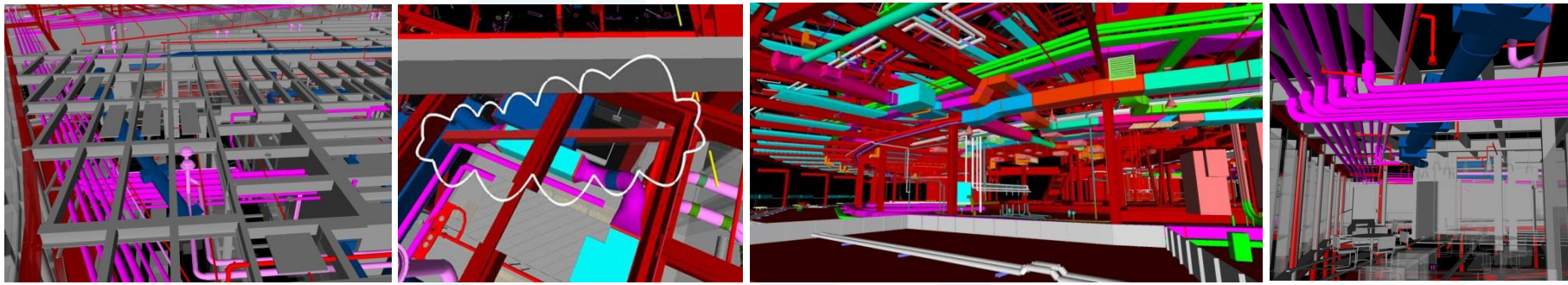
# Model Integration Lessons

**ARCHITECTURAL**

**STRUCTURAL**

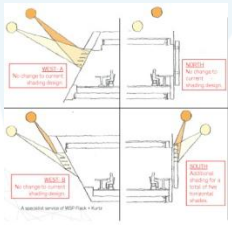
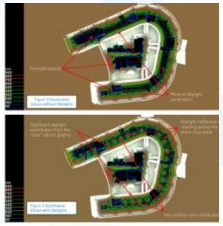
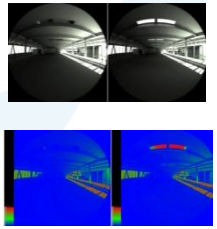


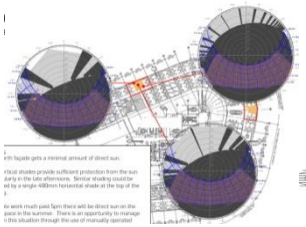
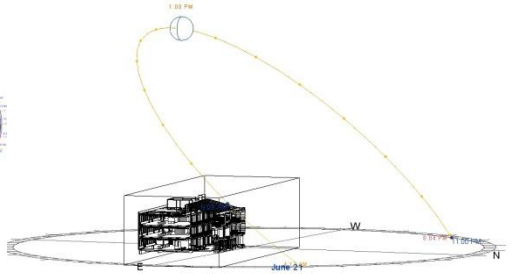
**MECHANICAL**



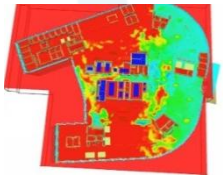
# Model Integration Lessons

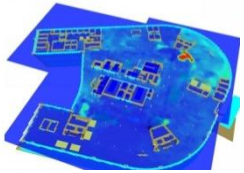
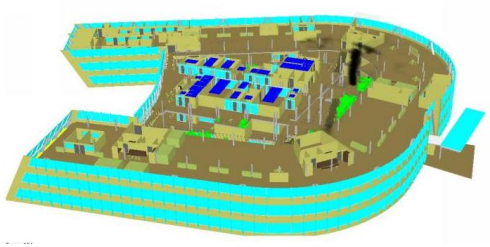
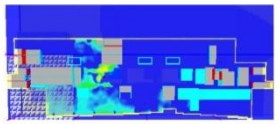
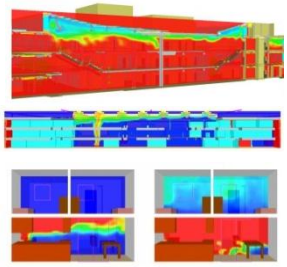
## LIGHTING

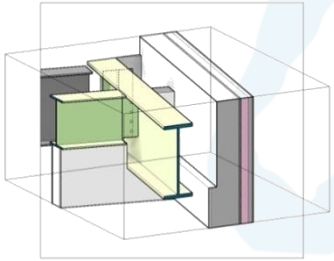
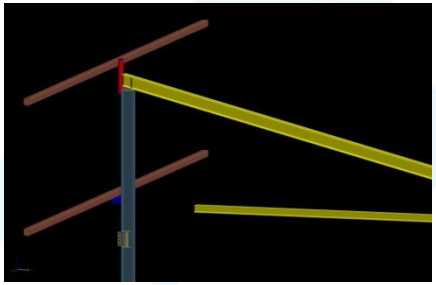



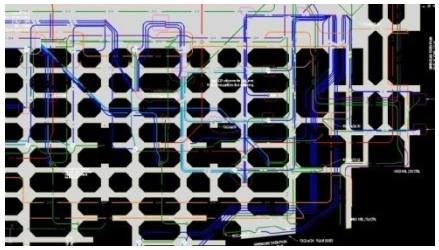
## SMOKE / CFD ANALYSIS



## DETAILING



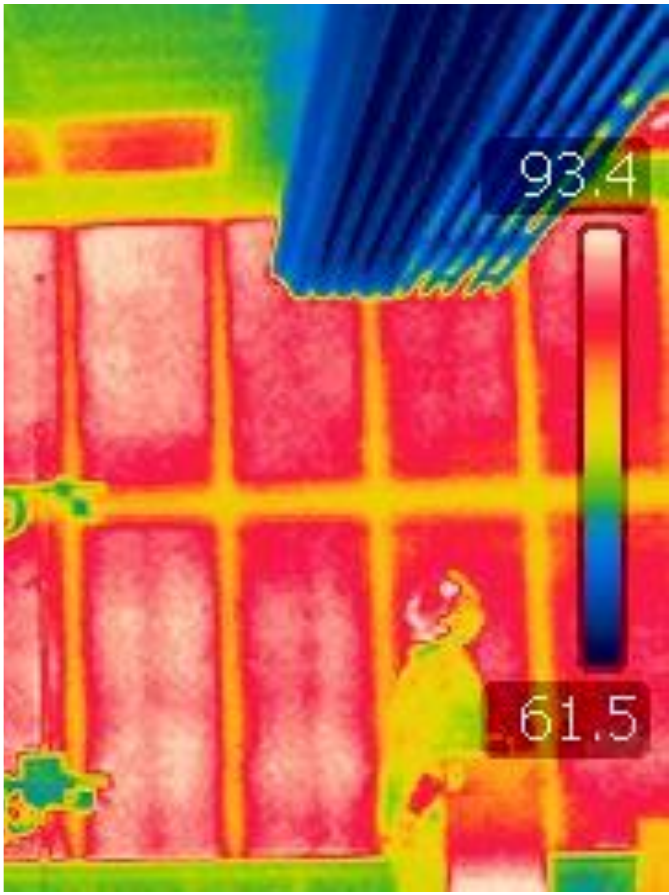
# Create and Test New Products

Through collaborative efforts, the team created and tested three new sustainable products utilized in the building and ready for the market.

