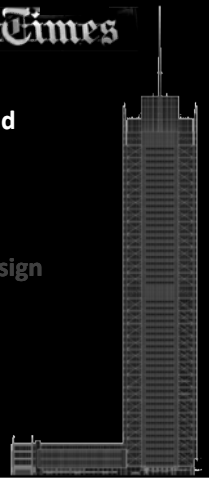
Project Team

The New York Times



Building Statistics

The New York Times Building

620 Eighth Ave. Times Square
Midtown Manhattan, New York, NY

Building Owners

- The New York Times Company: Floors 2 - 27
- Forrest City Ratner Companies: Floors 29 - 50

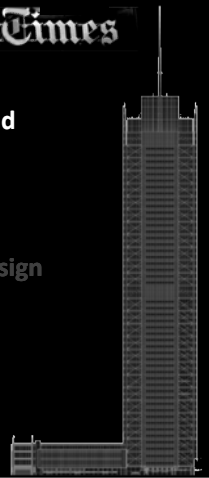
Building Cost

- Assumed construction cost of $ 1 billion
- New York Times Portion: $ 604 - $ 624 million

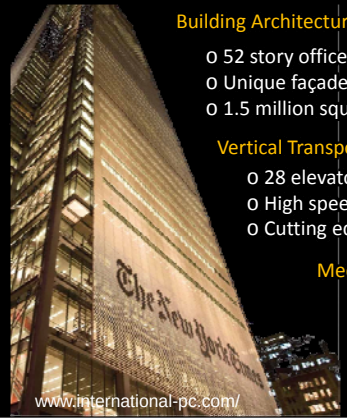
Building Function

- Class A Office Building
- Retail Space on Ground Floor

The New York Times



Building Background



Building Architecture

- 52 story office building, 745’ tall
- Unique façade with ceramic rod shading system
- 1.5 million square feet

Vertical Transportation

- 28 elevators serving the tower
- High speed “smart” design (1,600 ft/min)
- Cutting edge call system

Mechanical:

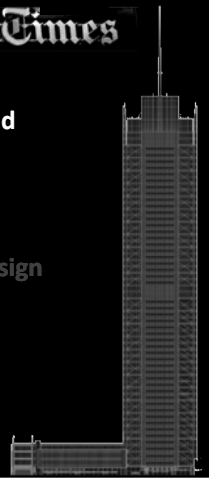
- 6250 ton chilled water system
- 1.4 MW cogeneration system
- District steam heating
- UFAD / VAV air distribution

Lighting/Electrical:

- 18,000 Luminaires
- Fixtures Controlled by a Digitally Addressable Lighting Interface (DALI)
- 5 Transformers with Room for Expansion

Structural:

- Composite Beam & Girder Floor System
- Steel Braced Frame Lateral Force Resisting System
- Outriggers on 28th & 51st Mechanical Levels
- Exposed Pretension Exterior Steel Rods
- Exposed 30”x30” Built-up Steel Columns
- Thermal Trusses on 51st Mechanical Floors



Project Team

Architects: Renzo Piano Building Workshop
FXFOWLE Architects

CM: AMEC Construction Mgmt. (Core & Shell)
Turner Construction (NYT Interiors)

Structural: Thornton Tomasetti

MEP: Flack and Kurtz

Project Milestones:

- August 23, 2004 – Excavation Begins
- July 2006 – Topping Out Ceremony
- November 19, 2007 – Grand Opening of the New York Times Building

The New York Times

- Intro
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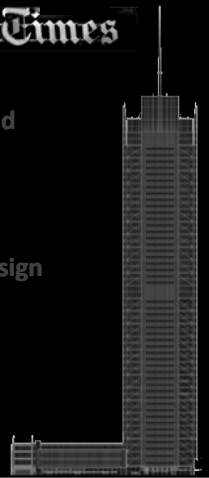
- **Proposal**
- Façade Redesign
- Floor System Redesign
- Core Redesign
- CoGen Redesign
- BIM/IPD
- Metrics of Success



Redesign Goals

www.international-pc.com/

Increased Profitability
- Operating Costs
- Leasable Space

Increased Marketability
- Sustainability
- Iconic Image

The New York Times

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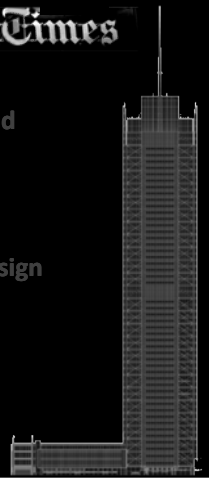
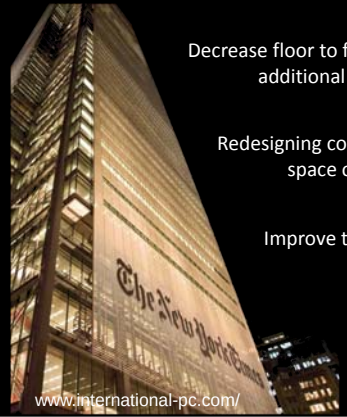


Redesign Strategies



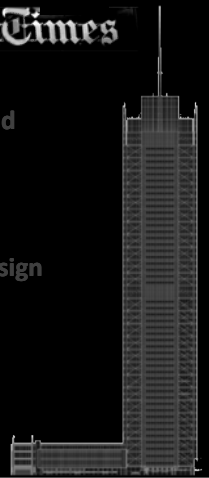
www.international-pc.com/

Decrease floor to floor height to allow for an additional rentable floor

Redesigning core to add additional rentable space on each floor

Improve the sustainability profile

The New York Times



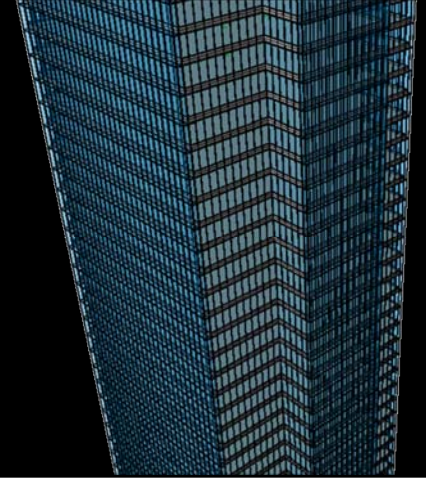
Façade Redesign

Façade Goals:

- o Increase Thermal Efficiency
- o Maintain or Exceed Daylighting Performance
- o Maintain Iconic Image
  - Transparency
  - Lightness
  - Innovative Design

Redesign Opportunities:

- o Explore Double-Skin Façade
- o Explore Alternate Shading Techniques



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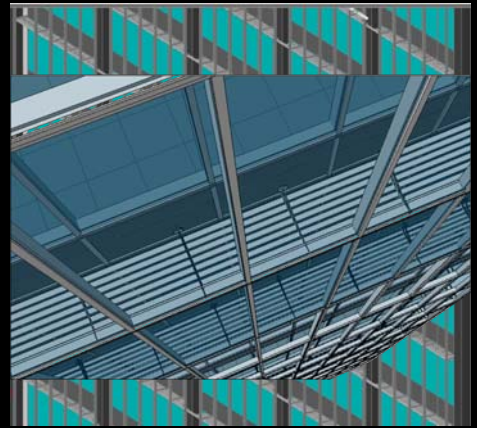
System Description

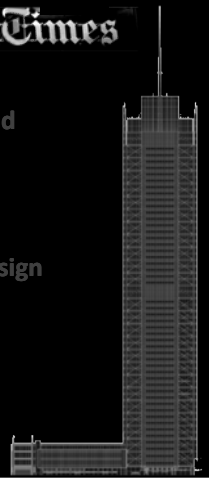
2’ 6” air cavity with horizontal louvered shading system

1” interior insulating glazing curtain wall

5/8” exterior laminated glazing unit

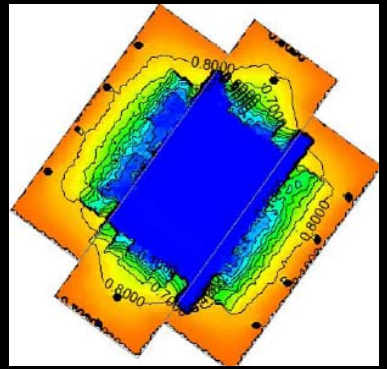


The New York Times

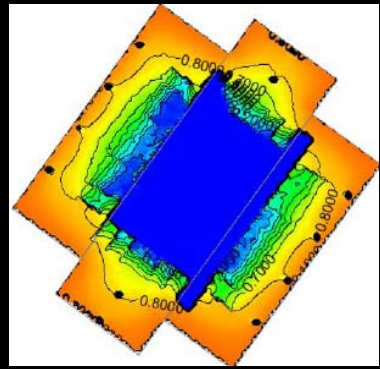


Façade Daylight Analysis

Daylight Autonomy: Rod Design



Daylight Autonomy: Louvered Design



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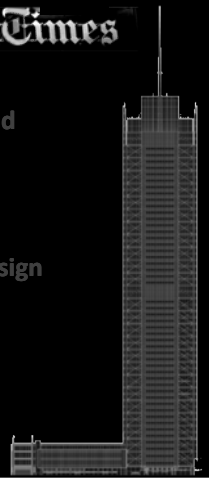


Façade Daylight Analysis

Eighth Floor Power Consumption

Maximum Potential: 71 kWh

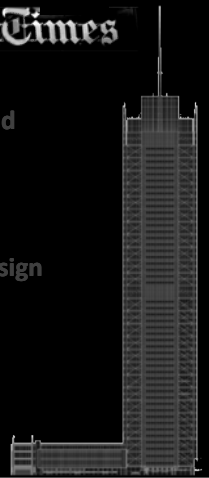
Rod Design: 27 kWh

Louvered Design: 28 kWh

60% Energy Savings

$10,000 / Year

The New York Times



Thermal Loads

Existing HVAC Envelope Loads:

- o Peak cooling: 58%
- o Peak heating: 75%

Double-Skin Façade Thermal Efficiency:

- o Decreased U-value
- o Decreased Shading Coefficient

	Existing Façade	Double-Skin Façade
U-Value	0.625	0.50
Shading Coefficient	0.750	0.38

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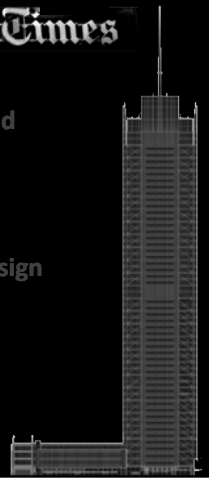

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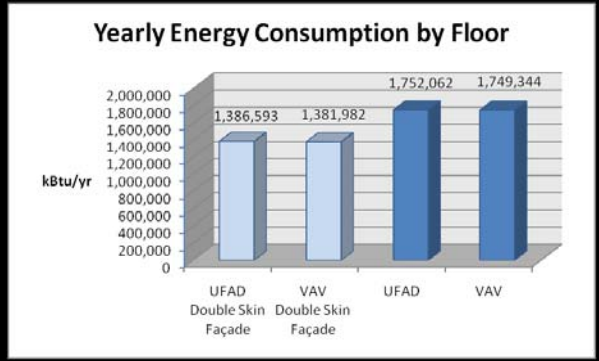
Double-Skin Façade Thermal Efficiency:

- o Decreased U-value
- o Decreased Shading Coefficient

Savings:

- o Energy (21%)



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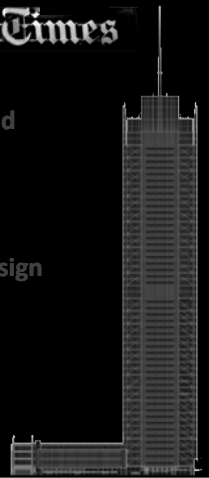

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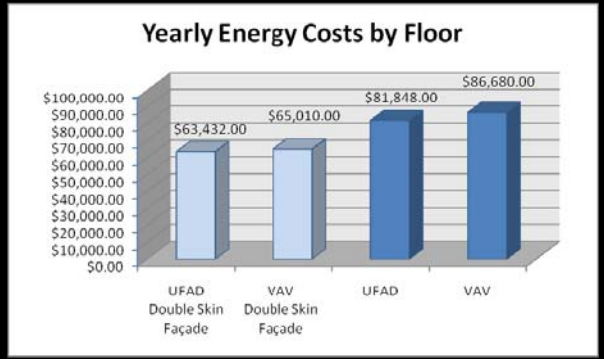
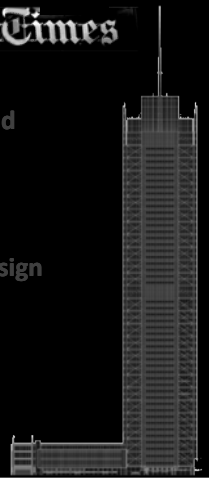
Savings:

- o Energy (21%)
- o Cost ($800,000 / year)





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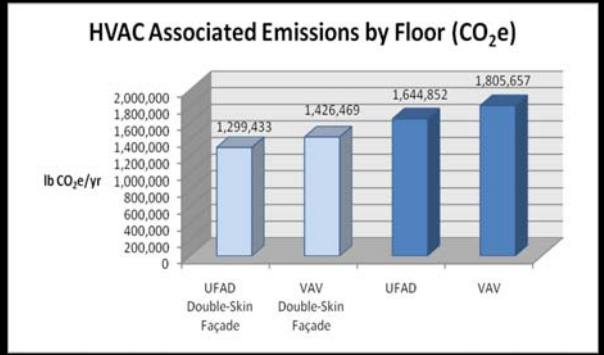
Double-Skin Façade Thermal Efficiency:
- o Decreased U-value
- o Decreased Shading Coefficient

Savings:
- o Energy (21%)
- o Cost ($800,000 / year)
- o Emissions (23%)



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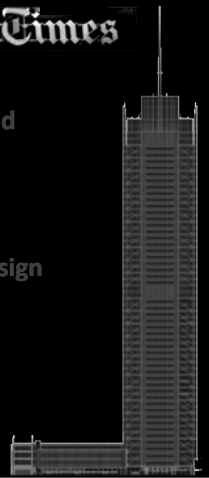
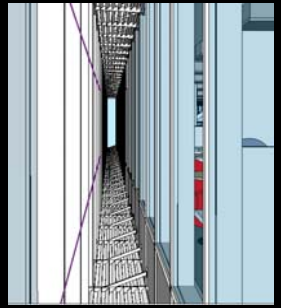
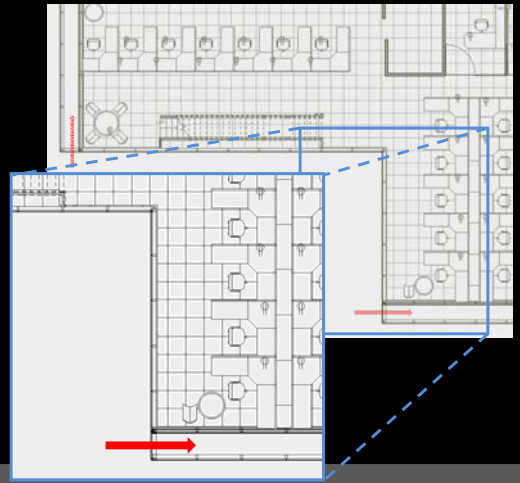


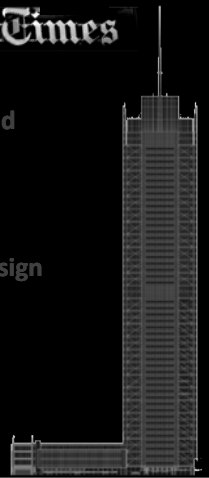
Serviceability and Maintenance

2.5’ accessible cavity

Louvers support walking loads







Cost Comparison:

Double-skin façade yields an $18.7 million increase in up front cost

Annual energy savings of $800,000

Simple payback period of 23.43 years

Original Façade System	$ 83,527,260
Proposed Double Façade	$ 102,273,745
Upfront Cost Increase	$ 18,746,485
Annual Energy Savings	$ (800,000)
Simple Payback Period	**23.43 Years**

