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THE NEW YORK TIMES BUILDING

THESIS PROPOSAL

IPD/BIM TEAM I

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Executive Summary

The following report provides an overview of the topics that will be researched for the final IPD/BIM Team 1 Thesis on The New York Times Building. The goal will be to deliver an optimized, high performance building, adaptable to future design of the built environment. This will be measured by life-cycle cost and energy efficiency and maintain or exceed criteria for occupant safety, health and comfort, while preserving the architectural integrity of the building and the desires of the owner. These goals will be investigated through the use of the Integrated Project Delivery Method and the use of Building Information Modeling tools.

The first area of analysis is the implementation of a Building Information Modeling Execution Plan. This plan will identify and promote information flow between members of the team and enforce a schedule for each team member to guarantee completion. The collaboration between members will also be tracked, and a fully developed process map will be delivered as a final product.

The New York Times Building is a steel framed building with eccentric and concentric braces. The gravity system redesign will investigate the reduction of structural members in a typical bay while maintaining required structural strength and serviceability. Additionally, constructability, cost implications, beam and slab penetrations for MEP will be considered to optimize the proposed system. Since the gravity system is being redesigned; building stiffness, framing layout, and moment connections could potentially affect the lateral system, therefore a lateral redesign will occur. Due to large lead time for the fabrication of the existing structural steel, this investigation will consider a concrete core alternative that will reduce and/or eliminate the outriggers, thermal trusses, and X-bracing to increase transparency of the building. This alternative system will have scheduling, constructability and labor implications which will be compared to the current design. Autodesk Navisworks will be utilized to develop a 4D model to display the differences between each structural system, along with the usage of the model to perform clash detection within the core for MEP wall penetrations.

Additionally, analysis will be performed to determine if changing the under-floor air distribution system to a side-wall displacement scheme will provide for an improved air quality and thermal comfort for the occupants, while coordinating new space requirements. Cost and schedule implications of this design change will also be addressed.

The façade of the New York Times building is one of the most notable architectural features of the building requiring collaboration between each of the disciplines. The current facade system consists of a ceramic rod shading system over a floor to ceiling ultra clear glazing system. This facade system works as an architectural element as well as a daylighting and energy control system for the interior of the building. The effects of daylight, thermal loads, structural performance, aesthetics, and cost and schedule implications will be investigated. The envelope will be studied using multiple modeling techniques to optimize performance and provide a higher level of comfort and occupant satisfaction. The use of Mixed-Mode Ventilation in a high-rise will be investigated and its implications on the building's energy use and façade design. A control strategy will be developed to operate the mixed-mode scheme. Furthermore, the use of renewable energy will be investigated to supplement utility fossil fuel usage, reducing the carbon footprint of the New York Times Building. An analysis on the control of direct light and shadowing will be performed. A redesign of the façade, incorporating a change in glazing, shading, and controls will be completed with use of an integrated team approach as well as BIM software analysis. Research will be completed to show the initial versus long-term cost implications provided by the changes.

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PROJECT BACKGROUND

The New York Times building is a 52 story tower located at 620 Eighth Ave. in Times Square, Midtown Manhattan, New York City. Jointly owned by The New York Times Company and the developer Forest City Ratner Companies, the first, twenty-eighth, and fifty-first floors are co-owned by both companies, with the first floor including retail, restaurant and performance spaces. The twenty-eighth and fifty-first floors are mechanical spaces serving both companies. The New York Times Company solely owns floors two through twenty-seven, and Forest City Ratner Companies owns floors twenty-nine and above. The building contains the new headquarters for The New York Times as well as several leasing companies in the Forest City Ratner spaces.



ARCHITECTURE

Architects Renzo Piano Building Workshop in association with FXFOWLE Architects locally, designed the building as a forty-eight story tower on top of a four story pedestal. The pedestal floors are approximately 79,000 sq. ft. and the tower floors average approximately 36,000 sq. ft. The pedestal contains TheTimesCenter cultural center and performance space along with an open-air paper birch garden. The first floor also contains restaurant and retail spaces within the lobby.

At 746 feet tall, The New York Times Building took the architects vision of transparency to a new level by using an exposed steel structure and ultra clear glass from floor to ceiling on the facade. The facade also includes a ceramic rod shading system on the exterior to help control daylighting and heat gain throughout the spaces.

CONSTRUCTION MANAGEMENT

Started in August 2004 and being completed in November 2007, the building required over three years to complete construction and cost over \$1 billion, being split between both owners. The New York Times Building is delivered as a Design-Bid-Build, CM-at-Risk hybrid contract. The hybridization comes

from the early involvement of the Interiors Architect Gensler, Structural Engineers Thornton Tomasetti, and MEP Engineers WSP Flack & Kurtz being involved early in the design process with the architects.

Having a confined site within an urban environment provides the problems of pedestrian and automobile traffic and safety, along with site congestion and safety and delivery coordination. There are also many constructability issues associated with the double-skin facade system proposed by the architects.

STRUCTURE

Below the building's 16-foot cellar, the tower and podium mostly bear on 20-40 ton per square foot capacity rock. However, the southeast corner of the tower bears on 8 ton per square foot capacity rock. 24-inch diameter 6,000 psi concrete-filled steel caissons of unknown length were used under 7 columns in the southeast corner of the tower. The other 21 columns are supported by spread footings with 6,000 psi concrete. The columns which fall in the cantilevered areas of the tower do not directly transfer load to the ground which removes the need for footings at these locations. The New York City Subway travels below Eighth Avenue and 41st Street which is located on the Northern and Western sides of the site. Though, the subway does not pass directly under the structure, vibrations may have impacted the design of the foundations and structure.