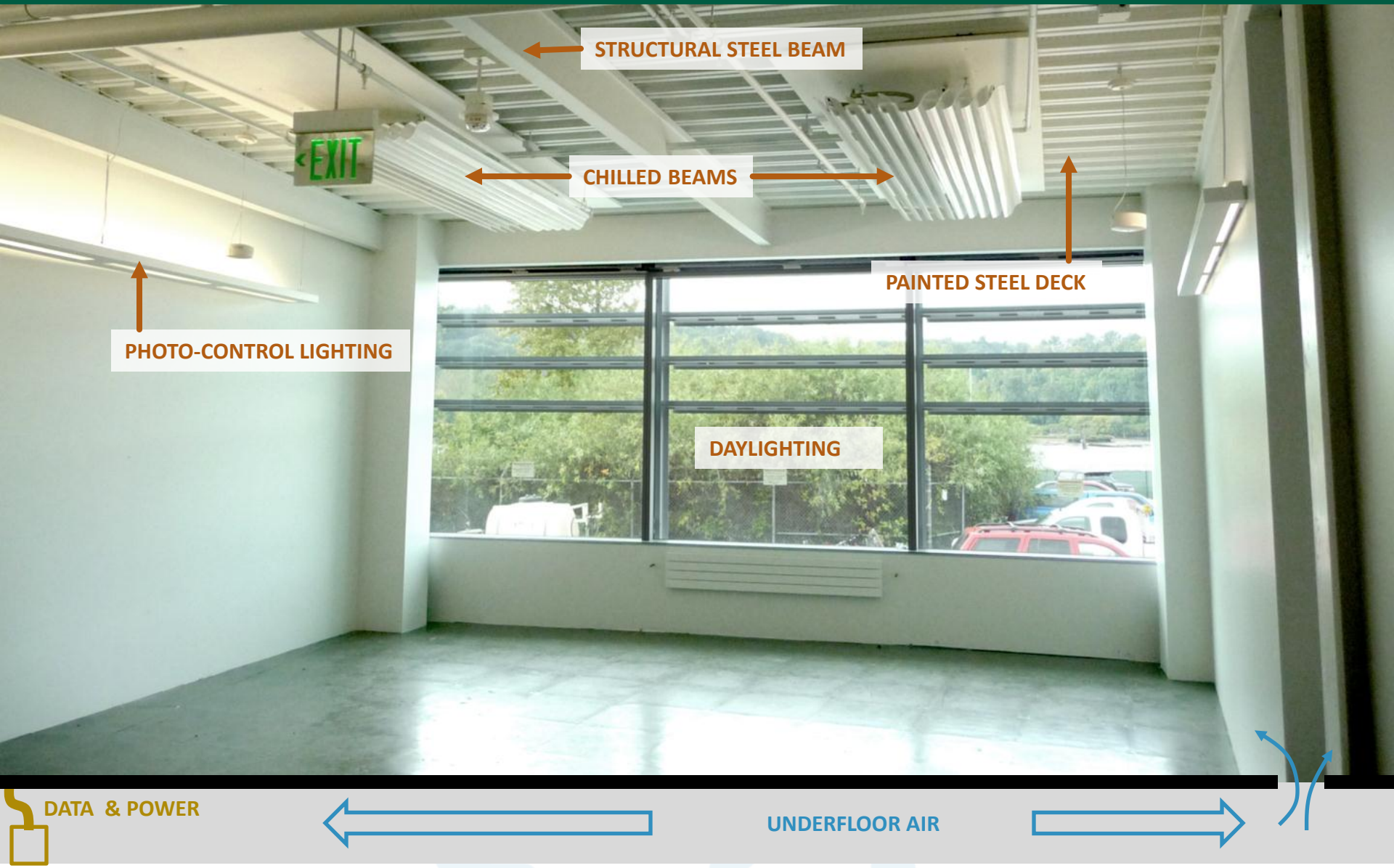
**Steel Shingles**

**Composite Beams**

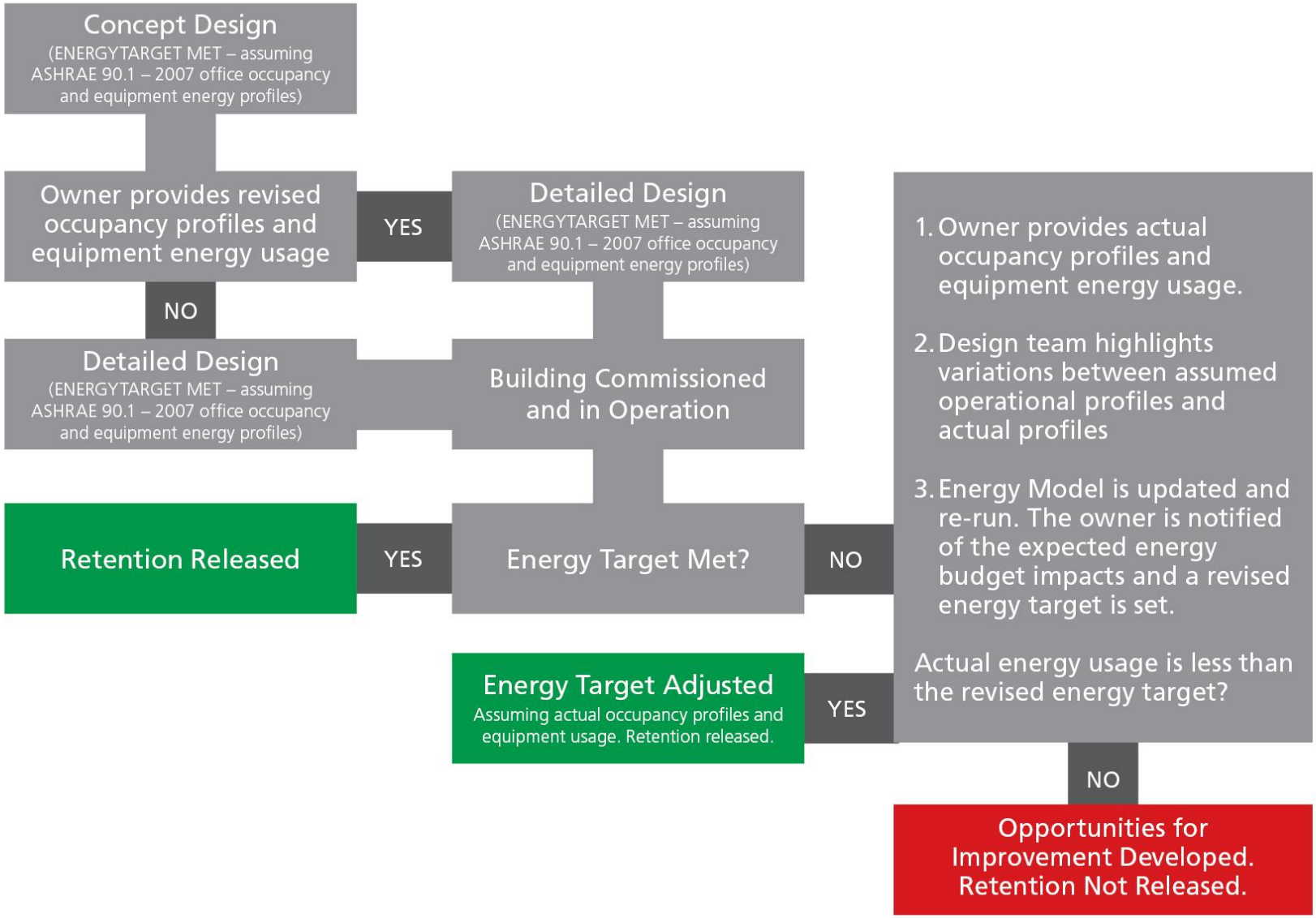
**Chilled Sails**



# Systems Integration Mock-up – R&D Lab



# M&V Process


Concept Design
(ENERGYTARGET MET – assuming ASHRAE 90.1 – 2007 office occupancy and equipment energy profiles)
Owner provides revised occupancy profiles and equipment energy usage
YES
Detailed Design
(ENERGYTARGET MET – assuming ASHRAE 90.1 – 2007 office occupancy and equipment energy profiles)
NO
Detailed Design
(ENERGYTARGET MET – assuming ASHRAE 90.1 – 2007 office occupancy and equipment energy profiles)
Building Commissioned and in Operation
Retention Released
YES
Energy Target Met?
NO
1. Owner provides actual occupancy profiles and equipment energy usage.
2. Design team highlights variations between assumed operational profiles and actual profiles
3. Energy Model is updated and re-run. The owner is notified of the expected energy budget impacts and a revised energy target is set.
Actual energy usage is less than the revised energy target?
Energy Target Adjusted
Assuming actual occupancy profiles and equipment usage. Retention released.
YES
NO
Opportunities for Improvement Developed. Retention Not Released.

**General Contractor:**
**SELLEN CONSTRUCTION COMPANY**

**Architect:**
**ZGF ARCHITECTS LLP**

**Sustainability Lead:**
**SELLEN SUSTAINABILITY**

**Design Consultants:**
**KPFF CONSULTING ENGINEERS, INC.**
**WSP FLACK + KURTZ/BUILT ECOLOGY**
**SITE WORKSHOP LLC**
**STUDIO SC**
**LERCH BATES**
**ROLF JENSEN & ASSOCIATES, INC.**
**HINMAN CONSULTING ENGINEERS, INC.**
**THE GREENBUSCH GROUP, INC.**
**TUAZON ENGINEERING**
**HART CROWSER & ASSOCIATES, INC.**
**LANE COBURN & ASSOCIATES, LLC**
**MCKINNEY ASSOCIATES**
**OTTO ROSENAU & ASSOCIATES, INC.**