The New York Times

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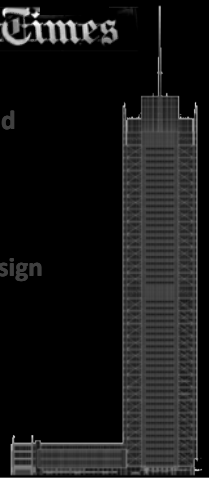
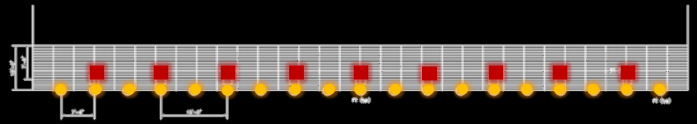
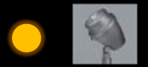


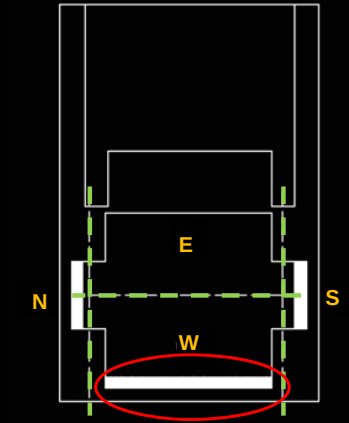
Façade Lighting Redesign





400W Floodlight

250W Floodlight



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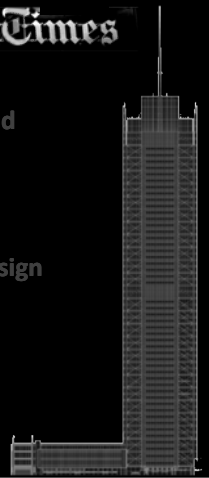

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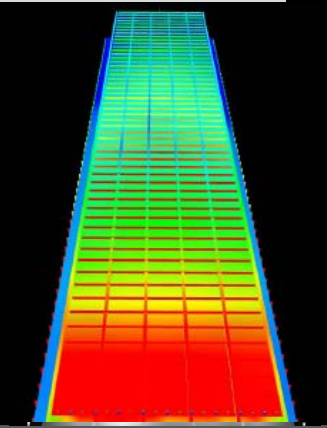

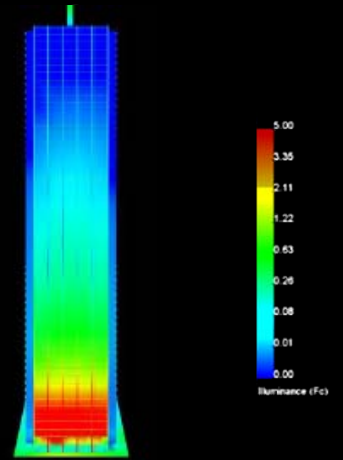

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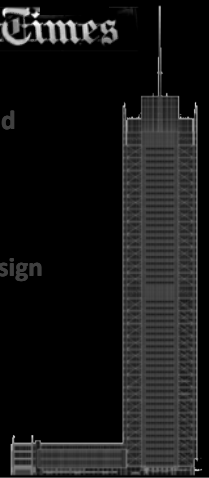

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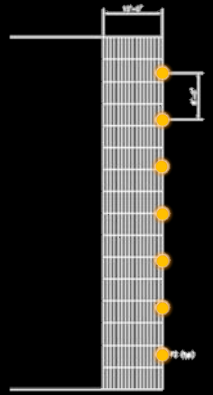

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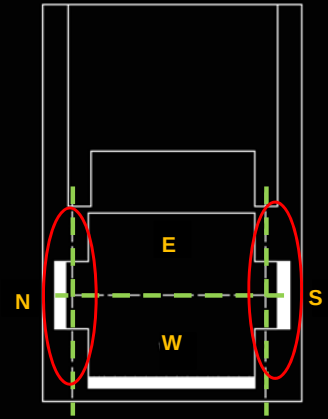

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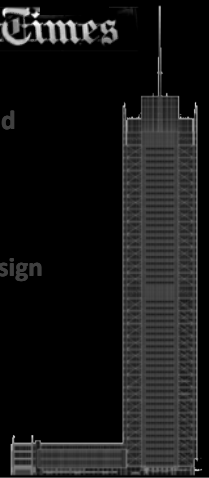

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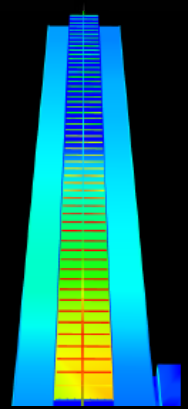

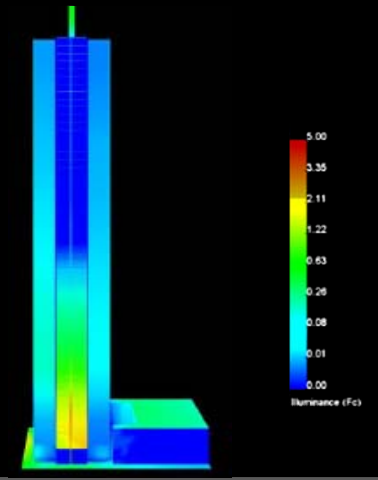

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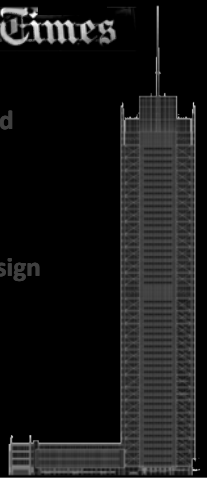

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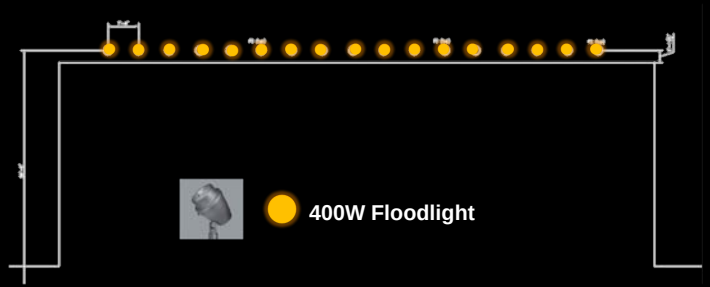

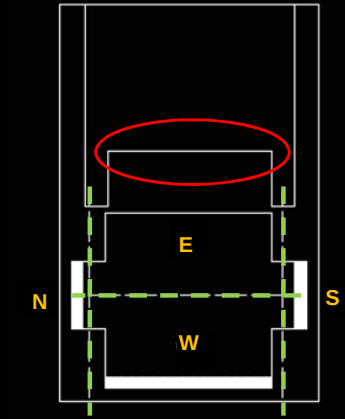

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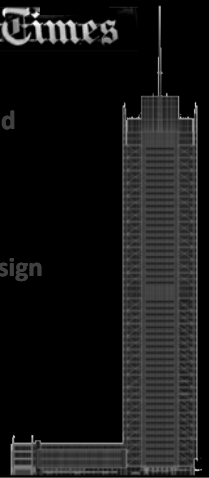

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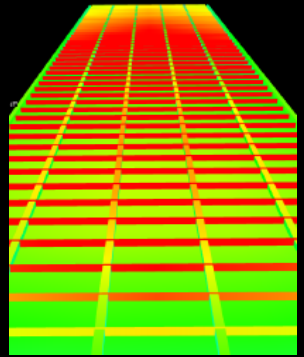

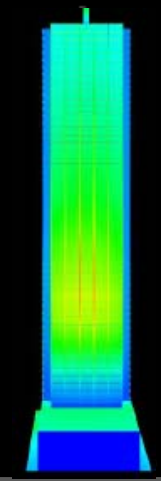

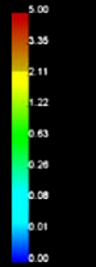

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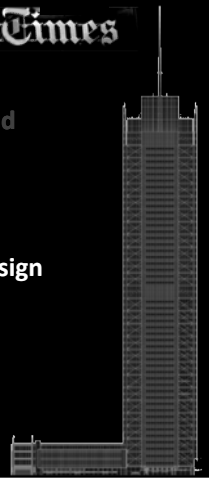


Floor System Redesign

Goals:

- o Increase rentable floor space
- o Decrease floor-to-floor height

Redesign Opportunities:

- o HVAC (UFAD/VAV to Chilled Beams)
- o Structural Floor System (Castellated Beams)

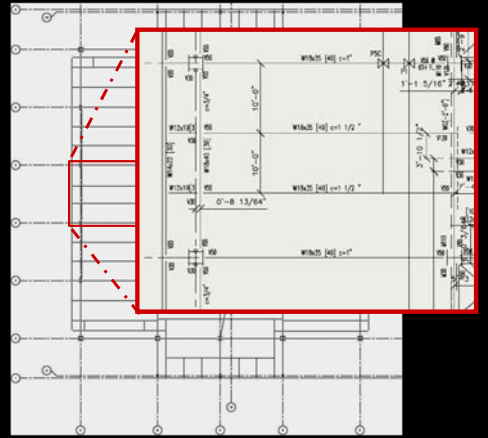
The New York Times

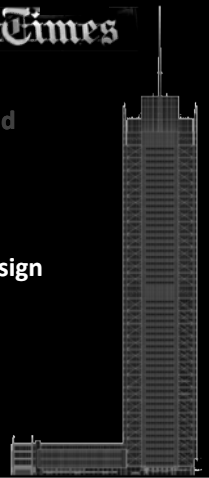
Structural Analysis

Initial Study
- o Investigate the required depth for interstitial space

Assumptions:
- o Loading conditions were the same as in the existing building
- o UFAD System would be removed

Result:
- o 28” Deep Castellated Beam Required





Structural Analysis

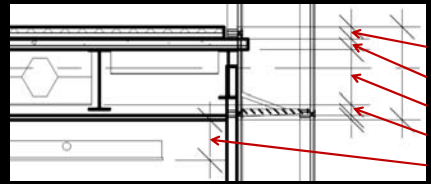
Initial Study

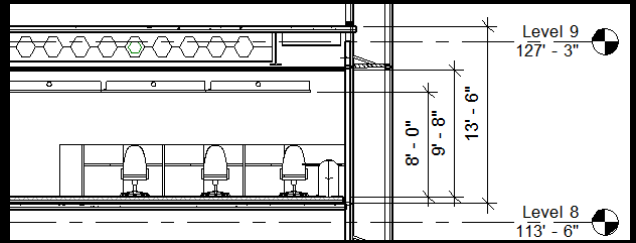
Investigate the required depth for interstitial space

Assumptions:

Loading conditions were the same as in the existing building

UFAD System would be removed





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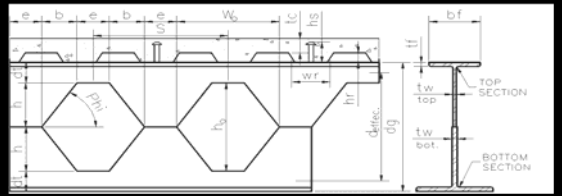
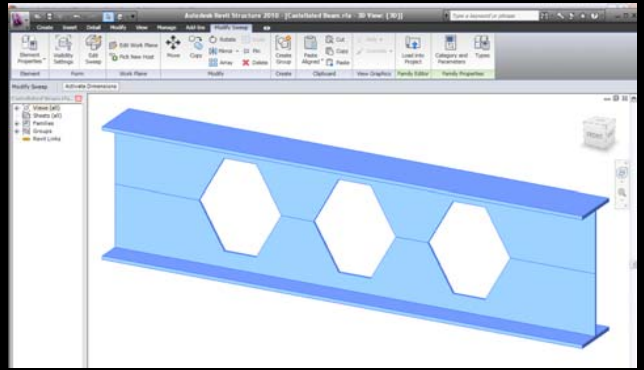
Structural Floor System

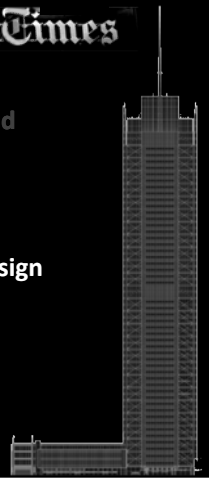
Structural Floor System Redesign:

Composite Castellated Beams

Allow for Coordination within Interstitial space







Structural Floor System

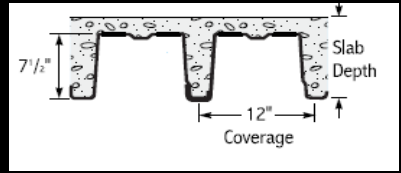
Structural Floor System Redesign:

Composite Castellated Beams

- Allow for Coordination within Interstitial space

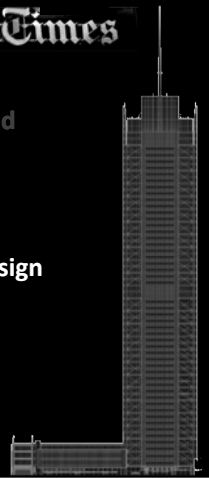
Metal Deck

- Long Span Metal Deck
- Dovetail Ribbed Composite Metal Deck



Long Span Metal Deck (LS)

Dovetail Ribbed Composite Metal Deck (DT)

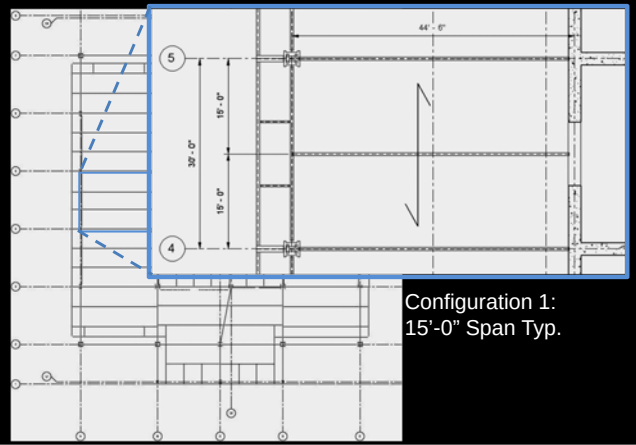


Structural Floor System

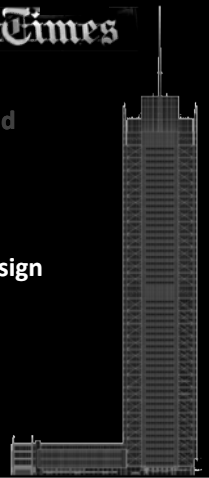
Structural Floor System Redesign:

Configuration 1:
- o Maximize Span
- o Minimize Number of Members

Configuration	Typ. Span	Option	Deck	Conc	Shoring?
1	15'-0"	1	LS	LWC	No
		2	LS	NWC	No
		3	DT	NWC	Yes
		4	DT	LWC	Yes



Configuration 1:
15'-0" Span Typ.



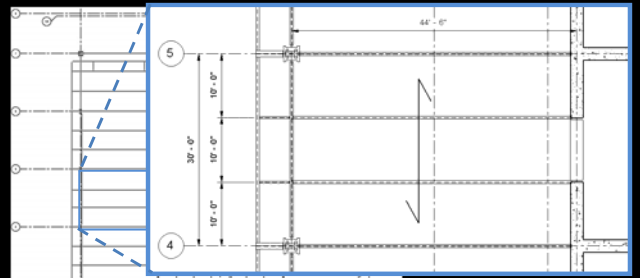
Structural Floor System

Structural Floor System Redesign:

Configuration 2:

- Minimize Shoring

Configuration	Typ. Span	Option	Deck	Conc	Shoring?
2	10'-0"	5	DT	NWC	No
		6	DT	LWC	No



Configuration 2:
10’-0” span Typ.

