The New York Times Building

IPD/ BIM Thesis Team II Proposal

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EXECUTIVE SUMMARY

The following proposal is intended to provide an overview of the four analytical phases of IPD/BIM Team 2 senior thesis project for the New York Times Building. Overall, the group chose to follow a strategy emphasizing the reduction of dependency on grid-based energy sources and more efficient systems design as determined by performance, initial cost, life cycle cost, and constructability.

Each of the four phases were chosen for the fact that they require the analysis of more than one team member and allow the team members to further experiment with the Integrated Project Delivery portion of the IPD/ BIM thesis. However, some team members have certain requirements that are required by their department- these goals are outlined in the section labeled Individual Team Member Goals.

PHASE I: FAÇADE REDESIGN

The current configuration of the façade is not the optimal configuration for either daylight utilization or solar shading. A series of passive, active, and glazing reduction strategies will be investigated in which the goal of the redesign will be to optimize thermal loads on the building, while maintaining the architectural vision and owner requirements. This phase requires the participation of all team members.

PHASE II: COGENERATION PLANT REDESIGN

As currently designed, the cogeneration plant is capable of offsetting a small portion of the required demand load. Gas turbine, internal combustion, microturbine, and fuel cell systems will be investigated with respect to total production of energy versus life cycle cost, initial cost, and utility consumption. This phase requires the participation of all team members.

PHASE III: STRUCTURAL ALTERNATIVES

An alternative steel braced-frame lateral system with one outrigger level is proposed after the research performed by the structural team member during Technical Report 3. Due to the high cost of the architecturally exposed X-braces and their connections, the structural team member will concentrate on a redesign of the system that will effectively eliminate the need for these braces as a method of controlling drift. The construction management team member will investigate the schedule and cost changes resulting from eliminating this element.

The progressive collapse resistance of the structure will also be analyzed, paying special attention to the twenty-foot cantilevers. Changes in member sizes and connections will be recommended based on findings.

PHASE IV: ALTERNATIVE DISTRIBUTION SYSTEMS

This analysis will target the specifics of the electrical and air distribution systems in the New York Times spaces and whether or not alternative systems are more or as effective with respect to energy efficiency, constructability, and first and lifecycle costs.

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TEAM VISION

The overall intent of the Team II analysis is to optimize building performance while preserving owner requirements and architectural vision. The Team II Redesign Analyses will focus on four key areas of study: facade, cogeneration, distribution systems, and the possible creation of a rentable penthouse for high-end tenants via new structural systems.

The optimization of building performance will be evaluated by comparing the alternative's first cost, life-cycle cost, maintenance considerations, and occupant flexibility individually within each of the four key areas of analysis.

PROJECT INTRODUCTION

The New York Times Building is a 52-story glass and steel structure designed to reinforce the values of the Times Company and its culture of transparency. Located at 620 Eighth Ave. between 40th and 41st streets in Times Square, the building utilizes water-white windows from floor to ceiling, exposed steel columns, and accents of red and gold making it a fitting home for a 21st-century media company. Architect Renzo Piano working with FXFOWLE Architects incorporate many themes into the architecture. The themes included are volume, views, light, respect for context and relationship to the street to provide a design that is open and inviting. This also presents occupants with a sense of the city around them.

The New York Times Building is co-owned by The New York Times Company and developer Forest City Ratner Companies. It houses the New York Times Company on floors 2-27, and many private companies on floors 1, 29-50, and 52. Floors 28 and 51 are co-owned mechanical spaces, and the first floor is co-owned retail space.

FAÇADE REDESIGN

Following the completion of the technical assignments, it was determined that redesigning the façade could improve the performance of the New York Times Building in a manner which is aligned with our team goals. The façade redesign will focus on strategies for efficient daylighting and optimizing the dynamic thermal skin loads.The team decided to focus on three main areas: passive analysis with respect to shading and thermal mitigation strategies, active shading systems analysis, and an analysis focusing on reducing overall glazing surface area.

LIGHTING AND ELECTRICAL

With respect to the façade redesign analysis, lighting and electrical analysis will be focused on three prime areas: Passive analysis, Active Analysis, and Glazing Reduction Analysis

Passive Analysis

A daylighting analysis on a typical office floor will be performed, which will assess the possibility of replacing the existing glazing with several proposed arrangements of fritted glass. This will be accomplished using the analytical programs AGI and Daysim. Using this information, establishing the resulting daylighting factors (increased from existing conditions, ideally) in conjunction with the mechanical team member will be necessary to ensure a positive change in energy savings.