**Key Subcontractors:**
**THE G.R. PLUME COMPANY**
**UNIVERSITY MECHANICAL CONTRACTORS**
**SEQUOYAH ELECTRIC, LLC**
**PATRIOT FIRE PROTECTION**
**MILLENNIUM TILES, LLC**
**NORTH SHORE SHEET METAL**
**WALTERS & WOLF**
**SESSLER**
**R.W. RHINE, INC.**
**BARCOL-AIR**
**LUTRON**
**LITECONTROL**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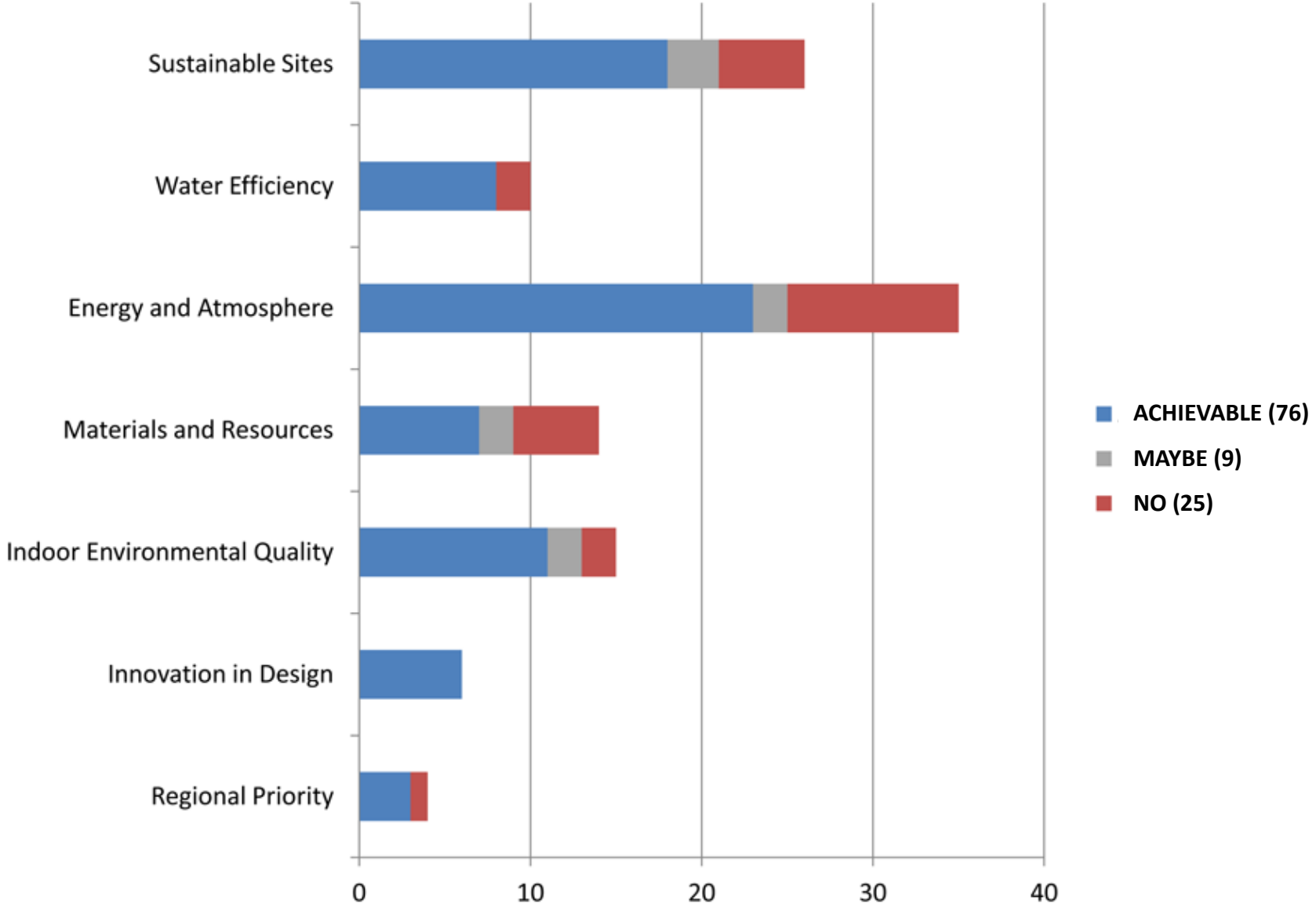
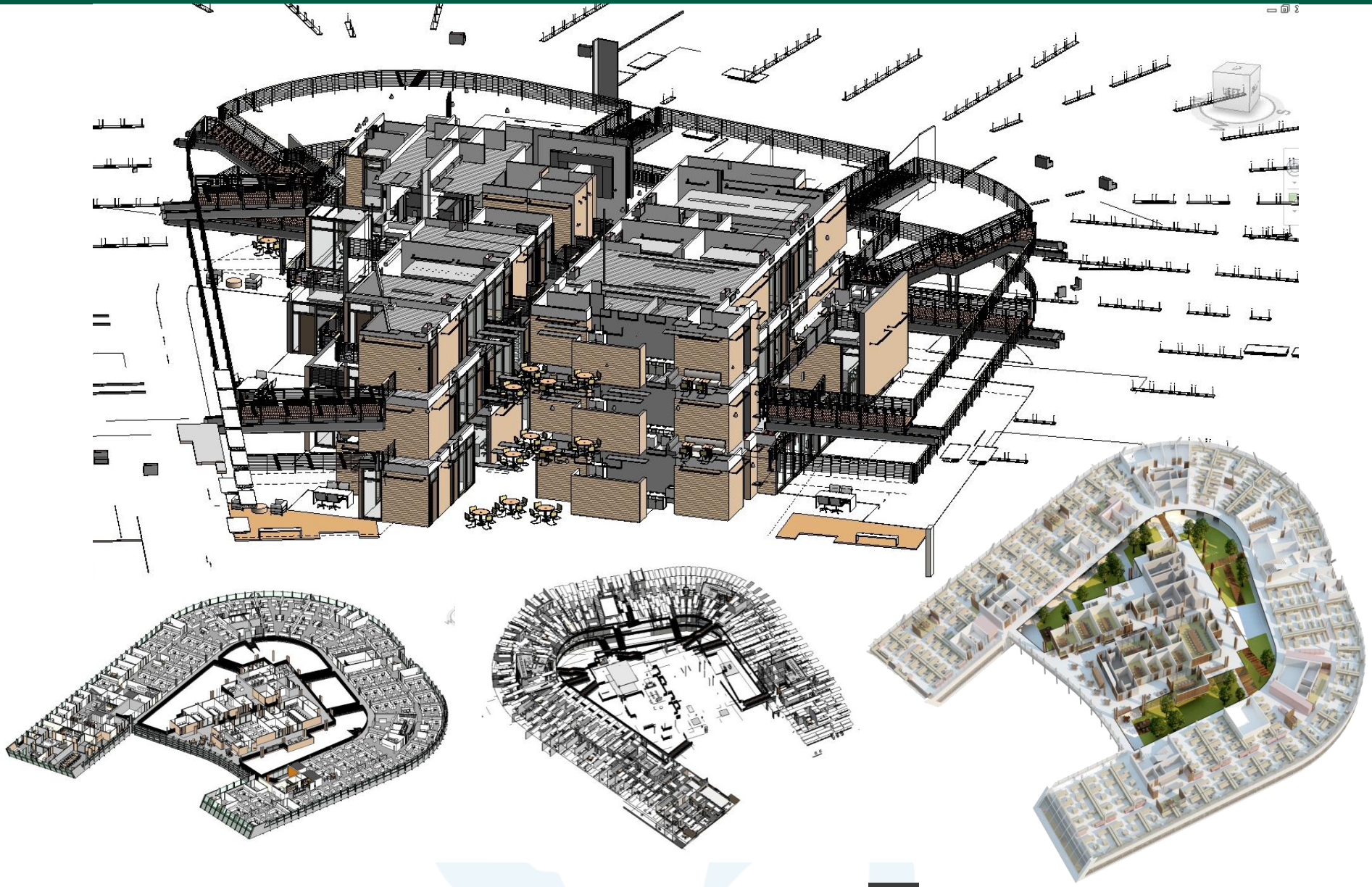
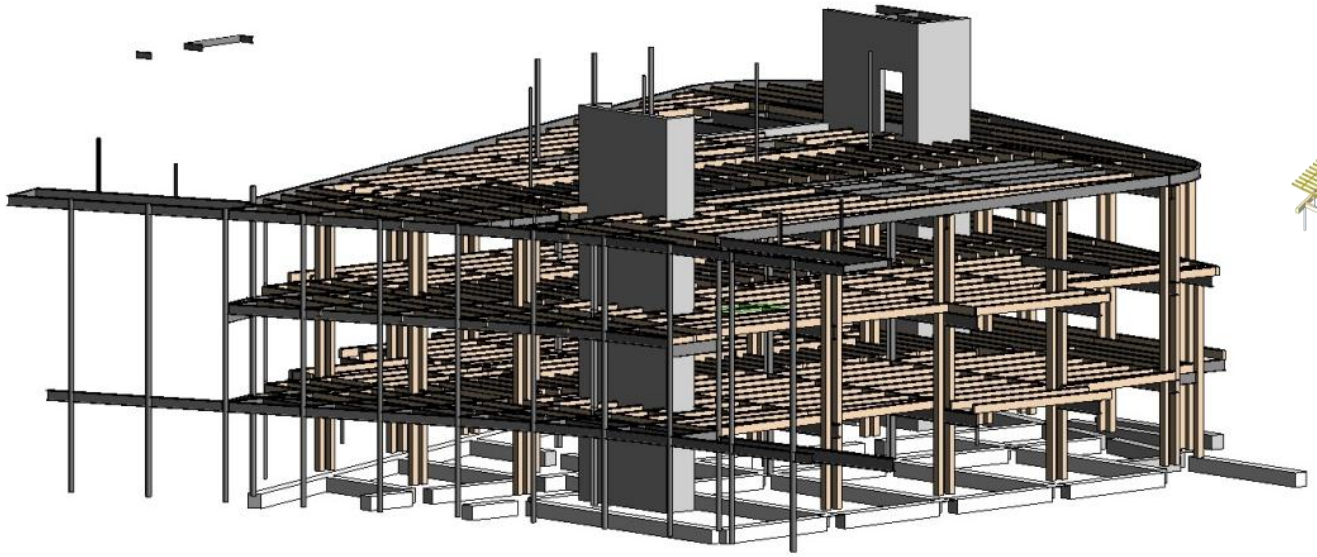
# LEED Gold Target