FIGURE 1: New York Times Building Location, Source: Bing Maps

The floor system is a composite system with a typical bay size of 30'-0" x 40'-0" surrounding a 90'-0" x 65'-0" core. There are 60'-0" x 20'-0" cantilever bays on the North and South sides of the tower. The floor system is made up of 2 ½" normal weight concrete on 3" metal deck, typically spanning 10'-0"

from W12s to W18s infill beams. The beams then span into W18 girders which frame into various 30" x 30" built-up columns. The exterior columns consist of two 30" long flange plates and two web plates inset 3" from the exterior of the column on either side. The flange and web plates vary from 4" thick and 7" thick respectively at the ground floor to 2" thick and 1" thick respectively at the fifty second floor. This is to account for the different steel areas needed for the higher forces at the bottom of the building.

Framing of the core consists of W12 and HSS shapes framing into W14 and W16 shapes which frame into W33 girders that frame into the core columns. These columns are a combination of built-up plate sections and rolled shapes. Column locations stay consistent throughout the height of the building, and every perimeter column is engaged in the lateral system which will be described later. To maintain consistent proportions at all floors, a hierarchy of flange plate thicknesses was developed.

In the New York Times spaces, the structural slab is 16" below the finish floor and the spandrel panel, due to the raised floor system for the under floor mechanical systems. For all the exterior steel of the building to maintain a centerline at the center of the spandrel panel, a crooked connection or 'dog-leg' was used. The 'dog-leg' connection allows for the end of the beam to rise 10" before it leaves the interior of the building and penetrates the building envelope. Figure 2 shows the 'dog-leg' connection penetrating the building envelope.



FIGURE 2- 'Dog-leg' penetrating building envelope

To prevent columns obstructing the glass storefronts at the ground level, a Vierendeel system was used at the 20 foot cantilever sections of the tower. The middle lines of the cantilevered bays have beams moment connected to the columns engaging every floor except at the outrigger levels. At the outrigger level; floor twenty eight and fifty one, large diagonal braces tie the middle line back to the core through the outrigger trusses. In extreme loading conditions, this provides a redundant load path. See Figure 4

on the next page for Vierendeel frame location. At the exterior beam lines of the cantilever, 2" diameter steel rods were connected from the columns to the ends of the beams to control deflection at every floor. This allowed the beams to be designed only for strength, thus avoiding bulky exterior members.

The main lateral load resisting system for the tower of the New York Times Building consists of a centralized, steel braced frame core, with outriggers on the two mechanical floors. The structural core consists of concentric braces behind elevator shafts and eccentric braces at the elevator lobby entrances. The core configuration remains consistent from the ground level to the twenty seventh floor as shown in Figure 4 on the next page. Above the twenty eighth floor, the low rise elevators were no longer required, and the number of bracing lines in the North-South direction was reduced from two to one, not shown in Figure 4 on the next page. The outriggers consist of diagonal braces shown in Figure 3 and Figure 4 on the next page, which increase the stiffness of the tower by engaging the exterior and interior columns in the lateral system.

In order to reduce lateral drift and acceleration, the double story steel rod X-braces were utilized instead of increasing the member sizes of the main lateral force resisting system which were sized for strength. The high strength steel rods shown in Figure 4 on the next page transition from 2.5" to 4" in diameter and were prestressed to 210 kips. With the addition of the X-braces in the main lateral force resisting system, the calculated deflection of the tower due to wind was $L/450$ with a 10 year return period and a building acceleration of less than 0.025g for non-hurricane winds.

Thermal differentials had to be considered due to interior steel members being maintained at room temperature and exposed steel members undergoing extreme temperature changes. The structure was designed using a range of -10°F to 130 °F. Due to temperature deformation, differential deflection at upper floors exceeded $L/100$. To combat these thermal differentials, the outrigger trusses were utilized with thermal belt trusses along the east and west face at the twenty eighth and fifty first floors. These trusses shown in Figure 4 on the next page provide bonus redundancy and limited deflection to $L/300$.



FIGURE 3- Outrigger bracing on mechanical floor, courtesy of Thornton Tomasetti

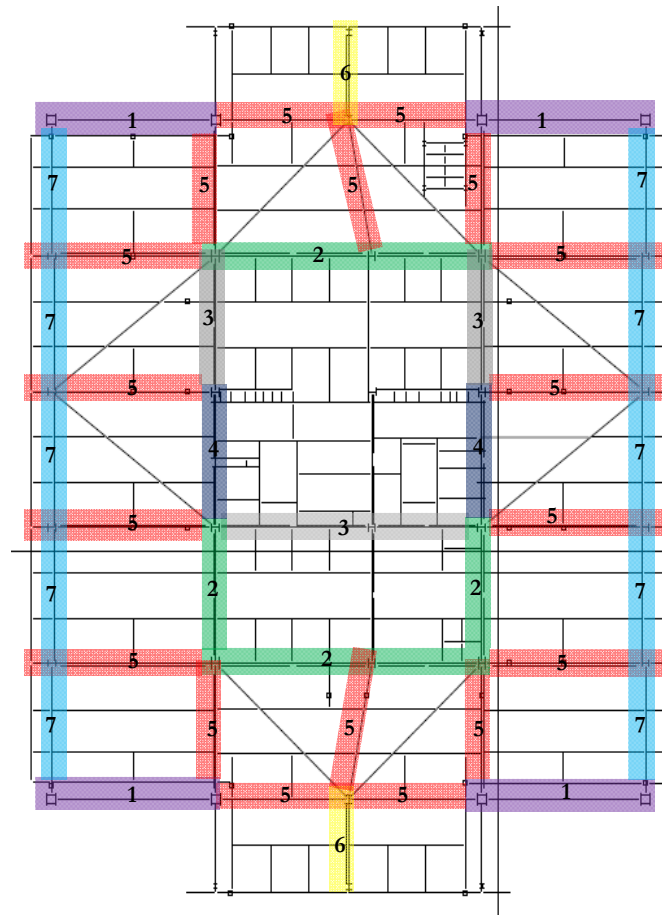


FIGURE 4 - 28th Floor Mechanical Floor Framing Plan

Key:

- Pre-Tensioned Steel Rod X-Bracing (1)
- Concentric Chevron Core Bracing (2)
- Eccentric Chevron Core Bracing (3)
- Single Diagonal Brace (4)
- Outrigger Bracing (5)
- Vierendeel System at Cantilever (6)
- Thermal Trusses (7)

MECHANICAL

The New York Times building was designed to meet the plaNYC 2030 initiative, which strives to improve the built environment by reducing green house gas emissions by 30 percent. There were several integrated design approaches taken to meet these goals. Flack and Kurtz worked alongside architects Renzo Piano and FXFOWLE to provide Mechanical, Electrical, Plumbing, Fire protection and Telecommunications design for the core and shell. Flack and Kurtz also partnered with Gensler to design the interior fit-out. Using an integrated approach, a high performance facade was developed which uses low iron clear glass and ceramic rods for passive external shading.