Active Analysis

The feasibility of replacing the existing rod-based passive design system for daylighting control with an active louver system to better control daylight and heat gain will be analyzed. The study will look at different sizes, angles, and shapes of blades that will increase daylight penetration, reduce direct daylight and glare, and increase the view out of and into the building while still maintaining the core principles of transparency put in place by the architect and owner. This redesign will be considered successful if the daylighting factor of the office is increased, direct glare is able to be decreased, as well as obtaining positive effects on energy savings while working with the mechanical engineering team member.

Reduction in Glazing

The mechanical and lighting and electrical team members will work together to ensure that there is no loss in daylight penetration into the space or loss of visibility out of the building while a balance of clear glazing and non glazing area is determined. Ideally, this will increase energy savings, not diminish from the daylight penetration into the space, and at the same time not reduce the views out of and into the building.

MECHANICAL

The mechanical team member will work closely with other team members during the Façade Analysis phase, particularly the lighting and electrical and CM team members. The façade redesign phase was chosen by the group to be first because of the impact any changes to the building envelope may have on energy consumption and structural loads.

Passive and Active Analysis

An energy modeling program can be used for the analysis of shading effectiveness. A comparison between the ceramic rod baseline and the newly proposed system will be investigated with respect to monthly solar gain savings. The façade redesign will be evaluated based on the cost effectiveness and payback period compared to that of the baseline facade.

Reduction in Glazing

An energy modeling program will be used to find an optimal window to wall ratio with respect to: heat loss, solar gain, daylighting and architectural vision. Reducing the glazing will have dramatic impacts on the building's energy profile, but no redesign can be implemented if it does not meet all other project goals.

STRUCTURAL

The structural team member will primarily ensure that any possible changes to loads are properly addressed by the building structure. Changes to the facade weight will have to be investigated for possible increases of wall loads; this, in turn, might necessitate a change in the support system for the facade. The impact the new shading device has on the wind loads will also be considered, since the shape of the device and the amount of wind deflected to the facade will change. In addition, the structural team member will have to consider out-of-plane forces and in-plane story drifts in the façade redesign.

A reduction in glazing will lead to a change in the facade dead load. This dead load will have to be applied to the supporting beams and columns for strength and serviceability analysis.

CONSTRUCTION MANAGEMENT

Any changes to the façade will need to be examined with respect to initial cost, life cycle cost, potential maintenance issues, and construction time/ methodology. It is important to note that if one system does in fact cost more initially, it may still be economically viable if the payback period falls within a certain amount of time. Given the occupancy duration of the previous building, a payback period of under 100 years is seen as a positive.

It is also important to maintain the initial vision of transparency from both the architect and building owner. While it is quite possible to redesign a façade to perform better with respect to energy and daylighting, it will certainly be more of a challenge to achieve those ends while still maintaining an aspect of transparency.

COGENERATION PLANT REDESIGN

The cogeneration plant existed for the purpose of providing an uninterrupted power supply to the data center if the power grid were to go down. If the cogeneration plant were to run at full output continuously, it would only provide a portion of the total electricity consumed by the New York Times Building. In addition, a utility investigation revealed that purchased steam and electricity was very expensive. The team would like to upgrade the cogeneration plant to at least provide all of the New York Times Building's heating requirements by evaluating the feasibility of alternative systems sucha s Fuel Cells, Microturbines, Internal Combustion, and Gas Turbine systems. Not only will the cogeneration plant save the New York Times Building on operating costs, it will also consume less primary energy compared to a seperate heat and power arrangement.

LIGHTING AND ELECTRICAL

The lighting and electrical analysis of the cogeneration plant will revolve around investigations of Prime Mover Systems and total system energy outputs.

Prime Mover

A comparison of the different electrical load outputs provided by different generator systems will be performed. Opportunities to find a chance for energy savings in implementing load shedding during peak hours will be investigated-overall success will be measured by savings in total energy usage and cost with the combination of savings in steam purchasing that the mechanical tea member will be investigating.

System Outputs

For the study of the systems outputs, the key focus will be on computing both the maximum and minimum loads of the building. Attempts will be made to compare the resulting costs and savings by comparing multiple generators. Working with the construction management team member, success for this study will be measured with respect to their initial and lifecycle costs.