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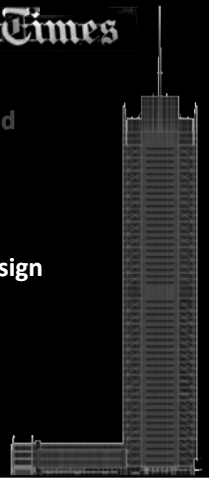


Structural Options Investigated

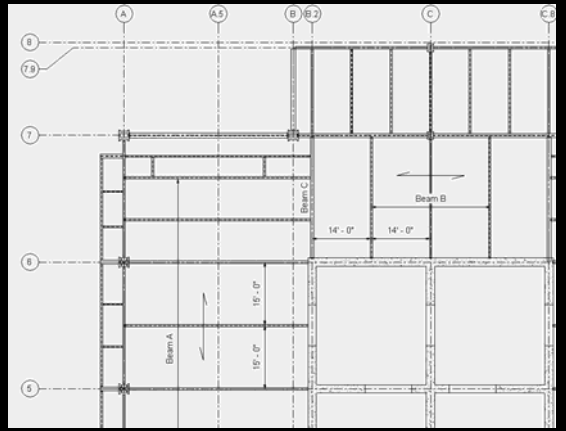
6 Options					
Configuration	Typ. Span	Option	Deck	Conc	Shoring?
1	15'-0"	1	LS	LWC	No
		2	LS	NWC	No
		3	DT	NWC	Yes
		4	DT	LWC	Yes
2	10'-0"	5	DT	NWC	No
		6	DT	LWC	No

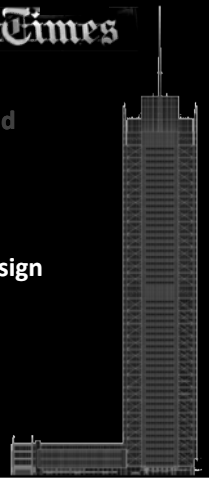
Gravity Loading
- o Superimposed Dead Load - 20 psf
- o Live Load – 50 psf (+ 20 psf partitions)

Structural Configuration 1

Slab Information					
Option	Deck	f'c (psi)	Slab t (in)		Slab Weight
			Overall	Topping	
1	EC450 LWC	4000	7	2.5	39
2	EC450 NWC	4000	7	2.5	49
3	0.0358	3000	5.25	3.25	63
4	0.0474	3000	5.25	3.25	49

Members				
Label	Option 1	Option 2	Option 3	Option 4
A	CB27x46/55	CB27x55/65	CB27x65	CB27x55/65
B	----	----	CB27x35	CB27x35
C	----	----	CB27x71	CB27x65

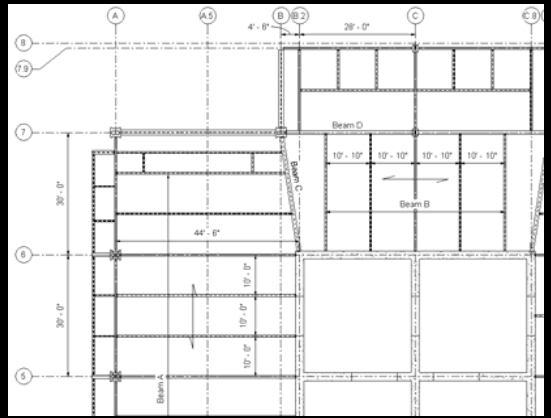


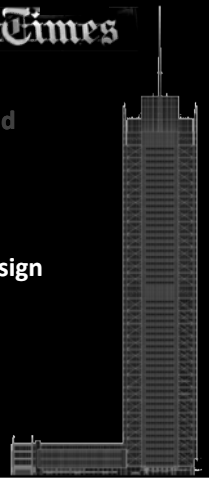


Structural Configuration 2

Slab Information					
Option	Deck	f'c (psi)	Slab t (in)		Slab Weight
			Overall	Topping	
5	0.6000	3000	5.25	3.25	63
6	0.6000	3000	5.25	3.25	49

Members		
Label	Option 5	Option 6
A	CB27x35/46	CB27x40
B	CB27x35/46	CB27x35
C	CB27x106	CB27x106
D	CB27x106	CB27x106





Structural Configuration 1

Structural Floor System Redesign:

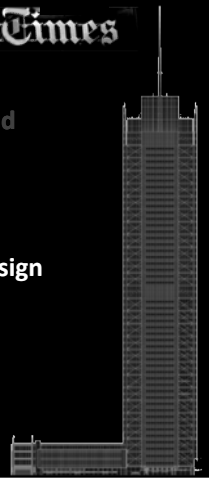
Floor Vibrations Due to Human Activity (AISC Design Guide 11)

Option	Deck	f'c (psi)	Slab t (in)		Slab Weight (psf)	Peak Accel. (% g)
			Overall	Topping		
1	EC450 LWC	4000	7	2.5	39	0.58
2	EC450 NWC	4000	7	2.5	49	0.55
3	0.0358	3000	5.25	3.25	63	0.40
4	0.0474	3000	5.25	3.25	49	0.48
Exist.	3 VL1 22	4000	5.5	2.5	53	0.42

Table 4.1
Recommended Values of Parameters in Equation (4.1) and a_o / g Limits

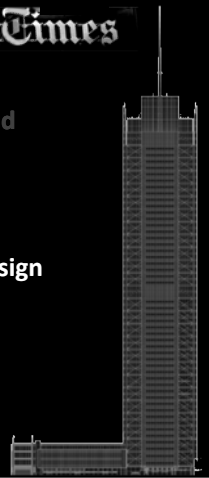
	Constant Force P_o	Damping Ratio β	Acceleration Limit $a_o / g \times 100\%$
Offices, Residences, Churches	0.29 kN (65 lb)	0.02–0.05*	0.5%
Shopping Malls	0.29 kN (65 lb)	0.02	1.5%
Footbridges—Indoor	0.41 kN (92 lb)	0.01	1.5%
Footbridges—Outdoor	0.41 kN (92 lb)	0.01	5.0%

* 0.02 for floors with few non-structural components (ceilings, ducts, partitions, etc.) as can occur in open work areas and churches,
0.03 for floors with non-structural components and furnishings, but with only small demountable partitions, typical of many modular office areas,
0.05 for full height partitions between floors.



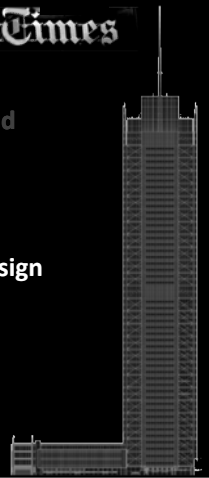
Structural Configuration 1

6 Options				
Configuration	Option	Deck	Conc	Shoring?
1	~~1~~	~~LS~~	~~LWC~~	~~No~~
	~~2~~	~~LS~~	~~NWC~~	~~No~~
	3	DT	NWC	Yes
	4	DT	LWC	Yes
2	5	DT	NWC	No
	6	DT	LWC	No



Structural Floor System

Selected Options for Cost Analysis				
Configuration	Option	Deck	Conc	Shoring?
1	3	DT	NWC	Yes
	4	DT	LWC	Yes
2	5	DT	NWC	No
	6	DT	LWC	No



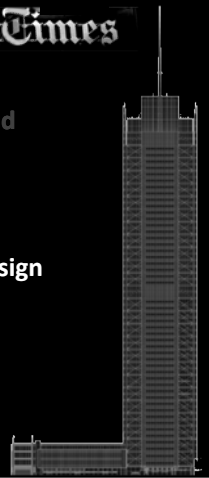
Cost Comparison of Floor Configurations

System	Steel Framing	Concrete Floor	Reshoring	Total
Lightweight Concrete - Config. 1	$ 7,920,000	$ 82,160,000	$ 2,490,000	$ 92,580,000
Normalweight Concrete - Config. 1	$ 7,920,000	$ 61,950,000	$ 2,490,000	$ 72,370,000
Lightweight Concrete - Config. 2	$ 8,540,000	$ 82,160,000	$ -	$ 90,700,000
Normalweight Concrete - Config. 2	$ 8,540,000	$ 61,950,000	$ -	$ 70,490,000

Floor Configurations Conclusions

Existing Floor Configuration
- o Configuration #2 – 10 ft. typical spans
- o Wide-flange Beams
- o Typical Composite Metal Deck

New Floor Configuration
- o Castellated Beams
- o Configuration #2 – 10 ft. typical spans
- o Dovetail deck



Structural Floor System Redesign

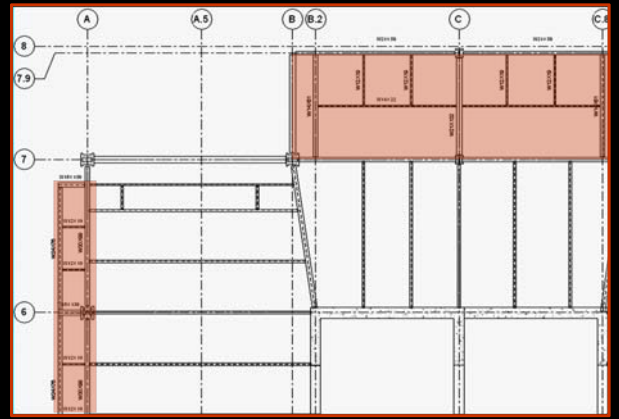
Member Check @ Cant. & Overhang

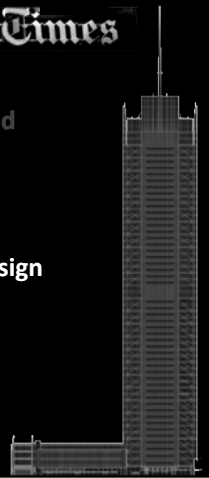
- o Used New Loading Conditions
- o Verified Existing was Adequate or Resized Appropriately

Beam Check Summary

Location	Existing Member	New Load		Existing Capacity		Deflection	Adequacy	New Member	New Capacity	
		M_u (k-ft)	V_u (k)	ϕM_n (k-ft)	ϕV_n (k)				ϕM_n (k-ft)	ϕV_n (k)
Cant.	W12x19	28.47	10.98	92.6	85.7	ok	OK	W12x19	92.6	85.7
Cant.	W14x22 (int)	259.3	36	277	85.7	ok	OK	W14x22	277	85.7
Cant.	W14x22 (ext)	372.56	36	125	94.8	----	NG	W14x61	1250	156
Cant.	W21x132	745.1	72	1250	426	ok	OK	W21x132	1250	426
Cant.	W21x50	63.03	18.73	413	237	ok	OK	W21x50	413	237
Edge	W12x19	7.21	5.77	92.6	85.7	ok	OK	W12x19	92.6	85.7
Edge	W18x130	96.39	25.05	1090	387	ok	OK	W18x130	1090	387
Edge	W24x76	117.2	13.51	750	316	ok	OK	W24x76	750	316
Edge	W18x40	577	57.7	294	169	ng	NG	W30x99*	1170	463

*Selected to elminate the coping of castellated members





HVAC Redesign

Multiservice Chilled Beams:
- o Integrated design

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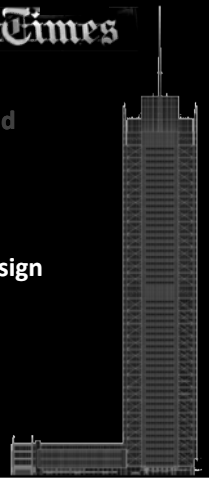
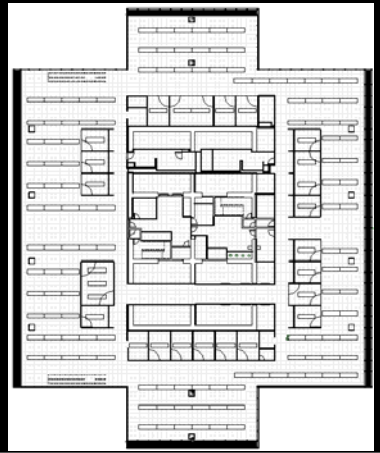


HVAC Redesign

Multiservice Chilled Beams:
- o Integrated design

Typical Layout:
- o 155 beams per floor



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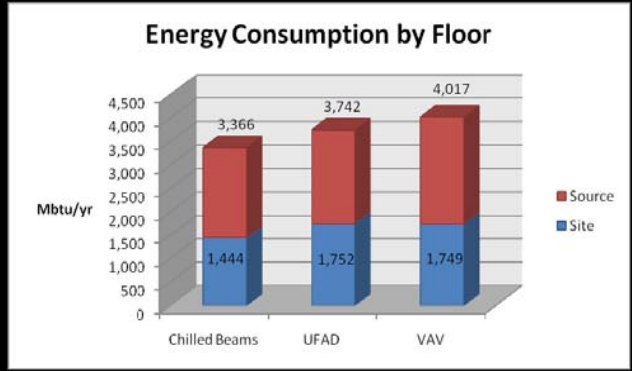
HVAC Redesign

Multiservice Chilled Beams:
- o Integrated design

Typical Layout:
- o 155 beams per floor

Savings:
- o Energy (10-16%)



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HVAC Redesign

Multiservice Chilled Beams:
- o Integrated design

Typical Layout:
- o 155 beams per floor

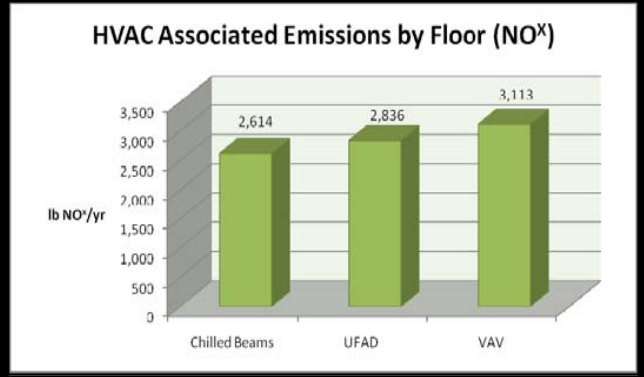
Savings:
- o Energy (10-16%)
- o Cost ($47,000 / month)

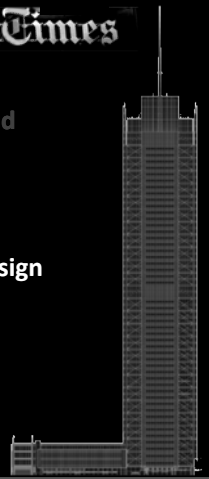
HVAC Redesign

Multiservice Chilled Beams:
- o Integrated design

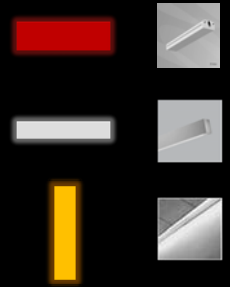
Typical Layout:
- o 155 beams per floor

Savings:
- o Energy (10-16%)
- o Cost ($47,000 / month)
- o Emissions (8-16%)





Office Lighting Redesign



Integrated 35W T5 Direct Pendant

4’ T5HO Direct/Indirect Pendant

4’ Recessed Cove

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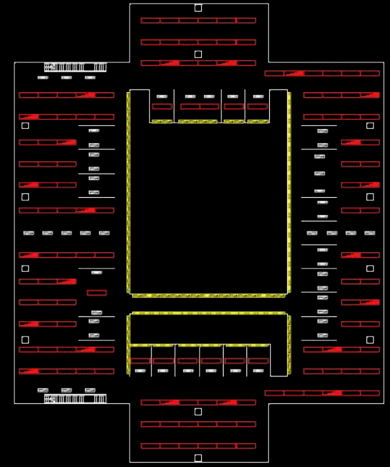

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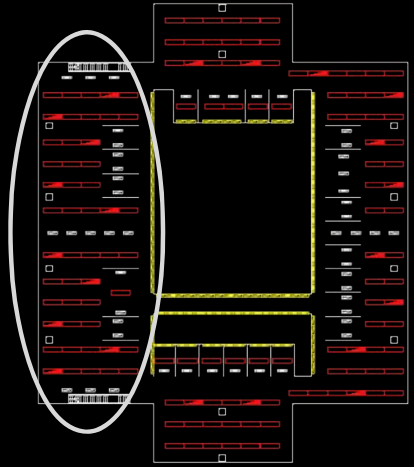
- Building Background
- Proposal
- Façade Redesign
- **Floor System Redesign**
- Core Redesign
- CoGen Redesign
- BIM/IPD
- Metrics of Success