The building cooling load is served by a 6250 ton chilled water system, which consists of five 1,200 ton centrifugal chillers and one 250 ton single stage absorption chiller. The chilled water is pre-cooled by the absorption chiller before it enters the centrifugal chillers. A natural gas-fired cogeneration plant with two parallel reciprocating engines provides the waste heat to run the absorption chiller. Both the chilled and condenser water system utilizes a variable flow primary pumping scheme, and a water-side economizer which provides “free cooling” and increased energy savings. Heating for the building is provided via high-pressure steam purchased from Consolidated Edison. Low-pressure steam is then distributed to each floor-by-floor air handler’s heating coil. As an added cost, the New York Times Company also uses steam to humidify outdoor air.

Air distribution is achieved via variable air volume boxes for interior zones and fan powered boxes with heating coils for exterior zones. The floors occupied by the New York Times utilize an UFAD system. Swirl diffusers were installed to provide occupant control, while in high occupancy spaces perforated floor tiles provide a more visually pleasing layout. A traditional overhead ducted system was implemented on the Forest City Ratner floors. Demand controlled ventilation is achieved via carbon dioxide and VOC sensors located in the return ducts for each floor. Outdoor air is brought in through outdoor air units in the two mechanical penthouses on the 28th and 51nd floors, and then is distributed throughout the building.

The cogeneration plant provides 1.4 MW of electricity for the building year-round, and is located on the 5th floor roof of the podium building. With an efficiency of 85%, the plant provides 40% of the power needs of the New York Times Company. The plant waste heat is used in an absorption chiller to pre-cool the chilled water for the electrical chiller plant. Waste heat is also used to produce perimeter heating hot water in the winter months. The cogeneration plant’s primary purpose is an uninterrupted power supply for critical spaces such as the New York Time’s data center. The cogeneration plant is not connected to the grid for re-metering, but the site is backed up by on-site diesel generators.

LIGHTING/ELECTRICAL

Though the design was started in 1999, the building uses a more sophisticated control system than most new construction today. Each luminaire contains a Digitally Addressable Lighting Interface (DALI) ballast. The New York Times portion of the building contains 18,000 DALI ballasts. Along with a Quantum lighting control system, the building is able to maintain a low Lighting Power Density of approximately .38W/ft². This system takes input from an array of sensors including open loop photosensors, closed loop photosensors, and occupancy sensors.

The lighting in the office was done by continuous fluorescent luminaires. These luminaires run from the east side of the building to the west side. This achieves the signature look from the outside. This direct lighting system meets the design criteria for the office, with the ability to control each occupant's light level separately. The energy savings resulted from four areas: lowering all light levels by 20%, occupancy sensors, fine tuning light to occupant's preferences, and finally daylight harnessing.

The New York Times building is comprised of two main tenants; The New York Times and the Forest City Ratner Companies (FCRC). These two tenants have two different distribution methods throughout the building. The New York Times tenants use conduit for all feeders throughout their part of the building, whereas the FCRC tenants run bus-duct throughout their part of the building.

A commonality between them is the shared incoming service. Though the system is metered for every tenant, including the per floor fit-out of the FCRC floors, Consolidated Edison provides a main utility entrance to the entire building. The service entrance is located in the cellar and distributed from there to each of the floors above. The New York Times tenants also have a co-generation plant, 1.4 Megawatts, to supplement the utility need. Due to the importance of servers in the New York Times spaces, a UPS system is also located in the cellar and distributed accordingly. The entire building has a main diesel generator for emergency use. The building has the ability to have remote generators connected at street level, should the generator need to be serviced.

While the lighting, appliance, and mechanical panels are on a floor-by-floor design, the emergency panels are located every third floor. In addition, the UPS system has panels spaced out in a similar design. Each floor contains an east and west electrical room. The loads are ran to the nearest electrical room. Each floor also houses a mechanical room and a server room.

CONSTRUCTION MANAGEMENT

PROBLEM IDENTIFICATION: BIM EXECUTION PLAN

Building Information Modeling is a growing term in the construction industry. The problem associated with BIM is that owners request it without proper knowledge of what BIM can do or what they would like BIM to do for their project. By developing a Building Information Modeling Execution Plan, owners, designers, engineers and management teams will know exactly what they will get out of BIM on their project as well as be able to plan and track the information flow throughout the project. A breakdown of the BIM Project Execution Planning Procedure provided by Penn State CIC Research can be viewed in Figure 1.

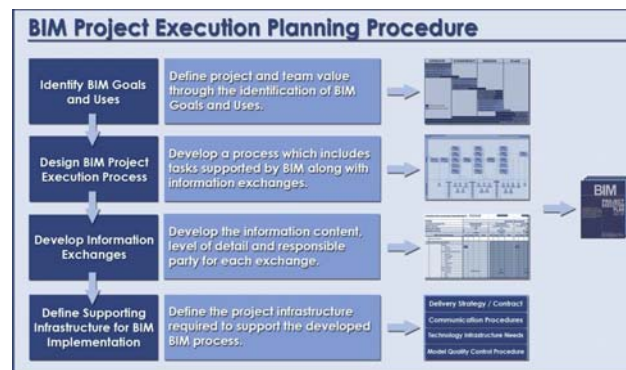


FIGURE 5 - BIM Execution Planning Procedure

With the integrated approach of the IPD/BIM thesis, one major obstacle is the control of information and work of the team. By tracking the flow of information throughout the project, the collaboration between team members will be controlled for the project. Developing goals for the project and the team are a key to success of the project.