MECHANICAL

Using the seasonal energy profiles, an optimal prime mover can be found based on thermal efficiency and operational characteristics. Case studies and manufacturer's data can be used to select the best prime mover and configuration (centralized vs. decentralized) with respect to primary energy use and owner requirements.

An energy modeling program can be used to compare the two cases of sizing the CHP plant for heating only and heating and electric demand. The alternatives must be evaluated over the lifetime of the building and with respect to each related building system.

STRUCTURAL

The primary role of the structural engineering team member during this phase is to support the other team members in ensuring that the additional loads created by equipment changes are properly mitigated by the structural system, specifically concentrating on the podium roof and mechanical floor framing.

CONSTRUCTION MANAGEMENT

The primary focus of the construction management team member (as well as the prime CM MAE investigation) will be with respect to the production of on-site steam.

Heat is a byproduct of the cogeneration plant equipment and is used to create steam to heat the building. However, the amount of steam produced is far less than the amount of steam required to heat the building. Based on a presentation by the New York Times design team and owner, a significant amount of steam is purchased from local utility Consolidated Edison to account for this difference.

By producing more steam on site, it is possible to reduce the dependency on purchased steam. This could have two very important consequences- a significant reduction in annual utility expenses, and a further reduction in dependence on the local utility grid.

Based on the types of cogeneration plant equipment chosen by the design engineering team members, an analysis on different manufacturers of similar equipment type will be conducted. Most MEP equipment is very long lead-time, and larger equipment can take a long time to transport from the manufacturing facility to the job site. The manufacturer that provides the best combination of lowest first cost and highest equipment efficiency, shortest lead-time and ease of installation, and the closest distance to the jobsite and its ease of transportation. These will provide the highest benefit to life cycle cost, schedule reduction or maintenance, and lowest carbon footprint, respectively.

STRUCTURAL SYSTEM ALTERNATIVES

An alternative steel braced-frame lateral system with one outrigger level is proposed after the research performed by the structural team member during Technical Report 3. Due to the high cost of the architecturally exposed X-braces and their connections, the structural team member will concentrate on a redesign of the system that will effectively eliminate the need for these braces as a method of controlling drift. The construction management team member will investigate the schedule and cost changes resulting from eliminating this element.

LIGHTING AND ELECTRICAL

The lighting and electrical team member will utilize the time during this phase to refine analysis from the previous two phases and begin work on the fourth phase while continuing work on individual lighting thesis requirements.

MECHANICAL

This phase will be primarily driven by structural and construction management team members. Two major problems present themselves in this phase. First, based on the decisions made by the structural engineering team member, it will be necessary to evaluate the relocation of the mechanical room. Second, should the structural engineer be able to change any floor to floor heights, this would dictate the exact sizing of the alternative distribution system outlined in Analysis IV.

STRUCTURAL

Please refer to the Structural Engineering portion of the *Individual Team Member Goals* portion of the report for a more complete analysis proposal for this portion.

CONSTRUCTION MANAGEMENT

Based on the lateral system analysis completed by structural team members, it is known that eliminating the exterior cross bracing is potentially feasible with a redesign of the system. The prestressed cross bracing members of the lateral system are connected to the rest of the structure through a knuckle connection. In order to successfully analyze and ultimately make a value engineering suggestion, several important points must be considered. Foremost, the knuckle connections and cross bracing were partially chosen based on architectural appearance. It will be compulsory to maintain a nearly identical (yet non-structural) connection in order to maintain original aesthetic design intent.

Second, these cross bracing members originally served to control building drift due to wind as a serviceability concern. Since multiple changes are being made to the structural system by other team members, it is important to ensure that these changes eliminate the need for this cross bracing system to be in place and serve a structural purpose. In other words, it is imperative that building drifts are controlled by different structural elements in place with respect to the lateral system so that the original aesthetic scheme envisioned by the client and architect remains consistent.

After selecting an alternative structural connection based on the criteria mentioned above, it will be necessary to document what the new construction procedure is in comparison to the old knuckle connection, noting any increase in cost or schedule time due to changes in construction methods, local labor requirements, or material lead times.

ALTERNATIVE DISTRIBUTION SYSTEMS

Bus ducts provide electrical service distribution for the upper rentable floors, while copper conductors in conduit is used for the New York Times spaces. The usage of copper conductors in conduit can have many challenges with respect to constructability, particularly when it is spanning over twenty-five floors.