Office Lighting Redesign



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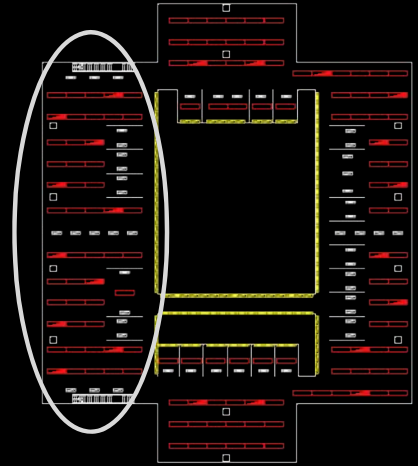

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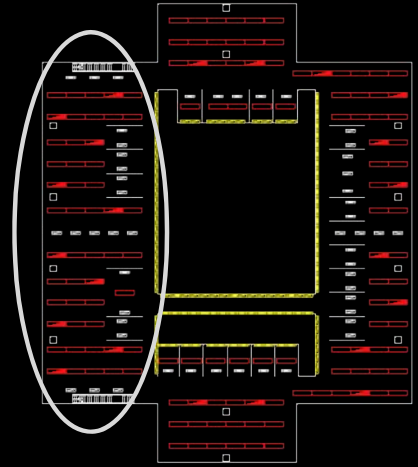

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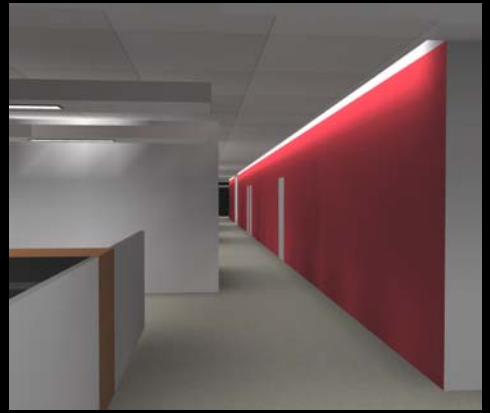

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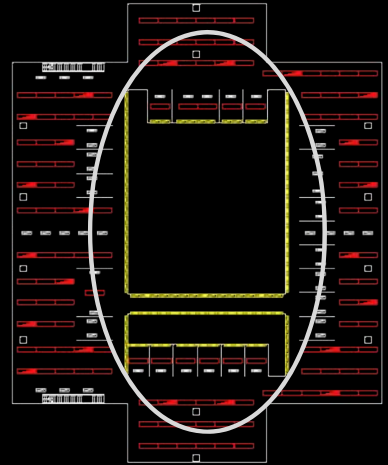

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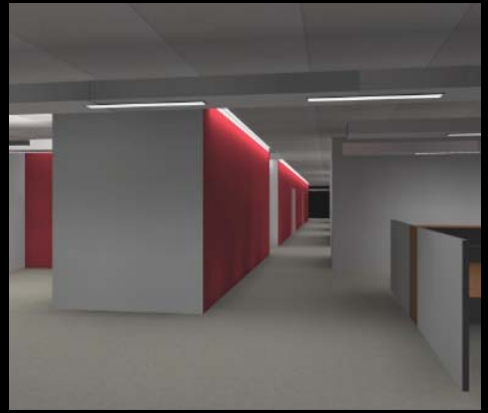

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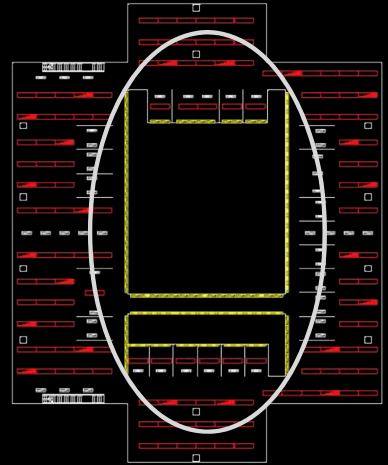

The New York Times

Office Lighting Redesign

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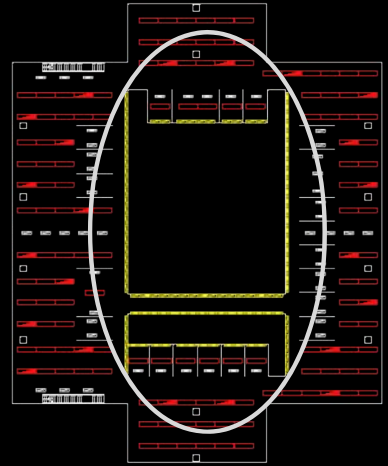

The New York Times

Office Lighting Redesign

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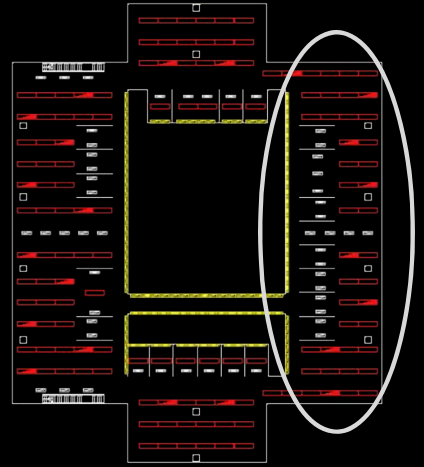

The New York Times

- Intro
- Building Background
- Proposal
- Façade Redesign
- **Floor System Redesign**
- Core Redesign
- CoGen Redesign
- BIM/IPD
- Metrics of Success

Office Lighting Redesign

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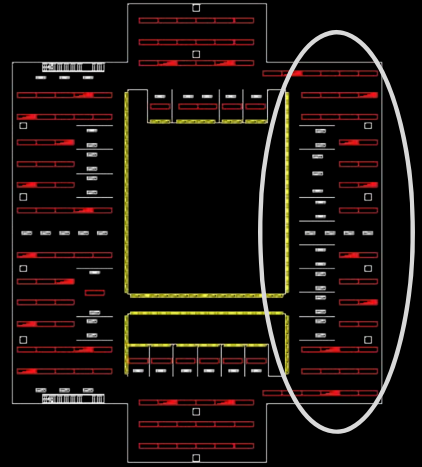

The New York Times

Office Lighting Redesign

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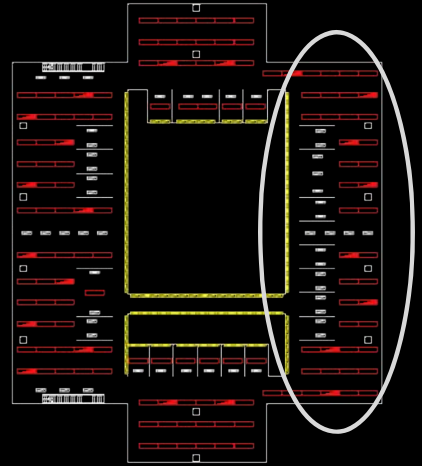
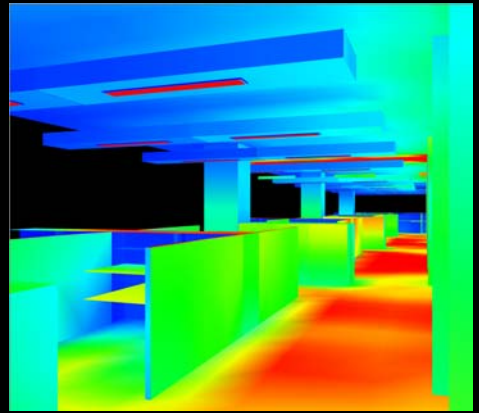
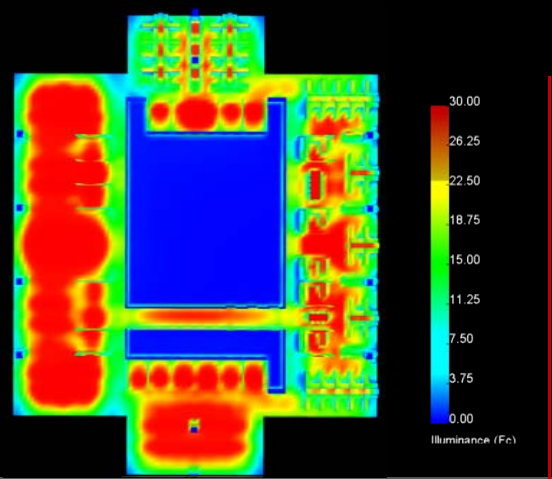
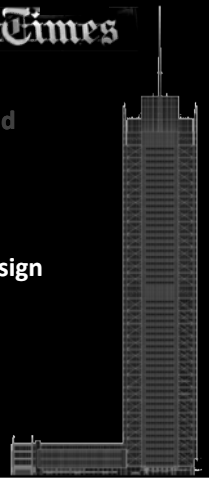


The New York Times

Office Lighting Redesign







Cost of Proposed Floor System

- Cost addition of extra floor

	New Floor System
Structure	$ 2,988,000.00
Raised Floor	$ 885,000.00
HVAC Cost	$ 3,328,000.00
Plumbing Cost	$ 303,000.00
Electrical Cost	$ 2,915,000.00
Communications	$ 1,027,000.00
Interiors	$ 607,000.00
Furnishing	$ 215,000.00
	$ 12,268,000.00

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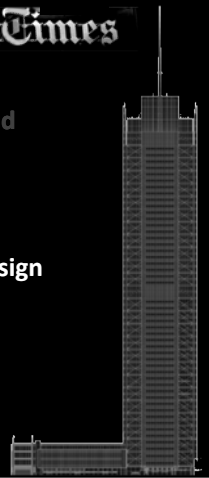
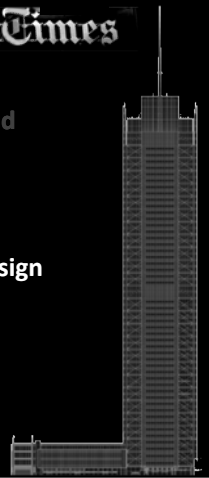


Cost of Proposed Floor System

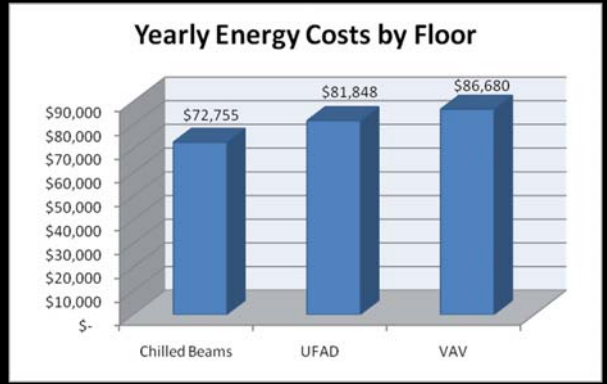
- Cost addition of extra floor
- Additional SF of leasable area

Additional Rent Annually	21,000 SF	$ 60 / SF Year	$ 1.26 million Year

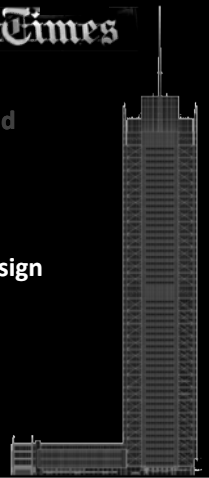


Cost of Proposed Floor System

- Cost addition of extra floor
- Additional SF of leasable area
- Chilled beam cost savings



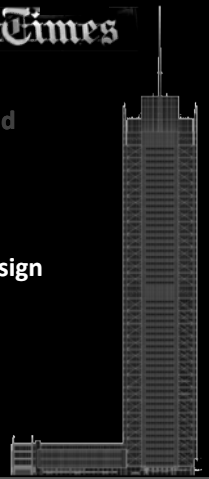
The New York Times



Cost of Proposed Floor System

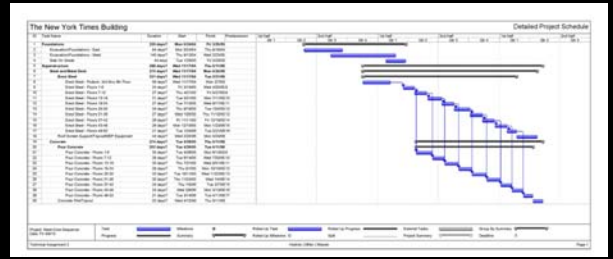
- Cost addition of extra floor
- Additional SF of leasable area
- Chilled beam cost savings
- Overall cost comparison

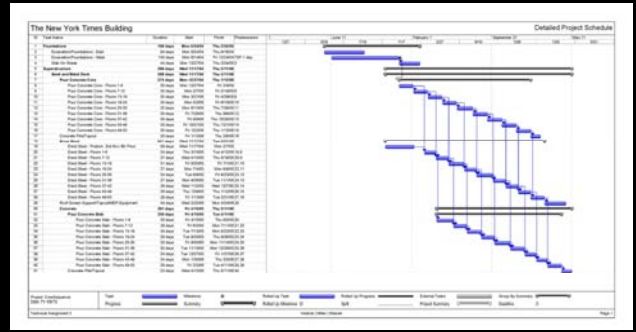
Additional System Cost	$ 12,268,000
Additional Rent	$ 1,260,000
Energy Savings	$ 565,800
Payback Period	6.72 years

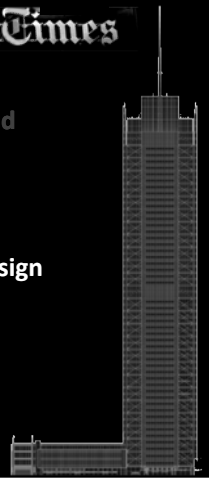


Integrated Design

o Constructability

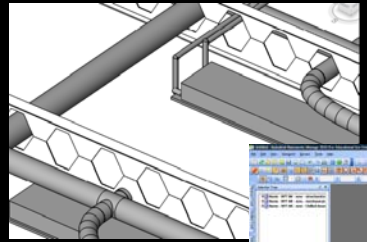


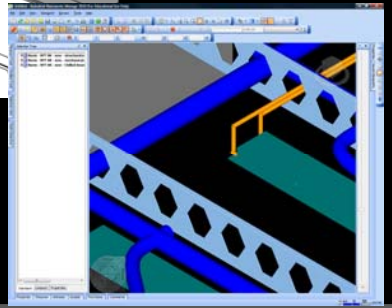




Integrated Design

- Constructability
- BIM Use Analysis
  - 3D Coordination
- Parties Involved
  - Structural
  - Mechanical
  - Lighting / Electrical
  - Construction Management
- Outcome





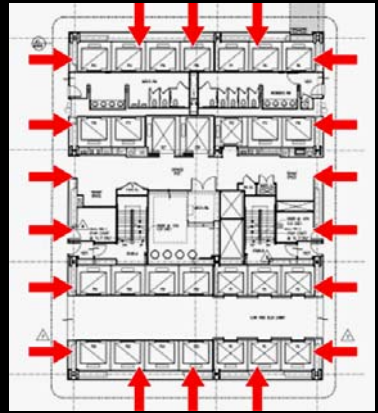
Core Redesign

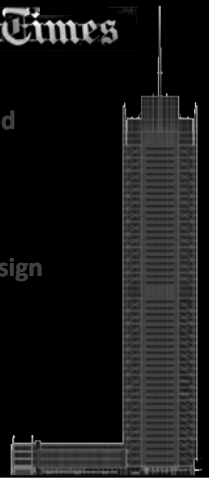
Goals:

- o Increase rentable floor space
- o Explore trade issues (Concrete vs. Steel Core)
- o Explore cost for core redesign

Redesign Opportunities:

- o Reconfigure core layout structurally and architecturally
- o Decrease footprint of the structural core
- o Service Space