GOAL

The goal of this research is to develop and enforce a BIM Execution Plan for the team. This plan will contain major project milestones with strict dates of completion. It will show the flow of information in and out of the model, and produce a timeline of when certain information is required for each team member to be successful. This will produce a better product for Team 1.

METHODOLOGY

Steps taken will include:

- Update developed BIM goals and uses throughout spring semester. Shown in Figure 6.
- Implement and update the BIM use analysis to determine which uses will be included in the research. Shown in Figure 7.
- Develop a Overview Process Map to work as a schedule for the Team. Shown in Figure 8.
- Modify and update the Process Map throughout the spring semester.
- Continually enforce the Process Map to ensure team success.
- Continually update and enforce the Team 1 semester schedule. Shown in Figure 9.

EXPECTED OUTCOME

It is expected that by developing, updating and enforcing the BIM Execution Plan, the project will become more efficient and provide a superior finished product. This Execution Plan will provide strict dates of completion which each team member must abide by to insure the other member's success. Transfer of information and collaboration between the team members will be critical to the success of this undertaking and the final deliverable will be a fully developed process model, an analysis of the BIM Execution process, advantages and disadvantages, and a successful team thesis.

TEAM 1 IPD/BIM GOALS – VERSION 2010.1

Priority (1-3)	Goal Description	Potential BIM Uses
1- Most Important	Value added objectives	
0	Pull all ideas together (Unification);(Sustainability)	ALL
1	Preserve Architectural Integrity (Desires of Owner)	Design Reviews, Design Authoring, Record Modeling
1	Emphasize Energy Efficiency (Carbon Neutral)	Energy Analysis, LEED Evaluation
1	Maintain/Exceed Occupant Safety/Health/Comfort	Energy Analysis, Daylighting Analysis, Code Validation, Structural Analysis, Disaster Planning
2	Optimize façade to meet goals	Energy Analysis, Lighting Analysis, LEED Evaluation, Site Analysis, Structural Analysis, Cost Estimation, Construction System Design
2	Optimize Electric Lighting to respond to Daylight	Lighting Analysis, Energy Analysis
2	Optimize Structural System for increased space, reduce construction duration, reduce cost	Structural Analysis, 4D Modeling, Cost Estimation, Construction System Design
3	Increase profitability of the building	Cost estimation, 4D Coordination, Digital Fabrication, Virtual Mockup

Figure 6 - BIM Goals and Uses

Team 1 IPD/BIM Use Analysis – Version 2010.1

BIM Use*	Value to Project	Responsible Party	Value to Resp Party	Capability Rating			Additional Resources / Competencies Required to Implement	Notes	Proceed with Use
				Resources	Competency	Experience			
	High / Med / Low		High / Med / Low	Scale 1-3 (1 = Low)					YES / NO / MAYBE
Maintenance Scheduling	LOW	NONE							N
Building Systems Analysis	HIGH	Ben	H			2			Y
		Craig	H			2			
		Nicole	H			2			
Record Modeling	MED	Justin	L			1			N
Cost Estimation	HIGH	Justin	H			2			Y
4D Modeling	MED	Justin	H			3			Y
Site Utilization Planning	LOW	Justin	L			1			N
Layout Control & Planning	LOW	Justin	L			1			N
3D Coordination (Construction)	LOW	Justin	M			2			N
Structural Analysis	HIGH	Ben	H			3			Y
Mechanical Analysis	HIGH	Nicole	H			2			Y
Lighting Analysis	HIGH	Craig	H			3			Y
Energy Analysis	HIGH	Nicole	H			2			Y
Site Analysis	HIGH	ALL	H			2			Y
Design Reviews	HIGH	ALL	H			2			Y
3D Coordination (Design)	HIGH	ALL	H			2			Y
Existing Conditions Modeling	HIGH	ALL	M			3			Y
Design Authoring	HIGH	ALL	H			3			Y
Programming	LOW	BOB	H			1			N
LEED Evaluation	LOW	ALL	L			1			M
Construction System Design	MED	Justin	H			1			M
Virtual Mockup	MED	All	H			3			Y