By switching to a bus duct system for electrical risers, it is quite possible to significantly reduce the amount of labor involved in constructing the electrical distribution system. It is possible that this could lead to schedule savings, overall project cost savings, and reduce conductor material consumption.

With respect to the mechanical system distribution, underfloor air distribution (UFAD) systems provide energy savings in almost every category except fan energy and are praised for the flexibility it provides for the owner. However, these marginal benefits do not outweigh the leading arguments against UFAD systems. These systems inefficiently use plenum space and in some cases, are harder to control than a more common variable air volume (VAV) system. This inefficiency could be translated into an increase in rentable space to the owner. The most significant pitfall of UFAD systems is the long-term depreciation of indoor air quality. The New York Times Building and similar high-rise office buildings could be in use for over a century. Dust and other pollutants will inevitably migrate into the underfloor plenum. This issue will be compounded when the building experiences moisture control problems due to inevitable equipment failure or occupant activity.

With these considerations, our design team will remove the UFAD system and use a uniform overhead ducted system throughout the building. Our team will explore two alternatives: traditional variable air volume and dedicated outdoor air systems with decoupled heating and cooling. These alternatives will be evaluated based on first cost, life-cycle cost, maintenance considerations and occupant flexibility. The analysis must focus on each system's performance with respect to the building as a whole. The system will be chosen based on energy modeling and a thorough cost and owner requirement investigation with the entire design team.

LIGHTING AND ELECTRICAL

The Electrical team member will assist the construction team member's economic and constructability analysis by providing engineering calculations to ensure that the proposed distribution systems are capable of handling the building electrical loads.

The primary investigation will consist of performing calculations (including short ciruit analysis) allowing an evaluation between different electrical distribution systems such as bus duct verses conduit based distribution systems and, aluminum verses copper conductors..

MECHANICAL

Considering the background information on the UFAD system, VAV versus a dedicated outdoor air system (DOAS) will be evaluated. The success of each of these systems will be evaluated through a comparison in first cost, life-cycle cost, maintenance considerations and occupant comfort and flexibility with respect to the existing system configuration.

STRUCTURAL

Structural engineering team member work in this phase will primarily consist of ensuring that loads imposed by different systems are properly mitigated by the structural system. The impact these distribution systems will have on dead loads to floors and transferred to foundations and the possible creation of floors or structural space will also be considered.

CONSTRUCTION MANAGEMENT

The New York Times Company was initially skeptical over the concept of a bus duct, and felt that after consulting with their facility management group that the more traditional wire in conduit method was more reliable than a bus duct system. If it is determined that a bus duct system is more economical and less of a burden on the schedule, further research will be conducted investigating the lifespan and ease of replacement on the two distribution methods to provide the owner with a more complete set of information.

In order for a successful analysis to take place, the approximate cost of the existing electrical system needs to be compared to that of a proposed bus-duct based riser system. Pricing on bus duct riser equipment will also need to be obtained from manufacturers as well as any relevant construction costs and issues prevalent with this type of system.

INDIVIDUAL TEAM MEMBER GOALS

In addition to basic IPD/BIM requirements, each team member will also be bound to complete a certain series of tasks related to their specific option as required by their advisor.

LIGHTING AND ELECTRICAL STUDIES

The lighting and electrical thesis will consist of several additional aspects not covered under the group based IPD/ BIM Thesis. Several key spaces will be analyzed for lighting design as well as electrical implications of from cogeneration and distributions system changes.

Lighting Analysis

1. Lobby:

   Taking into account the comments provided by the professionals at Lutron, electrical team member will complete the redesign of the lobby to successfully create a design that will meet initial design consideration while meeting code lighting level and other requirements of the Lighting Hand book.

2. Offices:

   The main office floor lighting will be redesigned as initially proposed in technical report 3. Meeting personal design considerations, professionals' comments, as well as IES suggested lighting levels will measure success in this space. A major focus will be on the facade redesign with the rest of my design group. A large portion of time will be put towards the integrated design of the facade for this space.