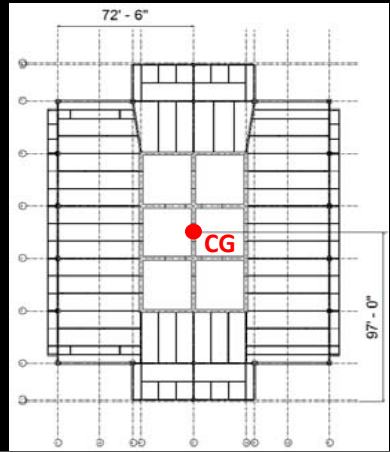




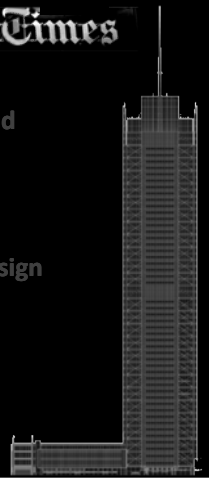
Core Configuration

Maintain structural symmetry

- Reduces torsional effects due to lateral loads
- Center of geometry converges with center of pressure, center of mass, and center of rigidity
- Layout of elevators



The New York Times

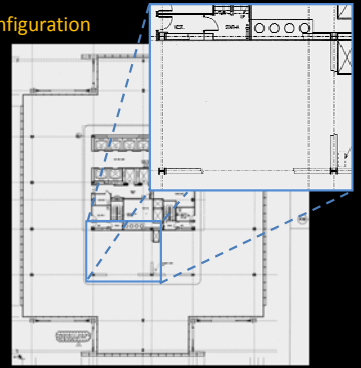


Core Configuration

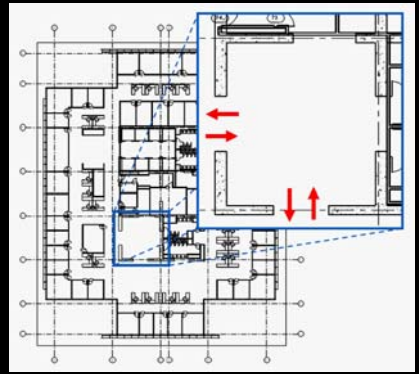
Maintain flexibility of space

Example: Floors 46 - 50

Existing Configuration



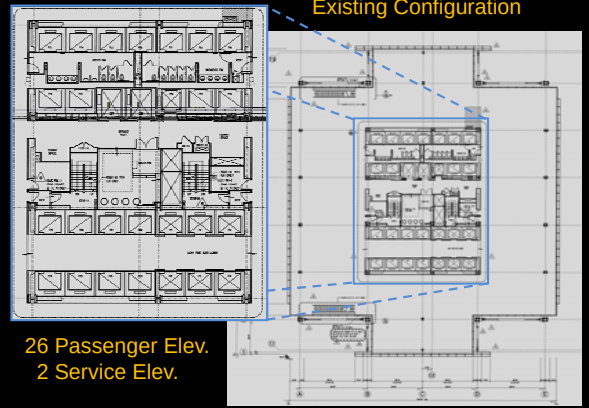
New Configuration



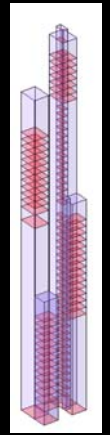
The New York Times

Elevator Configuration

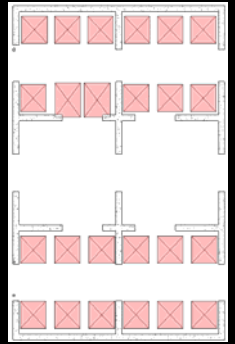
Existing Configuration



26 Passenger Elev.
2 Service Elev.



Feasibility Study: Elevator Reduction

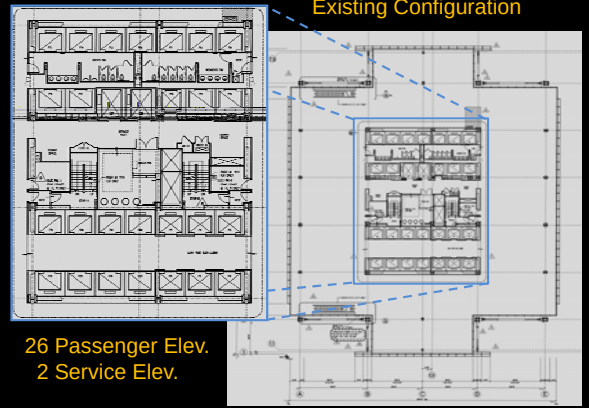


22 Passenger Elev.
2 Service Elev.

The New York Times

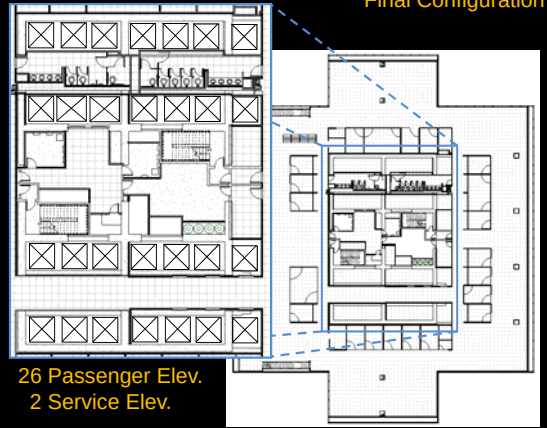
Core Configuration

Existing Configuration



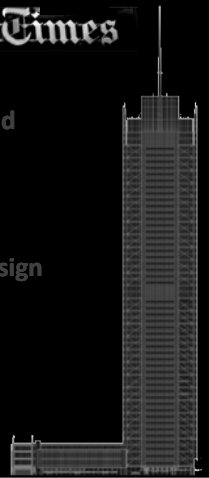
26 Passenger Elev.
2 Service Elev.

Final Configuration



26 Passenger Elev.
2 Service Elev.

The New York Times

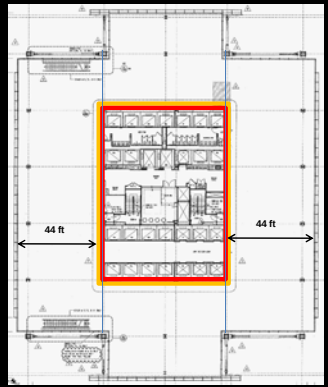


Architectural Configuration

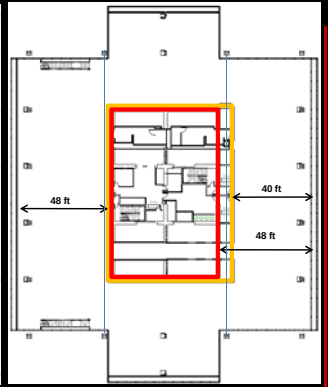
Floor	Occupant	Existing Leasable Area (SF)	New Leasable Area (SF)	Difference (SF)
50	FCRC	21,943	22,126	183
49	FCRC	21,943	22,126	183
48	FCRC	21,943	22,126	183
47	FCRC	21,943	22,126	183
46	FCRC	21,943	22,126	183
45	FCRC	21,943	22,126	183
44	FCRC	21,650	22,126	476
43	FCRC	21,650	22,126	476
42	FCRC	21,650	22,126	476
41	FCRC	21,650	22,126	476
40	FCRC	21,244	21,456	212
39	FCRC	21,244	21,456	212
38	FCRC	21,244	21,456	212
37	FCRC	21,244	21,456	212
36	FCRC	21,244	21,456	212
35	FCRC	21,244	21,456	212
34	FCRC	21,244	21,456	212
33	FCRC	21,244	21,456	212
32	FCRC	21,244	21,456	212
31	FCRC	21,244	21,456	212
30	FCRC	21,244	21,456	212
29	FCRC	20,429	20,959	530
		472,371SF	478,235 SF	5,864 SF

Additional Rent Annually	5864 SF	$60 / SF Year	$ 351,840 Year

Existing Core Configuration



New Core Configuration



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The New York Times

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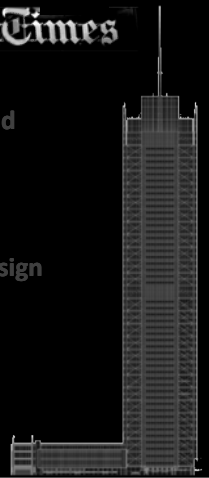
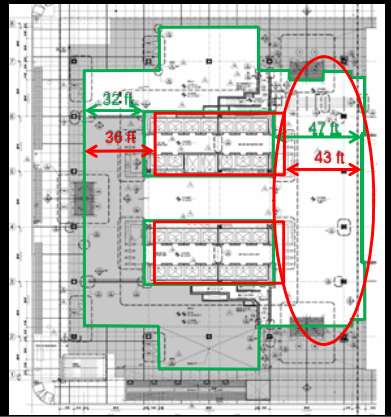


Core Configuration



Existing Lobby

New Lobby Rendering

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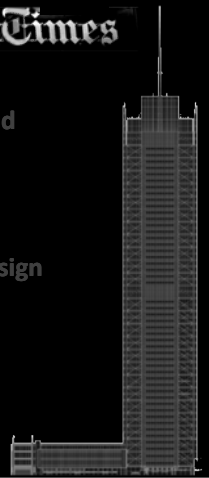
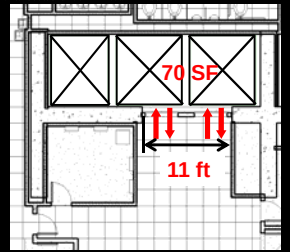


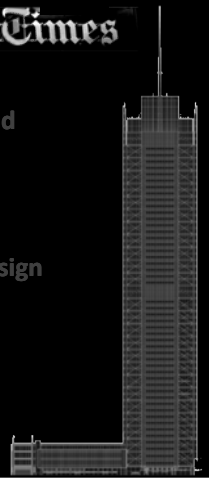
Service Space Configuration

Area	Existing SF	New SF
Mechanical	360 SF	347 SF
Electrical	180 SF	182 SF
Risers	235 SF	206 SF
Stairs	297 SF	303 SF
Tenant Space	277 SF	267 SF

Service Elevators



The New York Times



Service Space Configuration

Bus Duct Vs Conduit Analysis

Existing Conditions in NYT Portion

18 3 1/2" Conduit Feeders
Powers Lighting and Appliance Panels

6 3 1/2" Conduit Feeders
Powers Mechanical Equipment Panels

Proposed Redesign

2 2500 Amp Aluminum Bus Duct Feeders
Powers Lighting and Appliance Panels

1 1600 Amp Aluminum Bus Duct Feeder
Powers Mechanical Equipment Panels

Bus Duct Vs Conduit Analysis

Total Cost System

Bus Duct: $1.75 million

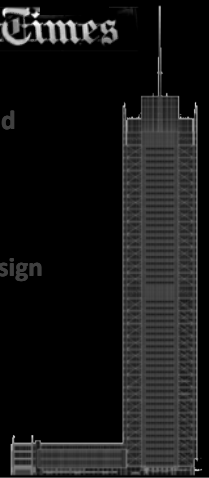
Conduit: $1.2 million

Space Comparison

Minimal difference between required space

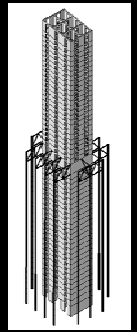
Benefit of Bus Duct Feeders

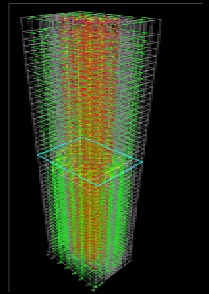
Possibility of Expansion Without Adding Additional Feeders

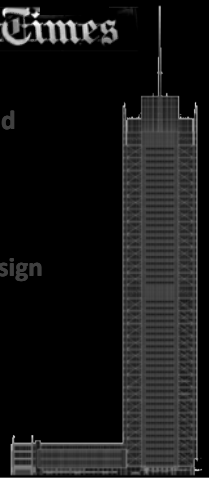


Lateral Force Resisting System

Concrete Shear Wall Core w/ Outriggers on the 28th Mechanical Floor







Lateral Force Resisting System

Initial Design Parameters

Exisitng Period of Vibration	
N/S	6.8 s
E/W	6.2 s
Tors. *	5.6 s
* Assumed	

Assumed Serviceability Governed Design

SRSS – Period of Vibration

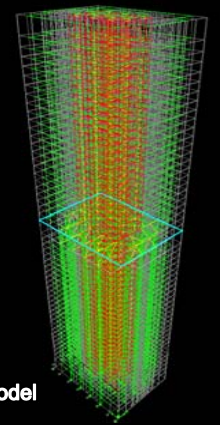
- 10% of 10.8s (Existing Design)

Serviceability Limit States Under Wind Load - Lawrence G. Griffis (AISC 1993)

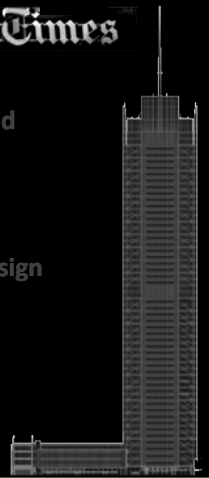
Lateral Drift & Deflection

- Wind - H/450 = 19.88" (Existing Design)
  - D+0.5L+0.7W (ASCE 7-05, CC.1.2)
- Seismic – $0.015h_{sx}$
  - 1.0 E

Design checked for Strength



ETABS Analytical Model



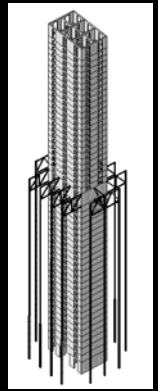
Lateral Force Resisting System

Design Summary

Shear Wall Core

Level	f'_c (ksi)	Wall t, E/W Direction (in)	Wall t, N/S Direction (in)
Base - 30	10	24	30
31-40	8	24	24
41-53	8	20	24

Coupling Beams
- 36" Depth
- Width Dependent upon Support



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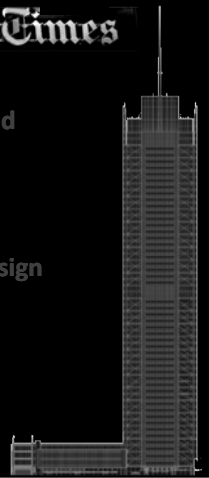
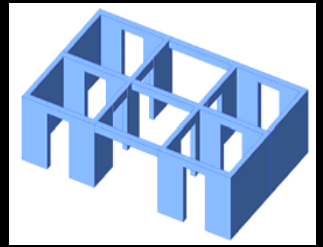


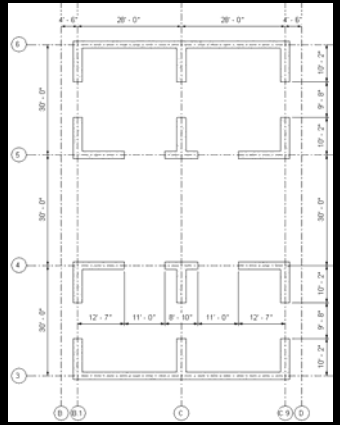
Lateral Force Resisting System

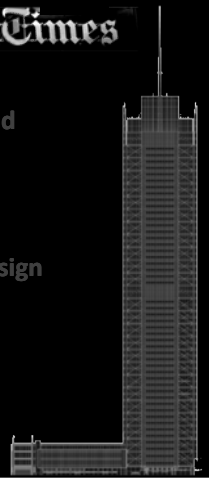
N
W E
S

Shear Wall Design: Base Level

Level	f'_c (ksi)	Wall t, E/W Direction (in)	Wall t, N/S Direction (in)
Base - 30	10	24	30
31-40	8	24	24
41-53	8	20	24



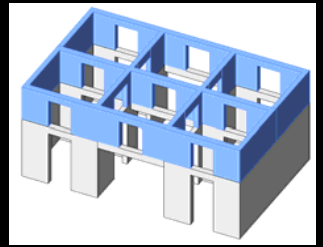




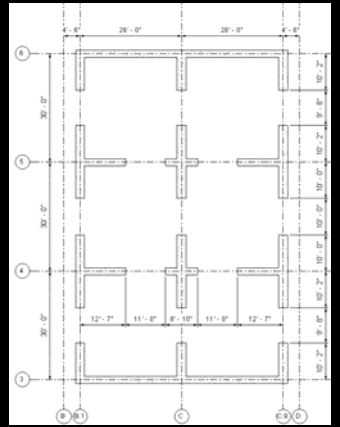
Lateral Force Resisting System

Shear Wall Design: Level 2 – Level 28

Level	f'_c (ksi)	Wall t, E/W Direction (in)	Wall t, N/S Direction (in)
Base - 30	10	24	30
31-40	8	24	24
41-53	8	20	24