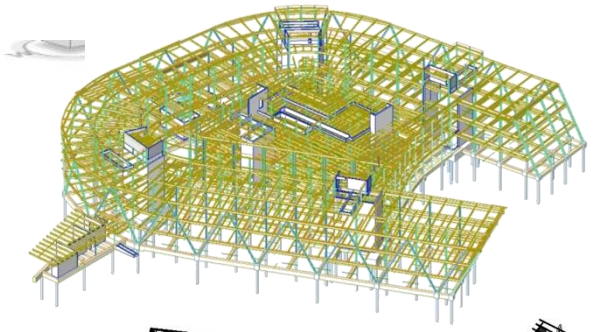


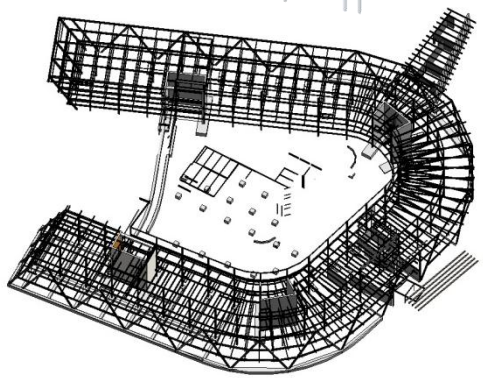
# Model Integration Lessons - Architectural

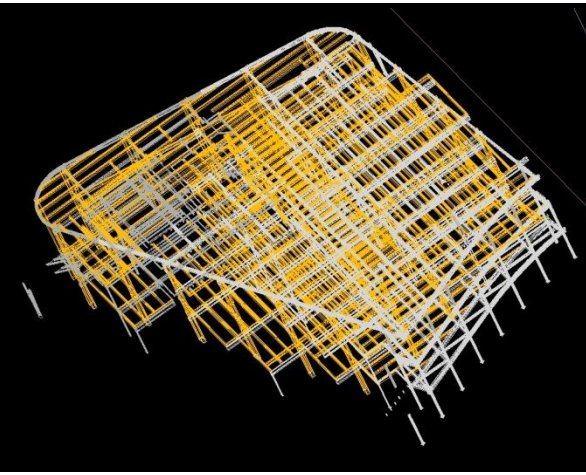


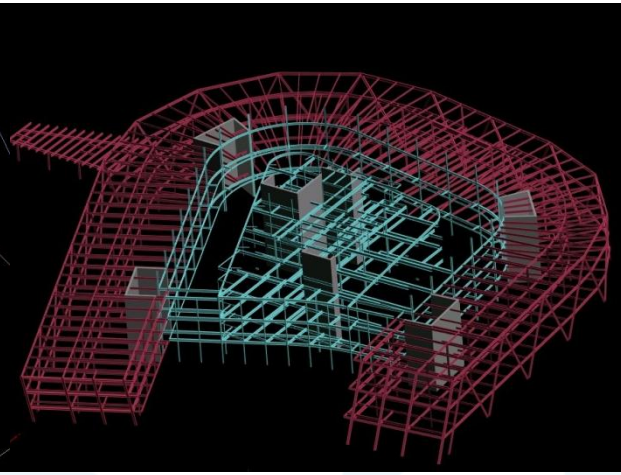
# Model Integration Lessons - Structural