FIGURE 7 - BIM Use Analysis

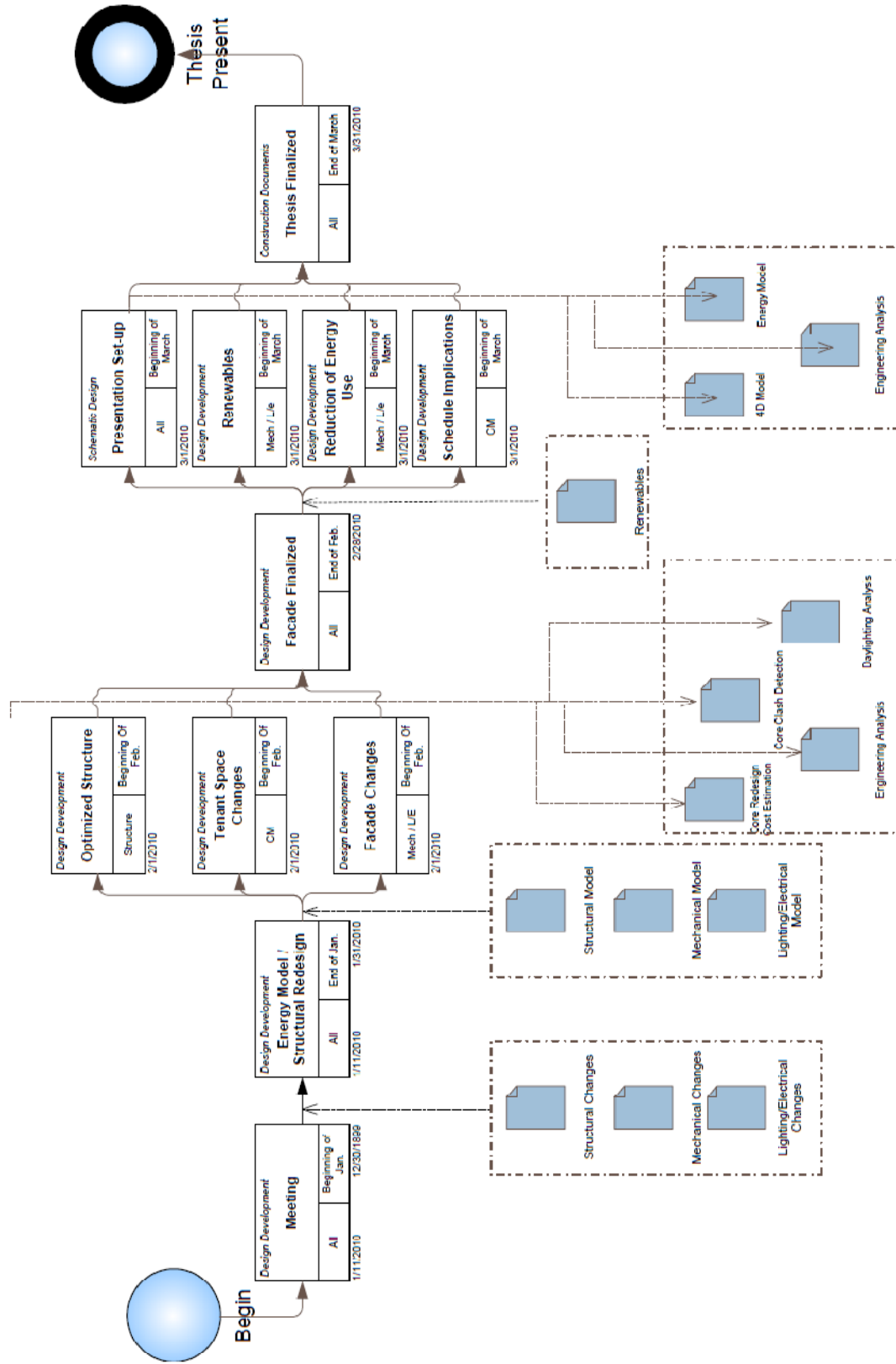


FIGURE 8- Overview Process Map and Schedule

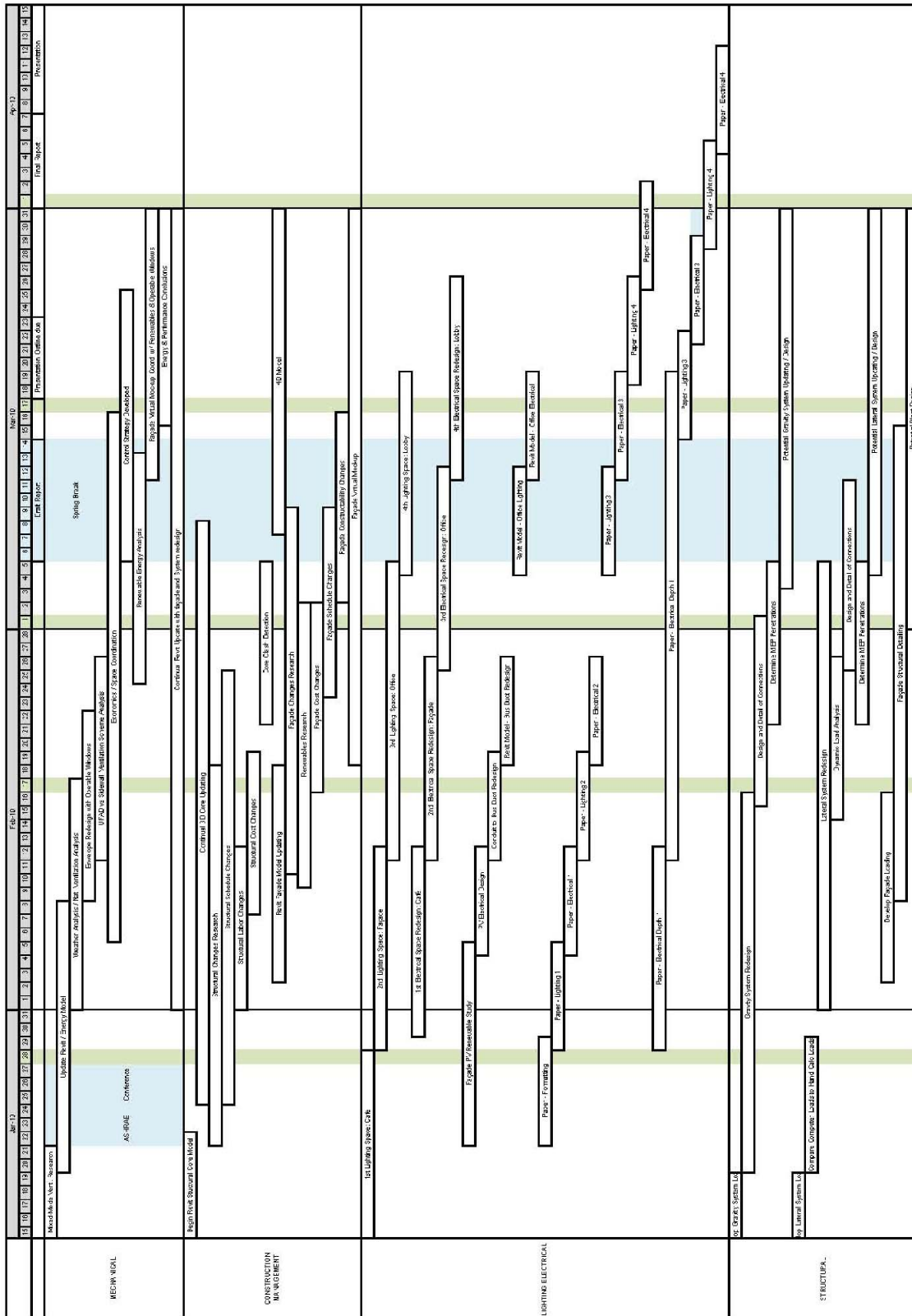


FIGURE 9 - Team Schedule

Milestone 1 – Energy Model / Structural Redesign;

Milestone 2 – Go / No-Go;

Milestone 3 – Façade Redesign;

Milestone 4 – Renewables/Energy Use/Feasibility;

Milestone 5 – Finalize Report/Presentation

PROBLEM IDENTIFICATION: STRUCTURAL CORE REDESIGN

The structural system of the New York Times Building consists of steel columns, girders and beams throughout the building. The lateral system of the building is comprised of built-up columns, large outriggers and thermal belt trusses and eccentric and concentric chevron braces. These systems require long fabrication time and the delivery of the members can also pose problems when delays occur due to traffic in the city or delays in manufacturing.