N
W E
S



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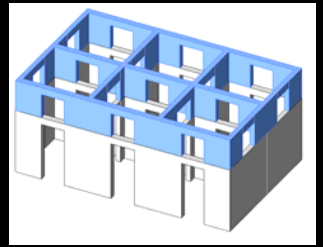
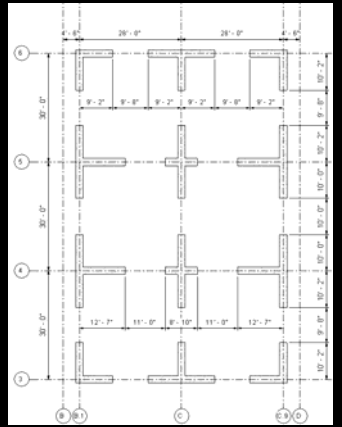
Lateral Force Resisting System

Shear Wall Design: Level 29 – Roof

Level	f'_c (ksi)	Wall t, E/W Direction (in)	Wall t, N/S Direction (in)
Base - 30	10	24	30
31-40	8	24	24
41-53	8	20	24



N
W E
S



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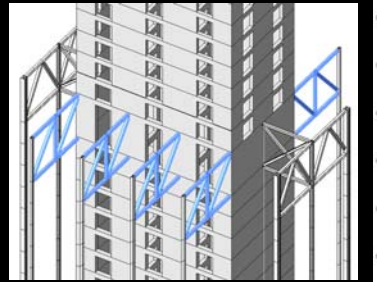
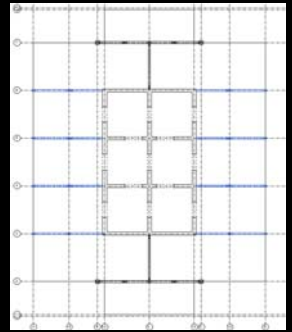
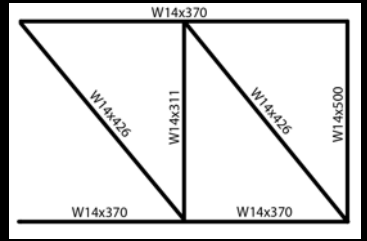
Lateral Force Resisting System

Outrigger Design – 28th Mechanical Floor

o Outrigger Design

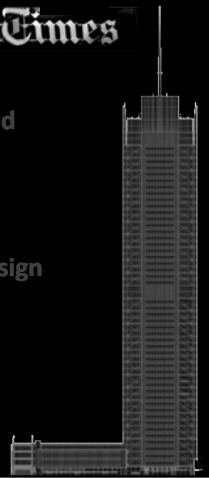






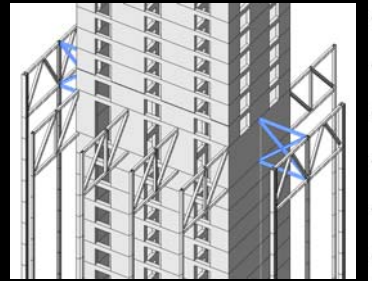
East / West Outriggers (Grid Lines 3, 4, 5 & 6)

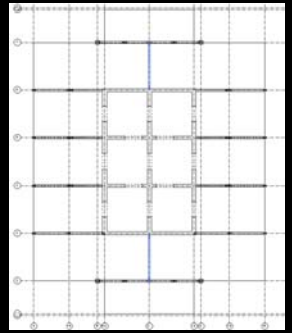
Member	Type	kL (ft)	Compression		Tension		Compliance
			P_u (k)	ϕP_n (k)	P_u (k)	ϕP_n (k)	
W14x426	Diag. Brce	36	2677.5	2730	960	5630	ok
W14x311	Vert. Brce	28	739.5	2580	2069	4110	ok
W14x370	Chords	24	1684	3520	690	4910	ok

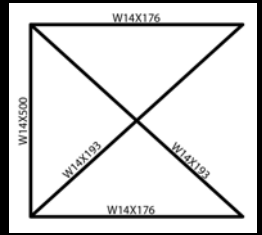


Lateral Force Resisting System

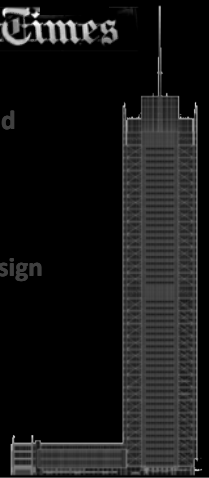
Lateral Force Resisting System
o Outrigger Design







North / South Outriggers (Grid Line C)							
Member	Type	kL (ft)	Compression		Tension		Compliance
			P_u (k)	ϕP_n (k)	P_u (k)	ϕP_n (k)	
W14x176	Chords	30	611	1300	611	2330	ok
W14x193	Brace	40	893	913	827	2560	ok



Lateral Force Resisting System

Lateral Force Resisting System
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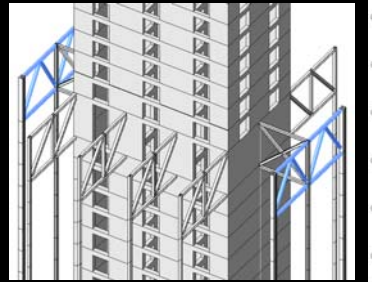
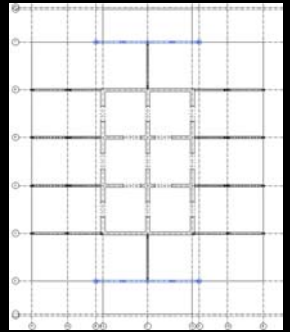
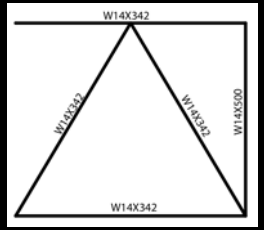
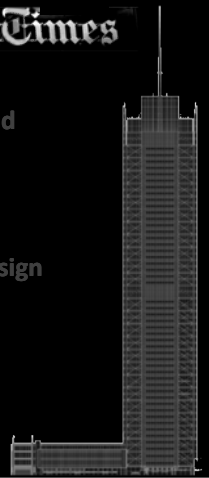






Belt Trusses (Grid Lines 2 & 7)							
Member	Type	kL (ft)	Compression		Tension		Compliance
			P_u (k)	ϕP_n (k)	P_u (k)	ϕP_n (k)	
W14X342	Brace	32	2071	2500	2064	4550	ok
W14X342	Top Chord	15	2111	3980	625	4550	ok
W14X342	Bot. Chord	30	312	2680	1055	4550	ok



Lateral Force Resisting System

Design Parameters

Assumed Serviceability Governed Design

SRSS – Period of Vibration

- 10% of 10.8s (Existing Design)

Serviceability Limit States Under Wind Load - Lawrence G. Griffis (AISC 1993)

Lateral Drift & Deflection

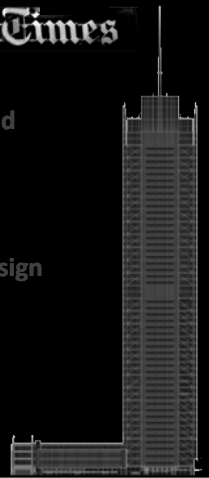
- Wind - H/450 = 19.88" (Existing Design)
  - D+0.5L+0.7W (ASCE 7-05, CC.1.2)
- Seismic – $0.015h_{sx}$
  - 1.0 E

Strength Check – Adequate

Period of Vibration		
Mode	Direction	T(sec.)
1	E/W	7.31
2	N/S	6.57
3	Tor	5.51
SRSS		11.2677
% of Existing		4.417
Compliance?		Yes

Lateral Displacement Due to 0.7 Wind			
Direction	Displ. (in)	H/450 (in)	Compliance?
N/S	10.9	19.88	ok
E/W	7.1	19.88	ok

Story Drift Check								
			Seismic			Wind		
Direction	Level	h_{sx} (ft)	0.015 h_{sx}	Calculated SD	Compliance ?	h/450	SD from ETABS	Compliance ?
E/W	41	13.26	0.1989	0.0125	ok	0.029467	0.0009	ok
N/S	37	13.26	0.1989	0.009	ok	0.029467	0.001	ok



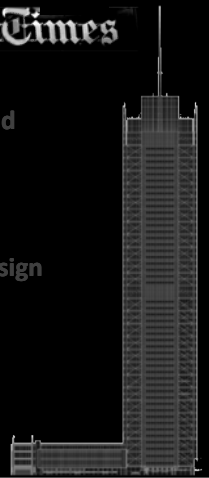
Cost and Schedule Changes

Cost of concrete core vs. existing steel core

General conditions changes
- o Superstructure schedule
- o GC cost changes
- o Constructability

Overall Cost Analysis

Item	Quantity	Cost
Steel Core		$ (37,171,395)
Concrete Core	21,500 CY	$ 18,676,730
~~Crane Addition~~	~~2.5 Month~~	~~$ 81,700~~
Temporary Heating	2 Winters	$ 4,000,000
Upfront Savings		**$ (14,412,965)**
*Additional Rent Annually	5,864 SF	$ 351,840 per year



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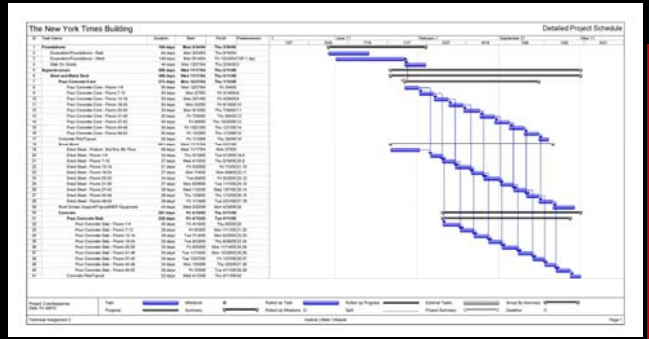

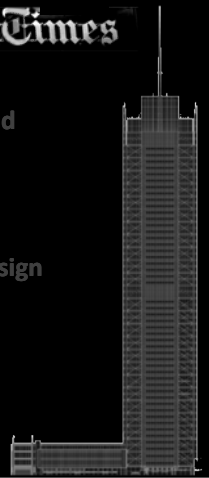

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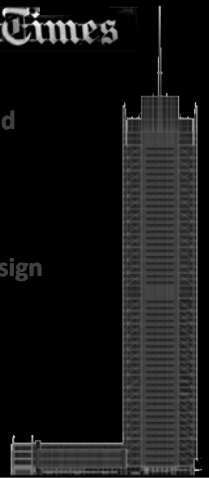

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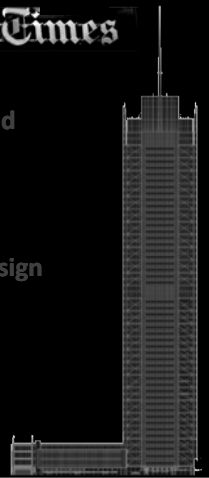
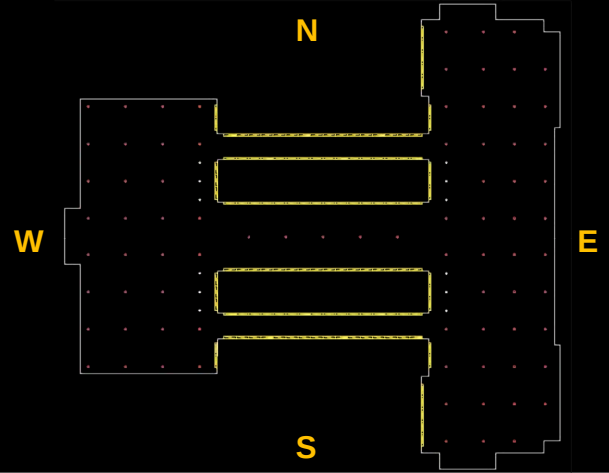


Lobby Lighting Redesign

9” Recessed Downlight

8” Recessed Directional Downlight

4’ Recessed Cove



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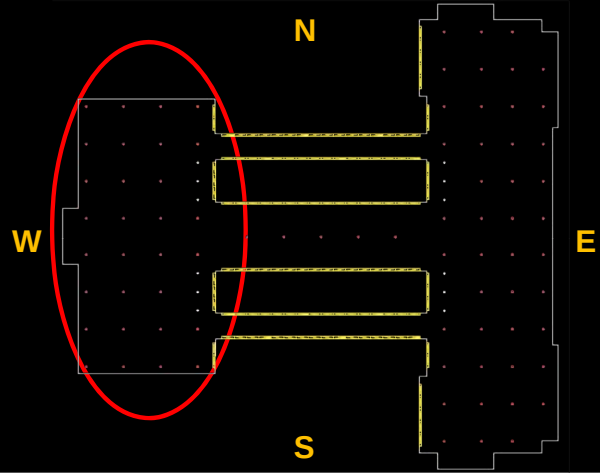
Lobby Lighting Redesign



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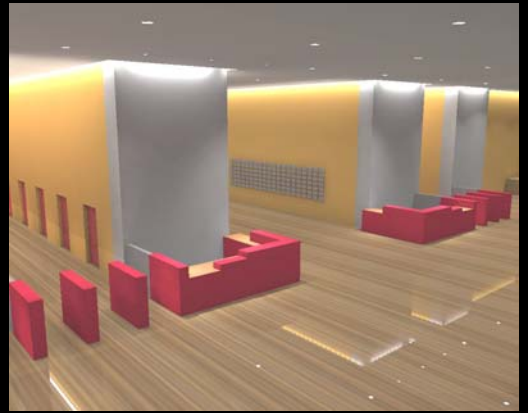

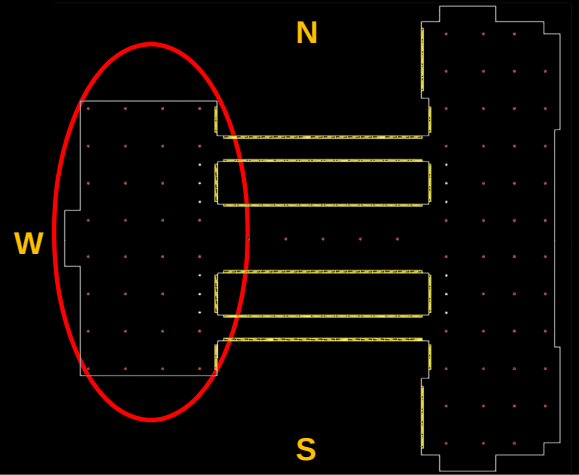

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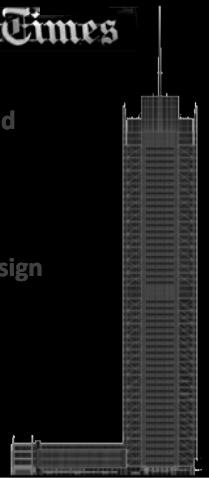

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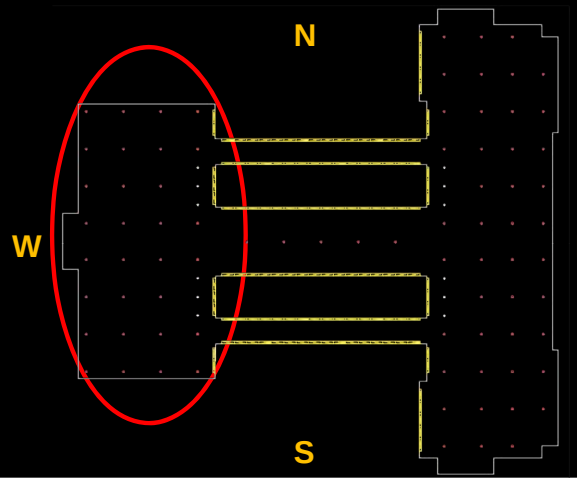