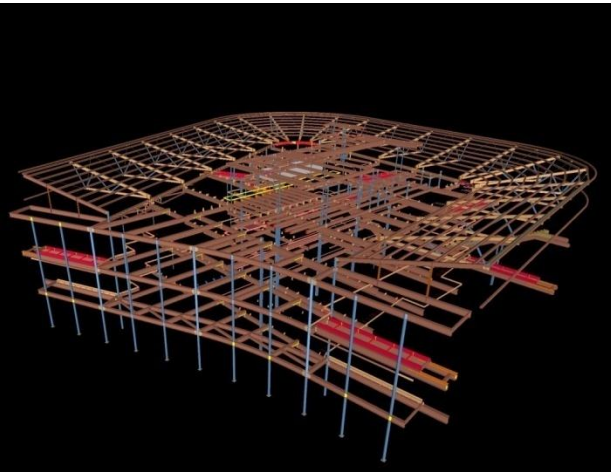




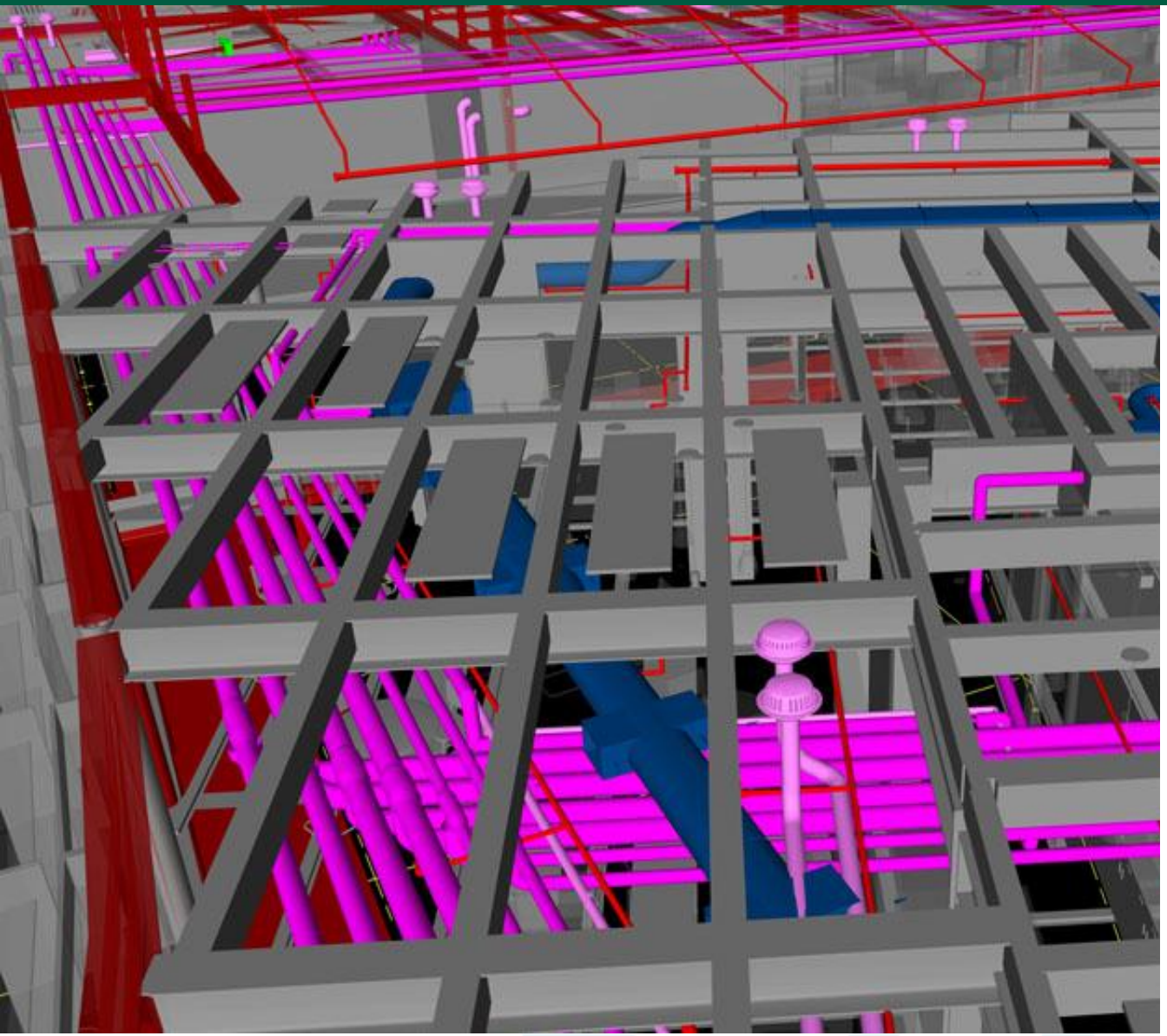


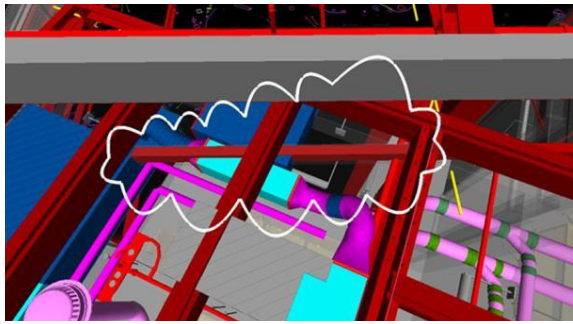


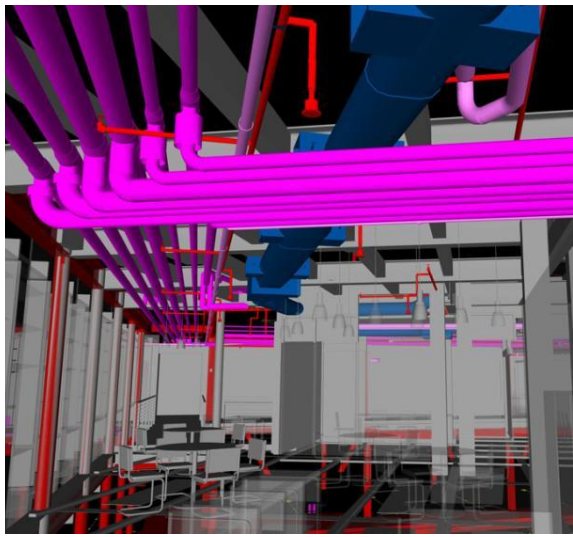




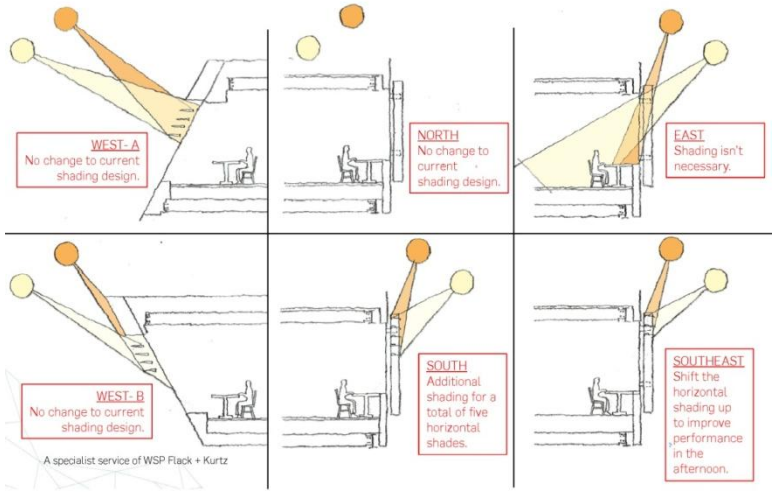
# Model Integration Lessons - Mechanical