GOAL

The goal of this analysis will focus on structural collaboration to design an alternative lateral system made of concrete for The New York Times Building. The benefits of the system will be researched, mainly comprising of the impact of the new system on the cost and schedule. Research will also be conducted to look at the changes in cost and schedule due to material and labor associated with the structural change.

METHODOLOGY

Steps taken will include:

- Create a three-dimensional computer model in Autodesk Revit software with correct dimensions, materials and locations of penetrations through the system.
 - Penetrations for doors will need to be placed within the model, as well as penetrations for mechanical, electrical and plumbing systems if needed. The MEP penetrations will be coordinated for correct placement and size. Assumptions will be made at the start and updated throughout the progress of the MEP analysis.
- Analysis of the model in RAM and ETABS to optimize the system.

- Develop the schedule and cost changes associated with the structural system changes.
- Develop a 4D model using Navisworks Manage and Microsoft Project to show the improvement of the new structural system with relation to the previous system.
- Secondary research will be provided by performing clash detection with Navisworks Manage for the new core system and a typical floor for the changes to the Mechanical and Electrical systems.

EXPECTED OUTCOME

With the new structural system, it is expected that a schedule reduction will occur due to less lead time required for prefabrication of the steel members for the core. This will occur by beginning concrete core construction while steel members are still being fabricated off-site and will be delivered when complete. Another anticipation is that the lateral system change will also affect the number of structural steel members and connections throughout the rest of the building. A main effect of the change will be a reduction of the size or number of outriggers located on the 28th and 51st stories shown in Figure 4. Column changes may also incur significant savings in tons of steel or number of connections. Time and cost could also be saved from removing the large knuckle connections and steel rods located every two stories along the columns on the exterior of the building shown in Figure 10.

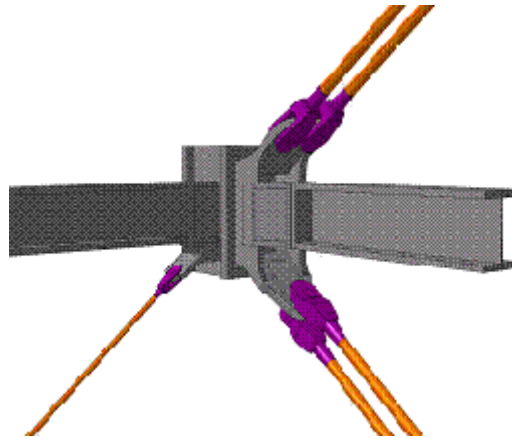


FIGURE 10 - Exterior Steel Knuckle Connection

PROBLEM IDENTIFICATION: COST AND CONSTRUCTABILITY OF FAÇADE REDESIGN

The façade system of The New York Times Building is comprised of a ceramic rod shading system over a floor to ceiling ultra-clear glazing system shown in Figure 11. The shading system was designed to control daylighting and energy gain within the building as well as act as an architectural feature. This system is the first of this kind used in New York and is very complicated for construction. Several physical mockups were constructed to make sure that constructability and design of the system were feasible to the building.



FIGURE 11 – Façade System

GOAL

The goal of this analysis is to track the constructability and cost implications associated with optimizing the façade system of The New York Times Building. Additionally, the investigation of adding renewable technologies to the façade system will occur. These changes will require a cost analysis to determine the feasibility of implementing the changes on the project.

METHODOLOGY

Steps taken will include:

- Analyze the cost, schedule and lead time implications associated with the new system.
- Analyze payback periods and government funding opportunities for the proposed changes.
- Collaboration with the Mechanical and Lighting/Electrical options to determine if the long-term benefits and efficiency will out-weigh the maintenance, schedule impacts and upfront costs of the new system.
- Determine the feasibility of the façade changes.

EXPECTED OUTCOME

This analysis is expected to conclude that the façade changes proposed will provide a long term cost savings beneficial to the project. It is not expected that the addition of renewable energy systems will entirely overcome the electrical usage of the building; however, the research is intended to show that the changes will maintain the constructability of the system while improving the overall project.

STRUCTURAL

PROBLEM IDENTIFICATION: GRAVITY SYSTEM REDESIGN

Figure 12 shows the existing floor system which is a composite system with 2 1/2" normal weight concrete on 3" metal deck, typically spanning 10'-0" from infill beams. The infill beams span into girders and built columns on either side. The current construction dead load is approximately 65 psf with a total dead load of approximately 90 psf, not including the facade weight, and 70 psf of live load.