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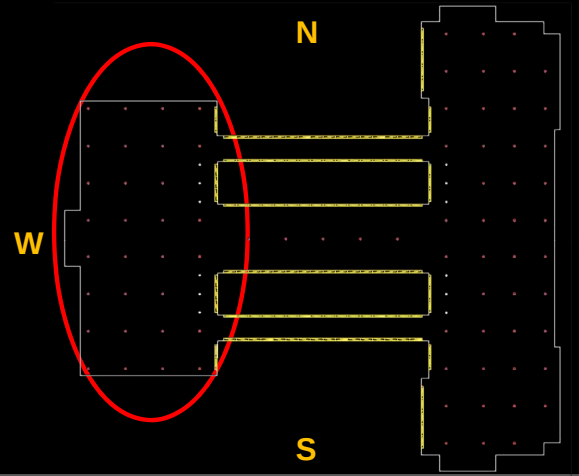

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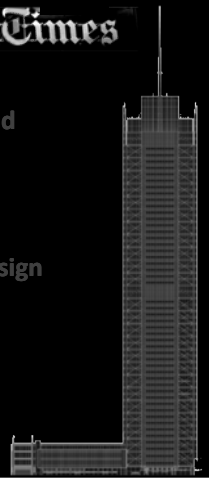

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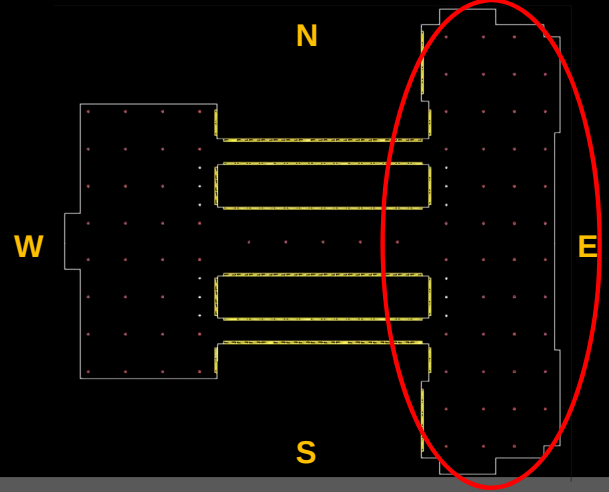

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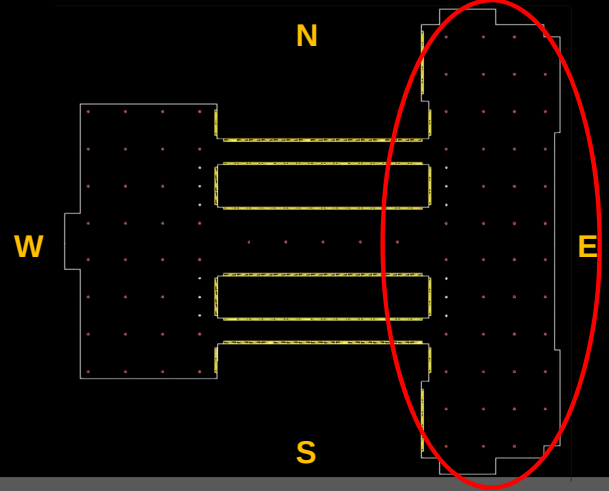

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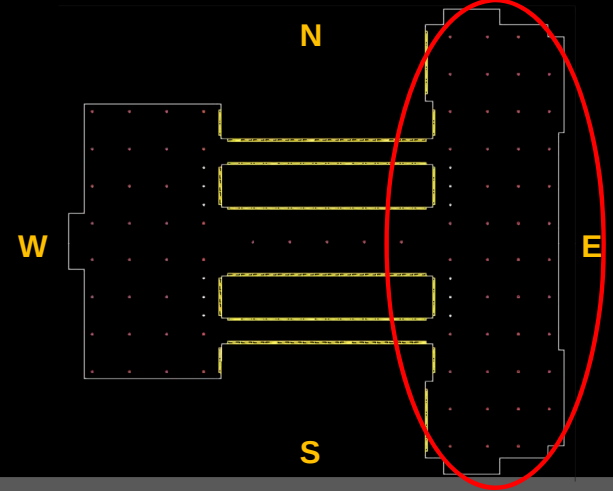

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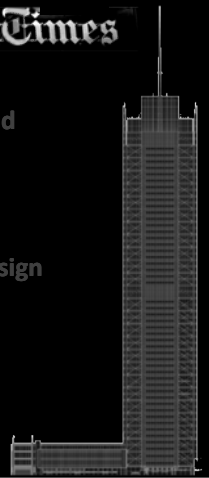

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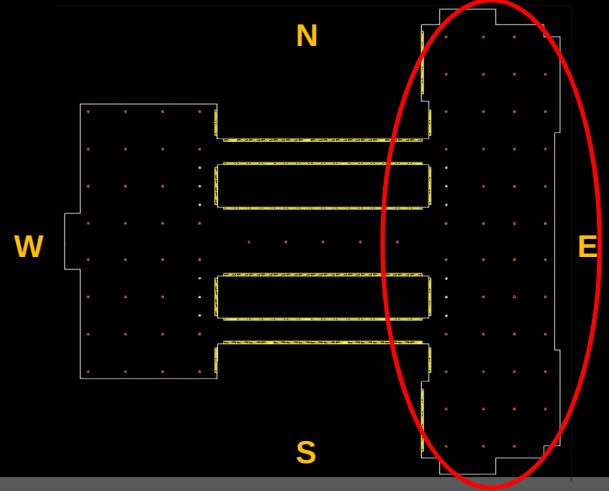

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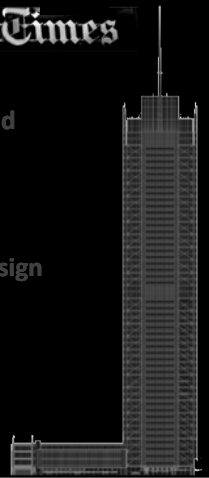

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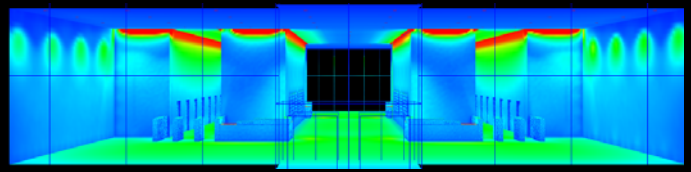
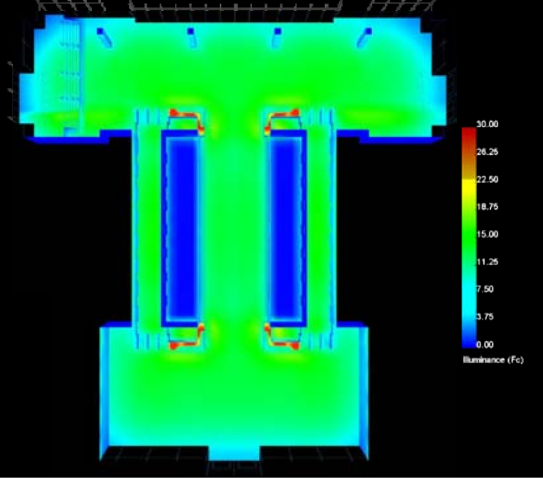
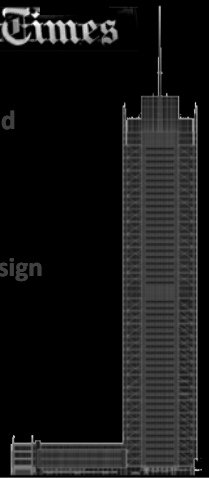






Existing System / Goals

Existing System:

- o 1.4 MW Internal Combustion
- o 40% power capacity for NYT
- o 250 ton absorption chiller

Redesign Goals:

- o 100% power capacity for NYT
- o Increased energy cost savings
- o Decreased energy associated emissions
- o All met!

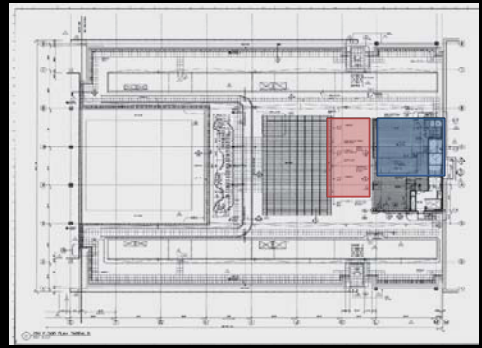
Redesign Considerations

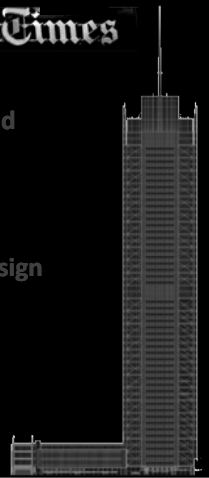
o Utility data / Spark gap

Utility	Yearly $/Unit	Reference
Natural Gas	$1.392/Ccf	New York State Public Service Commission
Electric	$0.249/kWh	New York State Public Service Commission
Steam	$18.36/Mlb	Consolodated Edison
Water	$2.31/per(748gals)	New York City Water Board

Spark Gap	
Fuel	Cost / (MMbtu)
Natural Gas	$ 11.27
Electricity	$ 72.97
Steam	$ 15.40
Gap	$ 61.70

o Space constraints (3000 ft² total)



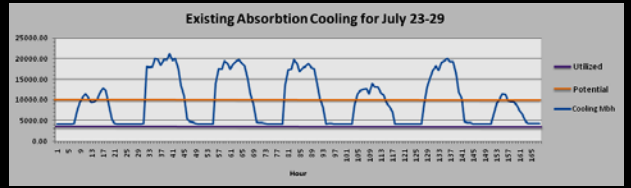


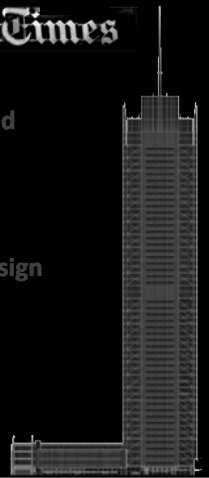
Redesign Consideration

Redesign Considerations:

- Building thermal and electrical loads

- Underutilized cooling potential





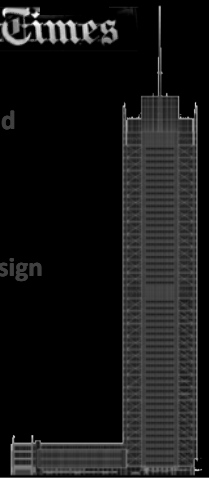
Redesign Alternatives

Prime Movers

CHP System	Existing	Alternative 1	Alternative 2	Alternative 3
Prime Movers				
Reciprocating Engine(s)	2 - 700 kW	6 - 700 kW	2 - 700 kW 1 - 1300kW	2 - 700 kW
Gas Turbine(s)	-	-	-	1 - 1300kW
Make, Model	Caterpillar, G3516 LE	Caterpillar, G3516 LE	Caterpillar, G3516 LE Caterpillar, DM5496	Caterpillar, G3516 LE Solar, Saturn 20
Fuel	Natural Gas	Natural Gas	Natural Gas	Natural Gas
Total Floor Area (ft^2)	1,600	4,800	2,970	2,735
Total Weight (lbs)	35,340	106,020	63,720	50,340

Gas Turbines

IC Engines



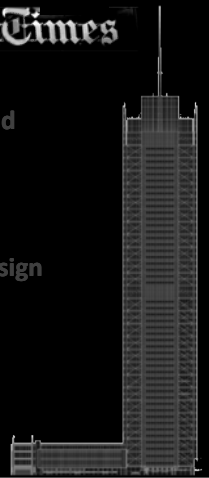
Redesign Alternatives

Prime Movers

CHP System	Existing	Alternative 1	Alternative 2	Alternative 3
Prime Movers				
Recipricating Engine(s)	2 - 700 kW	6 - 700 kW	2 - 700 kW 1 - 1300kW	2 - 700 kW
Gas Turbine(s)	-	-	-	1 - 1300kW
Make, Model	Caterpillar, G3516 LE	Caterpillar, G3516 LE	Caterpillar, G3516 LE Caterpillar, DM5496	Caterpillar, G3516 LE Solar, Saturn 20
Fuel	Natural Gas	Natural Gas	Natural Gas	Natural Gas
Total Floor Area (ft^2)	1,600	4,800	2,970	2,735
Total Weight (lbs)	35,340	106,020	63,720	50,340

Existing System: 1,400 kW

IC Engines



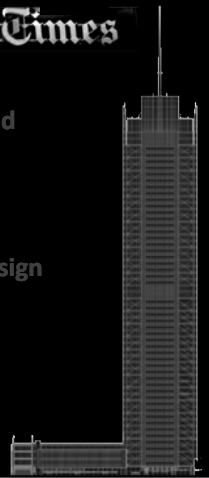
Redesign Alternatives

Prime Movers

CHP System	Existing	Alternative 1	Alternative 2	Alternative 3
Prime Movers				
Recipricating Engine(s)	2 - 700 kW	6 - 700 kW	2 - 700 kW 1 - 1300kW	2 - 700 kW
Gas Turbine(s)	-	-	-	1 - 1300kW
Make, Model	Caterpillar, G3516 LE	Caterpillar, G3516 LE	Caterpillar, G3516 LE Caterpillar, DM5496	Caterpillar, G3516 LE Solar, Saturn 20
Fuel	Natural Gas	Natural Gas	Natural Gas	Natural Gas
Total Floor Area (ft^2)	1,600	4,800	2,970	2,735
Total Weight (lbs)	35,340	106,020	63,720	50,340

Alternative 1: 4,200 kW

IC Engines



Redesign Alternatives

Prime Movers

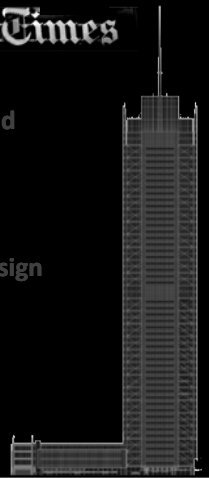
CHP System	Existing	Alternative 1	Alternative 2	Alternative 3
Prime Movers				
Reciprocating Engine(s)	2 - 700 kW	6 - 700 kW	2 - 700 kW 1 - 1300kW	2 - 700 kW
Gas Turbine(s)	-	-	-	1 - 1300kW
Make, Model	Caterpillar, G3516 LE	Caterpillar, G3516 LE	Caterpillar, G3516 LE Caterpillar, DM5496	Caterpillar, G3516 LE Solar, Saturn 20
Fuel	Natural Gas	Natural Gas	Natural Gas	Natural Gas
Total Floor Area (ft^2)	1,600	4,800	2,970	2,735
Total Weight (lbs)	35,340	106,020	63,720	50,340

Alternative 2: 2,700 kW

IC Engines

+

1,300 kW IC Engine



Redesign Alternatives

Prime Movers

CHP System	Existing	Alternative 1	Alternative 2	Alternative 3
Prime Movers				
Reciprocating Engine(s)	2 - 700 kW	6 - 700 kW	2 - 700 kW 1 - 1300kW	2 - 700 kW
Gas Turbine(s)	-	-	-	1 - 1300kW
Make, Model	Caterpillar, G3516 LE	Caterpillar, G3516 LE	Caterpillar, G3516 LE Caterpillar, DM5496	Caterpillar, G3516 LE Solar, Saturn 20
Fuel	Natural Gas	Natural Gas	Natural Gas	Natural Gas
Total Floor Area (ft^2)	1,600	4,800	2,970	2,735
Total Weight (lbs)	35,340	106,020	63,720	50,340