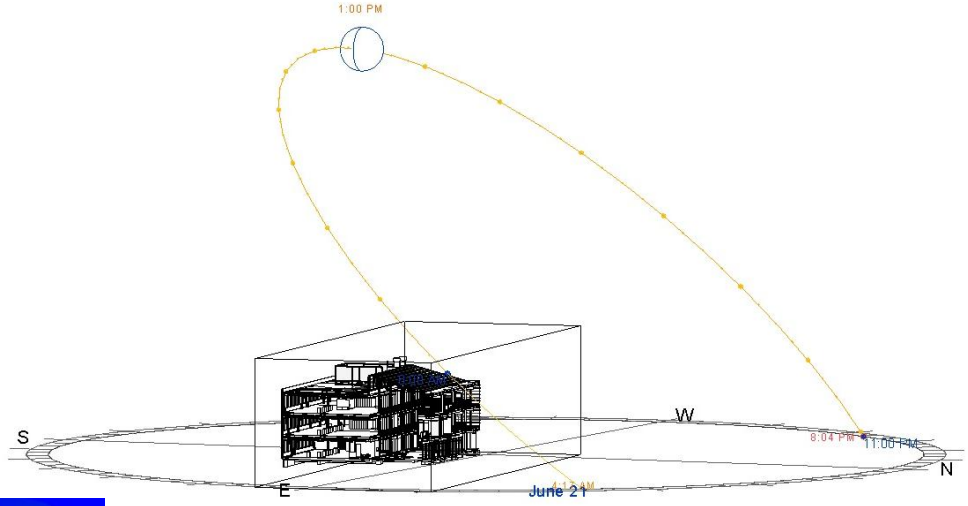


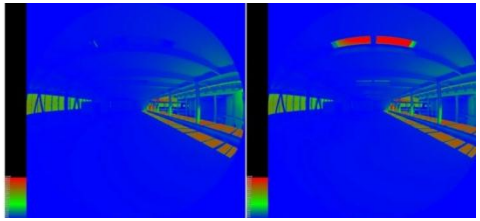


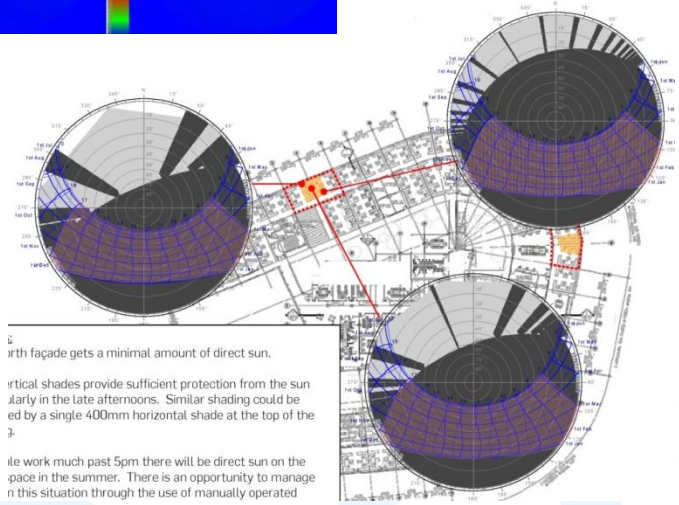


# Model Integration Lessons - Lighting



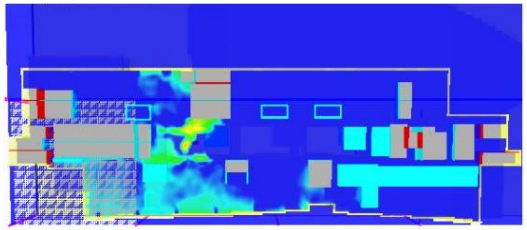
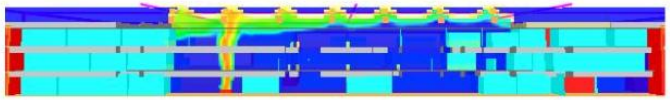
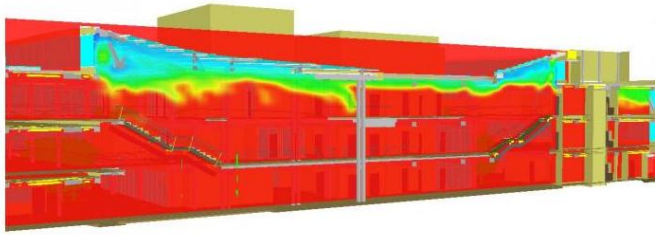
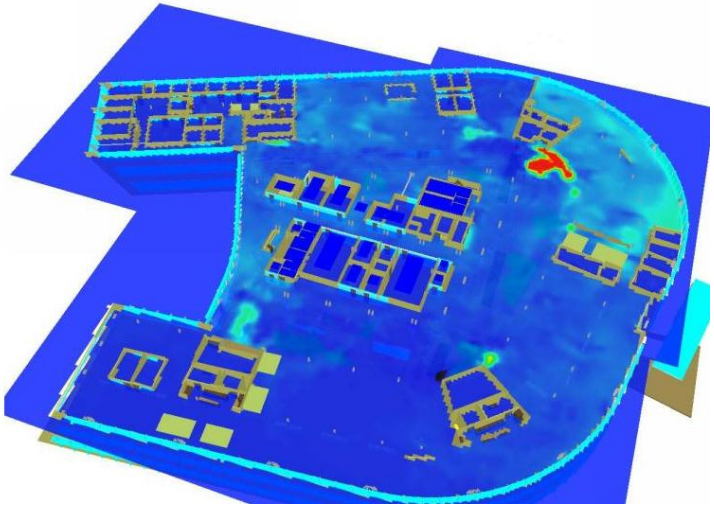
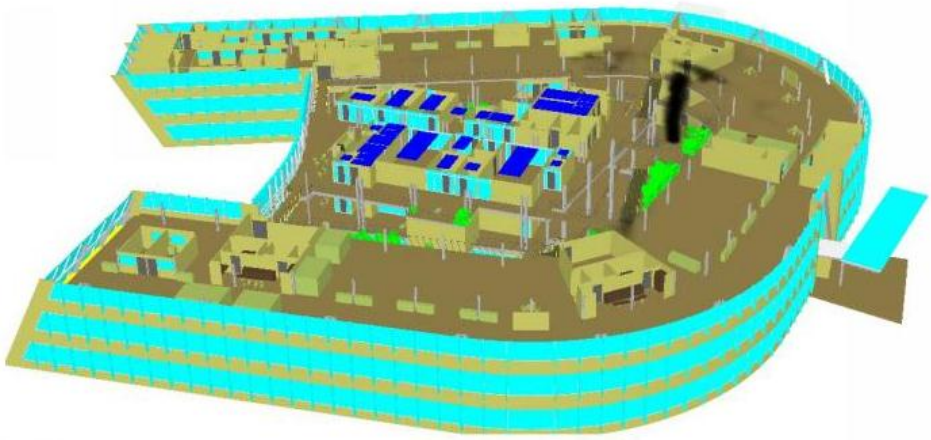
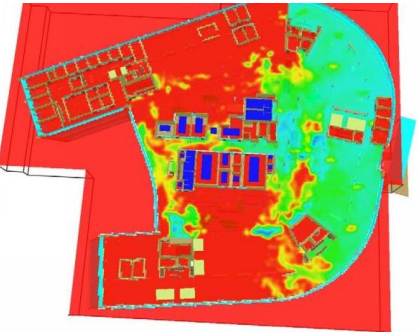
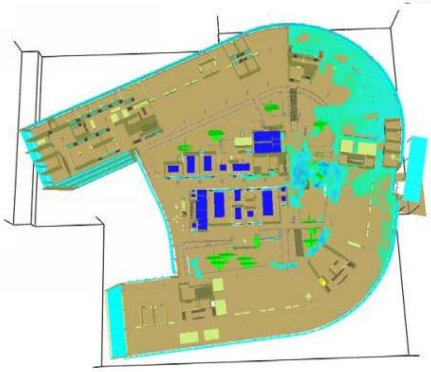
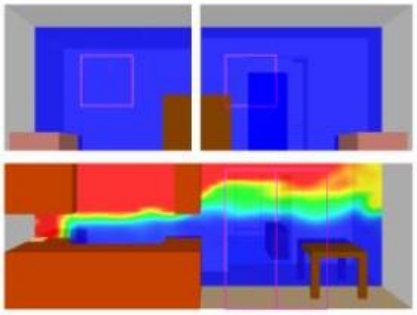
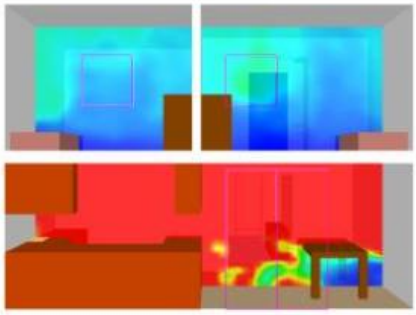