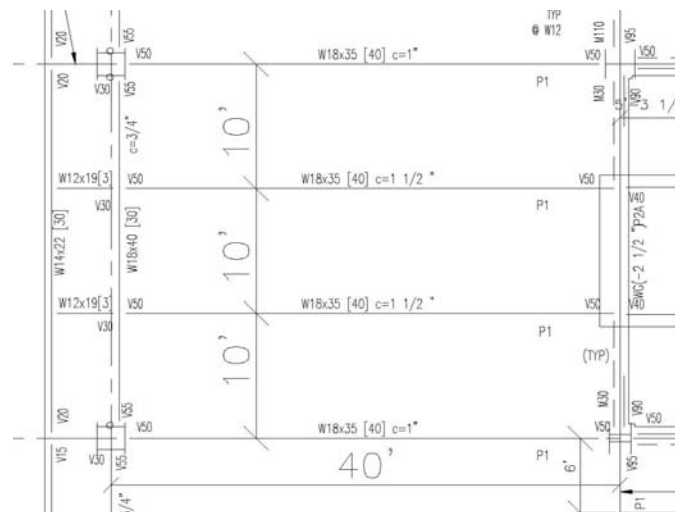


Figure 12: Existing Gravity System

GOAL

The goal of this analysis is to investigate alternative floor systems with less structural members in a typical bay while maintaining strength and serviceability requirements. Two framing layouts will be investigated with three different options being explored; castellated beams versus rolled W shapes, lightweight concrete versus normal weight concrete, and long span deck versus typical deck. As part of the MAE requirements, typical shear and moment connections will be design. In addition, dynamic principles will be utilized to assess vibrations of a typical bay and a computer model of the gravity system will be created to aid in analysis. Changing the gravity system of the New York Times Building would also affect the lateral system which is addressed later. The analysis will track constructability, scheduling impacts and cost implication due to material and labor associated with the gravity system redesign. Coordination for beam and slab penetrations is essential to optimize the proposed gravity system.

METHODOLOGY

Steps taken will include:

- Develop a typical floor plan in RAM and Revit Structures
- In depth analysis of one infill beam spanning 40'-0" framing into 30'-0" girders system
 - Investigate lightweight concrete versus normal weight concrete
 - Investigate typical metal deck versus long span deck
 - Investigate castellated beams versus typical W shapes
- In depth analysis of two infill beam spanning 30'-0" framing into 40'-0" girders system
 - Investigate lightweight concrete versus normal weight concrete
 - Investigate typical metal deck versus long span deck
 - Investigate castellated beams versus typical W shapes
- Design and detailing of connections for the structural members
- Team coordination of design and analysis changes

EXPECTED OUTCOME

This investigation is expected to result with fewer structural members in a typical bay causing a lighter weight system. In turn, the changes should provide cost savings to the project and decrease structural erection time. The computer model of the structure will allow for better coordination of the trades and prevent any potential clashes.

PROBLEM IDENTIFICATION: LATERAL SYSTEM REDESIGN

The existing lateral system consists of eccentric and concentric chevron braces in the core with outriggers and thermal trusses engaging the perimeter built-up columns with exposed X-bracing rods along the perimeter of the building. At the time of design, there existed an issue between the steel and concrete unions which prohibited the erection of steel during placement of overhead concrete at the core.



Figure 13: Core bracing during construction, courtesy of Thornton Tomasetti

GOAL

The goal of this analysis is to investigate a concrete core alternative that will reduce cost, accelerate speed of construction, and reduce and/or eliminate the outriggers, thermal trusses, and X-bracing to increase transparency of the building. In addition to maintaining strength the target period of vibration of 6.8 seconds is necessary to compare to the current building dynamic properties and acceleration. As part of the MAE requirements, a computer model of the lateral system will be created to assess the dynamic properties of the proposed design. The analysis also will track constructability, cost implication due to material and labor, and schedule implications associated with the lateral system redesign. Coordination for wall penetrations is essential to optimize the proposed lateral system.

METHODOLOGY

Steps taken will include:

- Develop hand calculations for lateral loads
- Develop the lateral system in ETABS and Revit Structures

- Team coordination of core redesign changes
- In depth analysis of a concrete core only option

EXPECTED OUTCOME

This investigation is expected to result in cost savings to the project and decrease structural erection time. With a concrete core only option investigated it is expected that column sizes will decrease due eliminating their use in the lateral system. It is also expected that there should be a balance between the architecture and the structural to design an efficient lateral system. It should be noted to obtain the same dynamic properties there needs to be a balance between mass of the building and stiffness of the structural system. The computer model of the structure will allow for better understanding of the inherent and accidental torsion, flexural, shear, and axial deformations, as well as P-Delta effects. In addition, the computer model will allow coordination of the trades and prevent any potential clashes.

MECHANICAL

PROBLEM IDENTIFICATION: ENVELOPE, LOAD REDUCTION & BIM WORKFLOW

The building envelope is a complex system with multiple performance and functional requirements requiring coordination between all disciplines. The façade of the New York Times Building is one of the most notable architectural design features and also one of the most significant contributors to the building's energy load profile. With a high window to wall ratio and the use of highly transparent glazing, the exterior walls become a heat sink during the cooling months and a poor insulator during the heating months.

The underfloor air distribution system used in the New York Times Building provides certain advantages and disadvantages. One noted issue with an unducted plenum for supply air is the possibility of air leakage resulting in efficiency losses. Air quality due to improper cleaning and maintenance will need to be addressed. Also, the space is partitioned which can block the flow of the floor diffusers from entering all of the spaces.

Additionally, the New York Times Building provides a unique opportunity to investigate the use of software interoperability for analysis and collaboration of disciplines to optimize design.

GOAL

The proposed research must emphasize energy efficiency and maintain or exceed criteria for occupant safety, health and comfort, while preserving the architectural integrity of the building and the desires of the owner. This research will investigate the mechanical engineer's role in optimizing the building design through the use of IPD/BIM coordination.

The main goal of the mechanical research will be investigating the workflow between 3D Building Information Models and energy analysis software utilizing the Green Building XML (gbXML) schema. This will involve documentation of geometry creation, interoperability issues and will draw conclusions of the advantages and disadvantages of this workflow.

Additionally, the envelope will be investigated using multiple modeling techniques to optimize performance and provide a higher level of comfort and occupant satisfaction. A parametric study

comparing different glazing and shading systems, along with incorporating lighting load reductions will be performed to reduce the ambient load profile of the building. The use of Mixed-Mode Ventilation in a high-rise will be investigated and its implications on the building's energy use and façade design. A control strategy will be developed for the new hybrid ventilation scheme.

Additionally, analysis will be performed to determine if changing the under-floor air distribution system to a side-wall displacement scheme will provide a better indoor air quality and thermal comfort for the occupants. Furthermore, coordination with all of the disciplines will be necessary to change to a ducted system.