Alternative 3: 2,700 kW

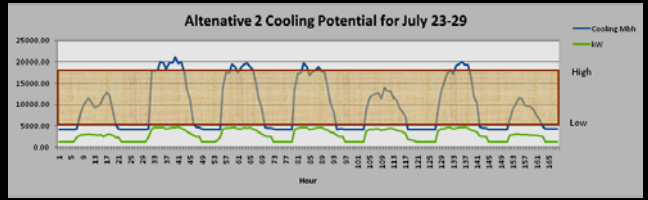
IC Engines

+

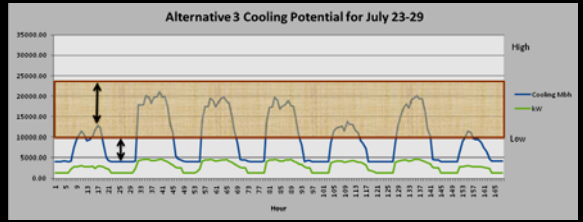
1,300 kW Gas Turbine

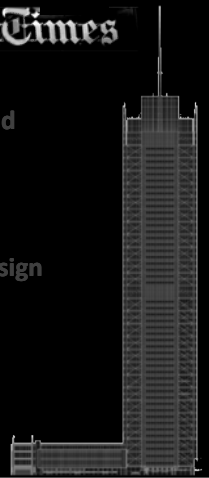
Redesign Alternatives

o IC Engine: Cooling Load Potential



o Gas Turbine: Excess Thermal

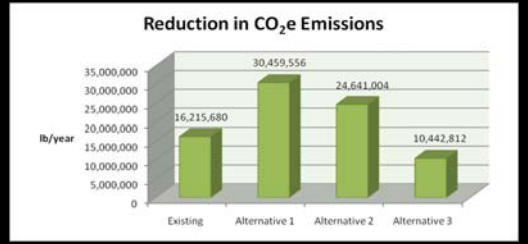


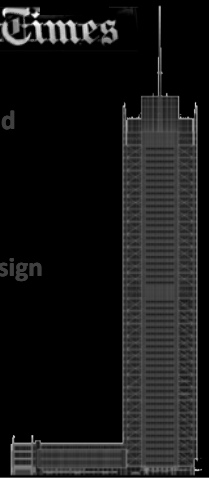


Redesign Alternatives

Energy / Emissions

CHP System	Existing	Alternative 1	Alternative 2	Alternative 3
Energy / Emissions				
Max Power Output (kW)	1,400	4,200	2,700	2,700
Yearly Power Output (kWh)	12,101,254	22,731,012	18,388,809	7,030,255 11,358,554
Max Thermal Rejection (Mbh)	9,340	28,020	15,240	18,940
Usable Heat Rejection (Mbh/year)	66,509,219	80,267,534	73,141,027	81,940,305
Fuel Consumption (scf/kWh)	12.49	12.49	12.11	13.35
Max Fuel Consumption (scf/hr)	17,485	52,455	32,692	36,045
Emissions Reduction (lbs CO_2e/year)	16,215,680	30,459,556	24,641,004	10,442,812



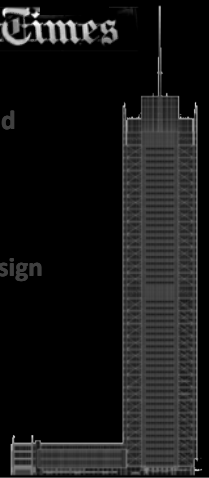


Redesign Alternatives

Energy Costs

CHP System	Existing	Alternative 1	Alternative 2	Alternative 3
Costs				
Installed Costs ($)	$5,600,000	$16,800,000	$10,800,000	$12,100,000
Maintenance Costs ($/kWh)	$0.005	$0.005	$0.005	$0.005 $0.015
Maintenance Costs ($/year)	$60,506	$113,655	$91,944	$205,530
Building Energy Costs ($/year)	$11,310,248	$9,766,130	$10,443,122	$10,649,749
Total Energy Cost Savings ($/year)	$2,272,786	$3,816,905	$3,139,912	$2,933,285
Payback Period (years)	0.00	7.83	6.71	14.29

Total Energy Costs: $13.5 million for SHP



Redesign Alternatives

Simple Payback Period

CHP System	Existing	Alternative 1	Alternative 2	Alternative 3
Costs				
Installed Costs ($)	$5,600,000	$16,800,000	$10,800,000	$12,100,000
Maintenance Costs ($/kWh)	$0.005	$0.005	$0.005	$0.005 $0.015
Maintenance Costs ($/year)	$60,506	$113,655	$91,944	$205,530
Building Energy Costs ($/year)	$11,310,248	$9,766,130	$10,443,122	$10,649,749
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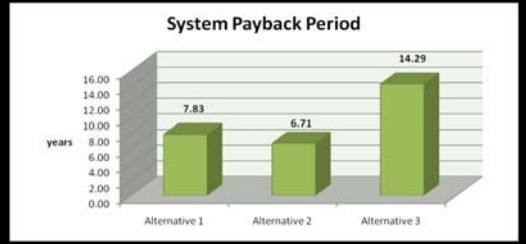
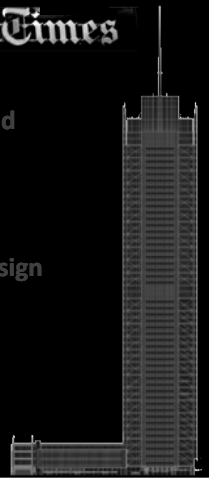


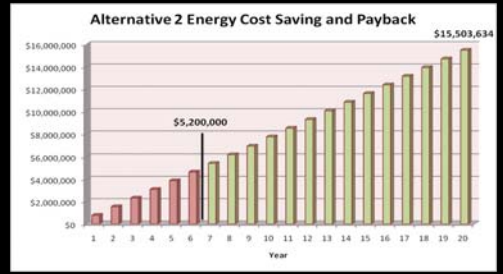


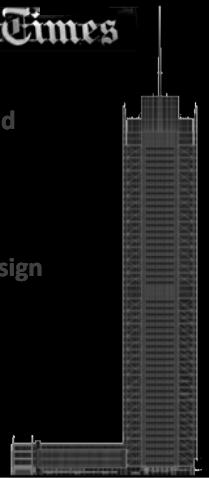
Redesign Alternatives

o Summary

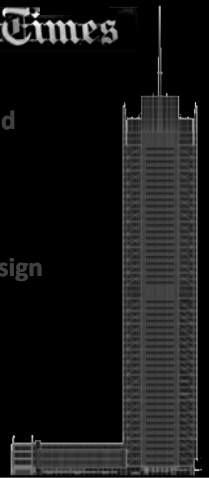
Overall Comparison	Existing	Alternative 1	Alternative 2	Alternative 3
Energy Cost	✖	☺		
Source Energy Emissions	✖	☺		
Payback Period			☺	✖
System Footprint	☺	✖		

Alternative 2: $10 million in savings over 20 years





Integrated Project Delivery Process



BIM Process

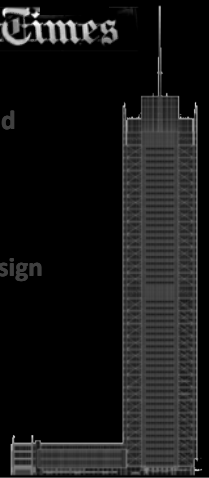
Building Information Modeling Process:

BIM Goals

Group Goals:
- o Enhance communication and information flow
- o Visualize project changes

BIM Use Analysis

Workflows



BIM Goals

Building Information Modeling Process:

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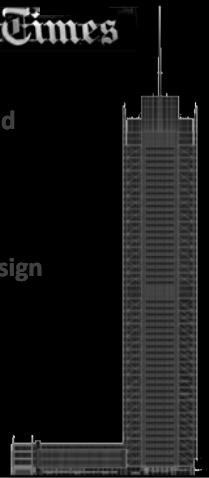
BIM Use Analysis

Workflows



BIM Use Analysis

Building Information Modeling Process:

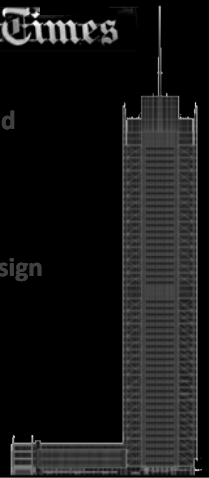
BIM Goals

Group Goals:
- o Enhance communication and information flow
- o Visualize project changes

BIM Use Analysis

Workflows

BIM Uses Analysis
Design Authoring
Design Review
3D Coordination
Phase Planning



BIM Workflows

Building Information Modeling Process:

BIM Goals

Group Goals:
- o Enhance communication and information flow
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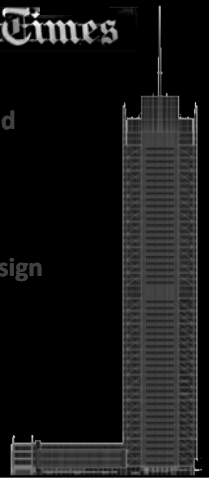
BIM Use Analysis

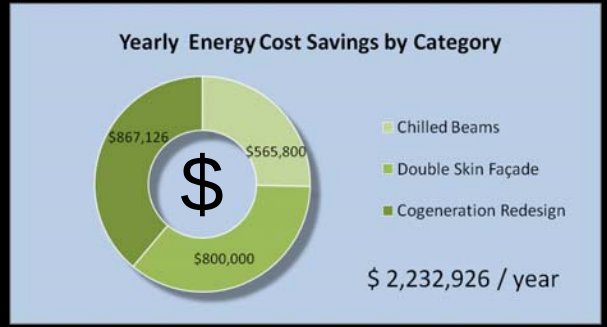
Workflows

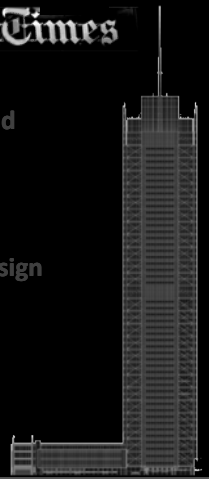


Metrics of Success

Increased Profitability
- Operating Costs
- Leasable Space

Increased Marketability
- Sustainability
- Iconic Image



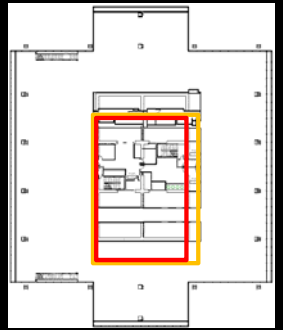


Metrics of Success

Increased Profitability
- Operating Costs
- Leasable Space

Increased Marketability
- Sustainability
- Iconic Image

Additional Square Footage	26,864 SF
Additional Rent	$ 1,601,840



Metrics of Success

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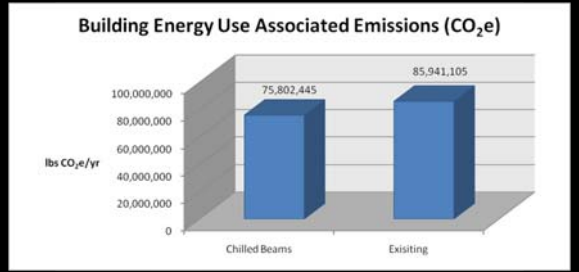

Metrics of Success

Increased Profitability
- Operating Costs
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Increased Marketability
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Metrics of Success

Increased Profitability
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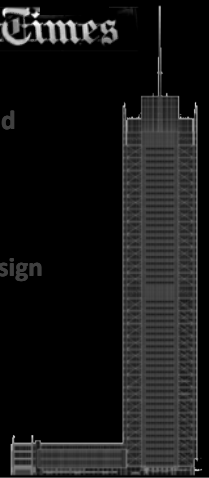

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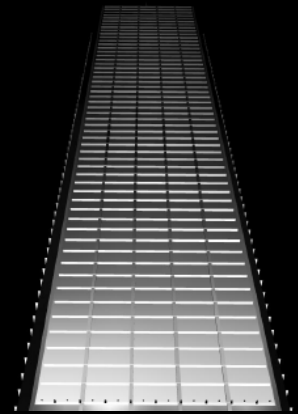

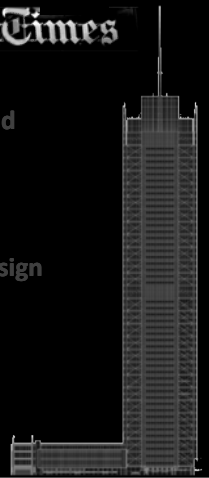

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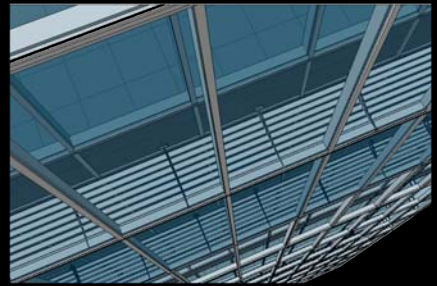

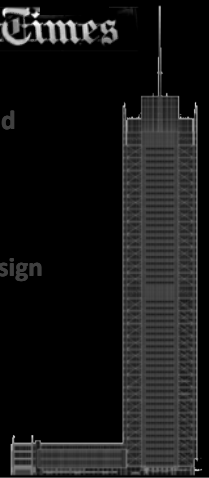

Metrics of Success

Increased Profitability
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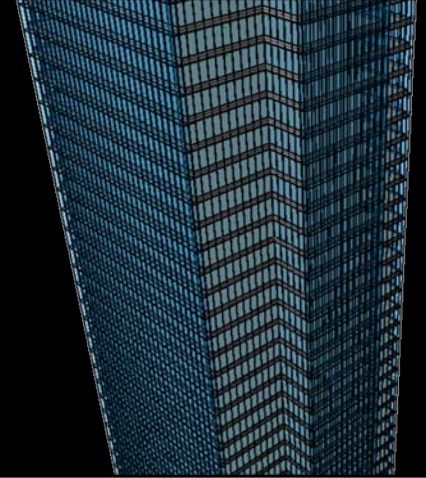
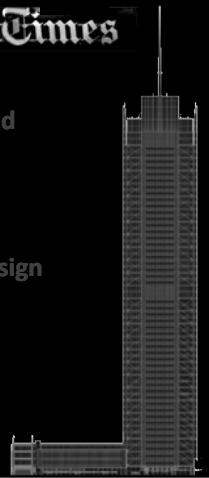




Metrics of Success

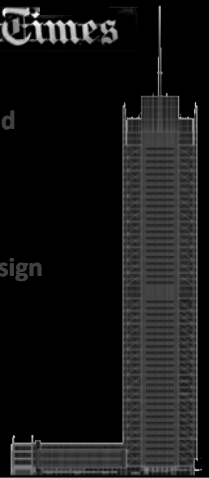
Increased Profitability
- Operating Costs
- Leasable Space

Increased Marketability
- Sustainability
- Iconic Image

Façade	
Upfront Cost	$ 18.7 million
Annual Energy Savings	$ 800,000
Payback Period	**23.4 years**

Floor System	
Upfront Cost	$ 12.3 million
Annual Energy Savings	$ 565,800
Annual Added Rent	$ 1.24 million
Payback Period	**6.72 years**

Core	
Upfront Cost	($ 14.4 million)
Annual Added Rent	$ 351,840
Payback Period	**NA**



Metrics of Success

Increased Profitability
- Operating Costs
- Leasable Space

Increased Marketability
- Sustainability
- Iconic Image

Overall Building	
Upfront Cost	$ 17 million
Annual Added Rent	$ 1.6 million
Annual Energy Savings	$ 2.2 million
Payback Period	**4.5 years**

Acknowledgements

Thank you to the following for all the support, assistance and guidance:

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- IPD/BIM Thesis Advisors:
  - Kevin Parfitt
  - Bob Holland
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  - Theodore Dannerth
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  - Jim Faust
- CHP Instruction:
  - James Freihaut, Ph.D.

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  - Thornton Tomassetti
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- CHP Contacts:
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  - Randy Musselman | Engineering, Cleveland Brothers, Power Systems Division
- High-rise Consultant:
  - Bob McNamara

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THANK YOU to All of our friends and family for their love and support!

Questions/Comments