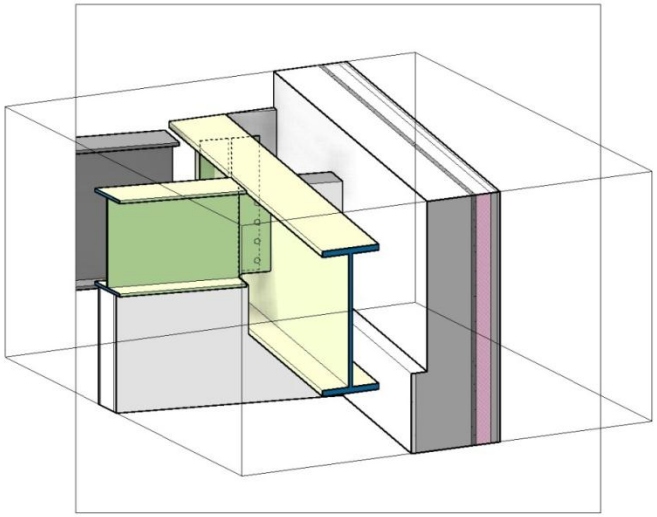



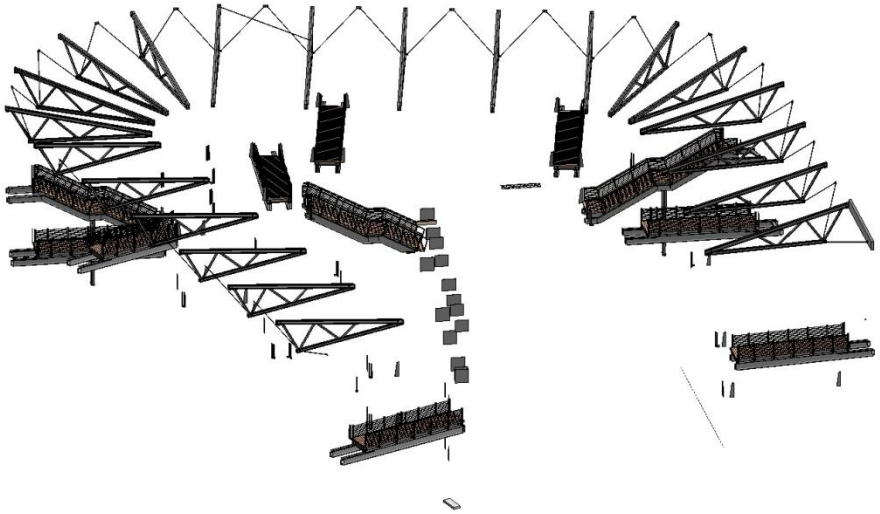


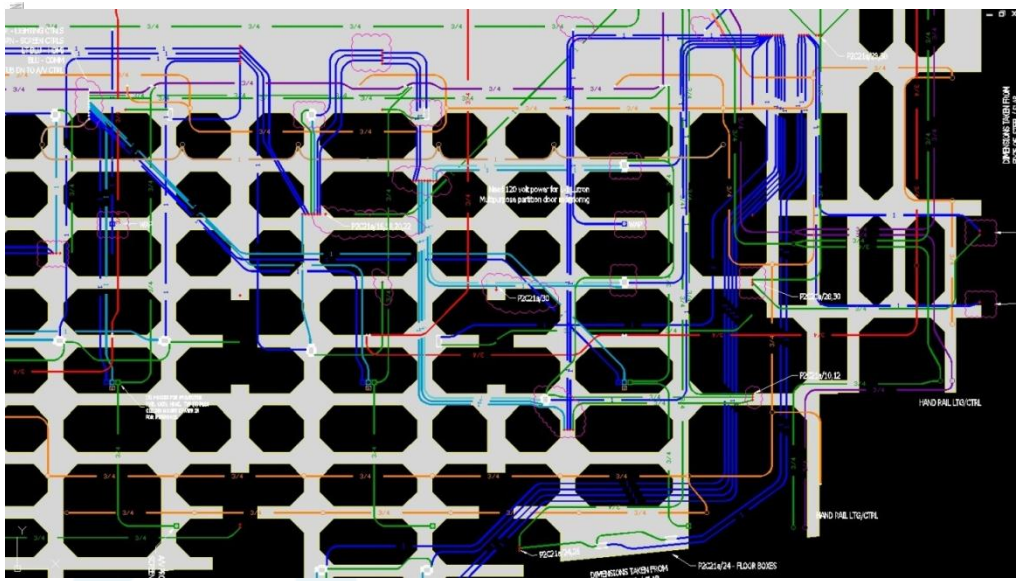
# Model Integration Lessons - Smoke

# Model Integration Lessons - Detailing





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