METHODOLOGY

Steps taken will include:

- 3D modeling and software interoperability investigation
- Use of energy simulations to optimize thermal and daylighting performance of the façade
- In depth analysis of weather data and natural ventilation feasibility study.
- Envelope redesign for operable windows.
- Control strategy developed
- Analysis of underfloor vs. sidewall displacement ventilation.
- Team coordination of space coordination and design changes

EXPECTED OUTCOME

The expected outcome of this analysis and design is to improve upon the indoor environmental quality and energy performance of the New York Times Building while maintaining architectural integrity of the building and optimizing life cycle costs. It is expected that the use of appropriate Building Information Modeling tools and Integrated Project Delivery methodology will improve upon this process.

LIGHTING/ELECTRICAL

PROBLEM IDENTIFICATION: FAÇADE REDESIGN

The façade of the New York Times building is one of the most important features of the entire building. The façade will be a major collaboration effort between each of the disciplines within the IPD/BIM thesis course. The reason for such collaboration is because the façade affects daylight, thermal loads, structure, and cost/schedule. From the lighting perspective, the control of direct light and shadowing is the utmost concern for this proposal.

In addition to the façade redesign, an in depth look into the office lighting design will be completed. A design of the office will be done to complement the daylighting integration. This design will focus on improving the environment for the employees. Along with a redesign of the office, a redesign of the lighting for the façade will also be completed. The façade and the open office will incorporate the use of IPD/BIM methods for completion of the design.

GOAL

Investigations in the area of daylighting will be the primary focus for the beginning part of the semester. As part of the MAE requirement, an analysis of the daylighting will be completed for its application to the New York Times façade redesign. The analysis will provide useful information for integration with the mechanical systems.

Lighting of the façade will be another focus for next semester. A study of current signature buildings will be completed to determine the best method for lighting a building in the New York Skyline. The final focus will be the collaboration of the designers on this project. It is important to understand how the process of Building Information Modeling can assist in a design project. The process outlined above will be tested during the beginning portion of next semester and iteratively refined to better reflect the actual project process.

Investigations into the use of a renewable energy source will be completed. By making use of the existing modeling, a shared model can be used within Ecotect to help with this calculation. The analysis

will be completed for payback time. The payback will be determined for each of the façade directions. The chosen system will have to integrate into the architecture of the building.

METHODOLOGY

Steps taken will include:

- Models will be created to optimize the lighting design with the mechanical design.
- Analysis of available solar energy will be completed in Ecotect and solar PV feasibility study.
- Use of BIM energy modeling software as well as daylighting analysis software.
- Documentation of lighting design including fixture schedules, plans, and calculations.

EXPECTED OUTCOME

The expected outcome of this project is an optimized design for the occupants of the building. The redesign will maintain the architectural integrity of the building, while optimizing energy performance with life cycle costs. A better understanding of the integration of Building Information Modeling and Integrated Project Delivery is also expected as a result of this project.

PROBLEM IDENTIFICATION: BUS DUCT ANALYSIS

In a high rise like the New York Times building, space is always a concern. Finding ways to conserve as much space as possible can lend to more leasable space or higher floor to ceiling heights. The New York Times tenants made a decision to use conduit for their vertical distribution throughout their 28 floors. This took a significant amount of room to run, and it may have added a significant cost.

GOAL

The second electrical depth will look into saving space within the core. To aid the structural systems needs, switching from conduit to bus duct for the New York Times tenant will be investigated. This will be modeled within the core revit model for sequencing with the CM. In addition to the space savings, a cost analysis will be completed comparing sizing and types of materials for the bus duct.

METHODOLOGY

Steps taken will include:

- Working with the CM, cost data will be collected for installation and materials for existing distribution.
- Cost data will be collected through existing electrical catalogues.
- An excel spread sheet will be developed to compare the cost data
- A model of the vertical distribution will be produced with the CM for space saving analysis.

EXPECTED OUTCOME

The expected outcome of this project is an optimized design for the occupants of the building. The expected outcome is a decreased installation cost and significant space savings within the core. An understanding of bus duct design is also an intended outcome for this part of the thesis proposal.

APPENDIX:

LUTRON COMMENTS

Lee Brandt

- Think about the lighting of the exterior near the stairwells, because the building is 24/7 the interior could be the color in the design
- Think about the façade's relation to the light from the interior
- Concepts at the entrance level were good
- The horizontal façade lighting is interesting, but could be hard to implement in reality
- How can the Lawrence Berkeley façade be improved?
- Pick one axis for direction of fixtures in the café
- Energy savings of the office for task control make sense, but zones going on and off can be distracting

Kari Nystrom

- Images of the café rendering had two different glazing conditions
- Try creating two psychological impressions with the same ceiling and lighting gear
- Rendering of office space, the cones of light gave effect of circular downlight instead of linear light
- Sketches were confusing
- Presentation was good and direct
- The right hand side of the power point was difficult to read

Luke Tighe

- The façade rendering was a disregard of the horizontal ceramic rods (didn't like it)
- Lighting of the exterior is the exterior lighting
- Lighting the spandrel panels takes away from the transparency
- How do you accomplish the circulation lighting in the lobby?
- Tough building to play with
- Think about the Flynn study more and what the goals are, what if it is used for an awards ceremony?
- When you're in the lobby, you're in the garden, and you're in the other side as well...how does the lighting design aid in this feeling of transparency?

- Building is not in the normal grid, so how can this be used?

The ideas presented in regards to the interior lighting as part of the façade lighting will be taken into consideration. Though throughout the design, the designers had constant feedback from the architect, this is not something we will be privileged with. With this in mind, a new design with concepts from today's energy standards will be applied. Since the main tower does not operate 24 hours a day 7 days a week, a design that is conscious of energy will be employed. In addition, the façade will be a cooperative learning experience in optimization between all members of the BIM team. Because of this, no definitive statements can be made in regards to the outcomes of the façade. A design for the café that encompasses the multiple usages of the space will also be taken in consideration.