Industry Feedback from Lutron Presentation

Sandra Stashik (GWA Lighting, Philadelphia, PA)

1) General:
   a. How was BIM different?
   b. Use of photos / graphics
   c. Overall very nice

2) Lobby:
   a. Good breakup of the space
   b. Good Schemes – overwhelming in section – try RCP view

3) Café:
   a. Good Model
   b. Careful with sketches – non uniform appeared uniform
   c. Good concepts

4) Office:
   a. Good introduction and explanation of thought process
   b. Good to come to a conclusion and choose one of the designs
   c. Good Daylighting analysis, issues, and graphics

5) Façade:
   a. Confusion as of location of fixtures add plan view to help

Helen Diemer (The Lighting Practice, Philadelphia, PA)

1) General:
   b. Careful with colors on slide, contrast and such
   c. Good descriptions of design criteria

2) Lobby:
   a. Cones of light hard to understand; show what light does more than where it comes from. Emphasize the surfaces it lights

3) Façade:
   a. Articulate purpose for minimizing skyglow
   b. Sustainable focus, where you will get the best impression
   c. Could use a bit further explanation
   d. Bottom of the building would be blocked in by other buildings so find a place to make the best impression at that level.

Electrical Analysis

1. Cogeneration System Analysis:

   Coordinating with the mechanical team member will be a main focus of the electrical study. The resulting changes will require new equipment and possible layout changes, as well as sizing or feeders and comparing results to NEC2009 and IBC regulations.

2. Electrical Distribution System:

   Short circuit analysis will take place from the main distribution board 3 to the series of panels located on floors 7, 8, and 9. This will also be the run where considerations of replacing the current conductors and conduit with bus duct will be taken into account. This will be done in coordination with the CM team member to ensure cost savings in time, initial cost, and constructability. A secondary study investigating the feasibility of replacing the same set of conductors with aluminum will also be conducted, also in coordination. A comparison between all 3 systems will then be performed, taking into account meeting any and all NEC requirements first and then savings in initial cost and installation.

MECHANICAL

In the façade redesign phase, the interoperability between Revit and various energy modeling programs such as Trane Trace and IES will be investigated and documented. The façade design alternatives will be modeled in Revit and should provide a suitable platform for compatible energy modeling programs. In previous experiences, there have been several barriers to accomplishing a successful workflow in this area. Furthermore, the "out of the box" compatibility of a Revit file exported into an energy modeling program will be evaluated for time spend resolving errors and the accuracy of the energy results.

In the alternative distribution systems phase, a thorough reproduction of a typical floor's mechanical systems will be created in Revit MEP to evaluate the program's usability. Several comments in industry have been that Revit Architecture is well developed and is a significant tool in the BIM and IPD process, but Revit MEP is severely lacking with respect to its library and ability to perform engineering calculations.

Both of these individual goals are based upon the overbearing project goals and schedule of Team II. However, the four phases do not contain equal amounts of work for each discipline. The individual goals of the mechanical team member will be fluid and they may work ahead or go back to revisit certain tasks as they see fit throughout the semester.

STRUCTURAL

Background

The New York Times Building structure is comprised of a composite steel and metal deck gravity system with a braced-frame core lateral system**.** Two-story outriggers located on both the 28th and 51st floors supplement the lateral stiffness of the frames. These floors house the mechanical equipment that supplies the tower. To further control drift and display the structural transparency of the building, pre-tensioned rods were added to the exterior of the building.

Existing Structure

The **foundation** of the New York Times Headquarters combines typical spread footings with caissons to achieve its maximum axial capacity. The tower and podium mostly bear on 20 tons per square foot rock; in this area, 6,000-psi spread footings were used under each column. At the southeast corner of the tower, 24-inch diameter concrete-filled caissons were used since the rock only has 8 tons per square foot capacity. The structural engineers did not disclose the depth of the caissons; it is only known that they extend until they reach rock with a bearing capacity of 20 tons per square foot or greater.

The New York City Subway passes below Eighth Avenue to the west and 41^{st} Street to the north of the New York Times Building. However, this is not a major site restriction since the transit system is not directly beneath the structure.

The **floor system** is a steel composite system with a typical bay size of 30'-0"x 40'-0", with 2½" normal weight concrete on 3" metal deck. Typical beam sizes are W18x35 with a 10'-0" typical spacing, bearing on W18x40 girders. The girders frame into the various built-up columns, box columns along the exterior and built-up non-box columns in the core. Framing of the core consists of W12 and HSS shapes framing into W14 and W16 shapes, which bear on W33 girders. Framing layouts for each floor of the tower are typical as shown in Fig. 1.

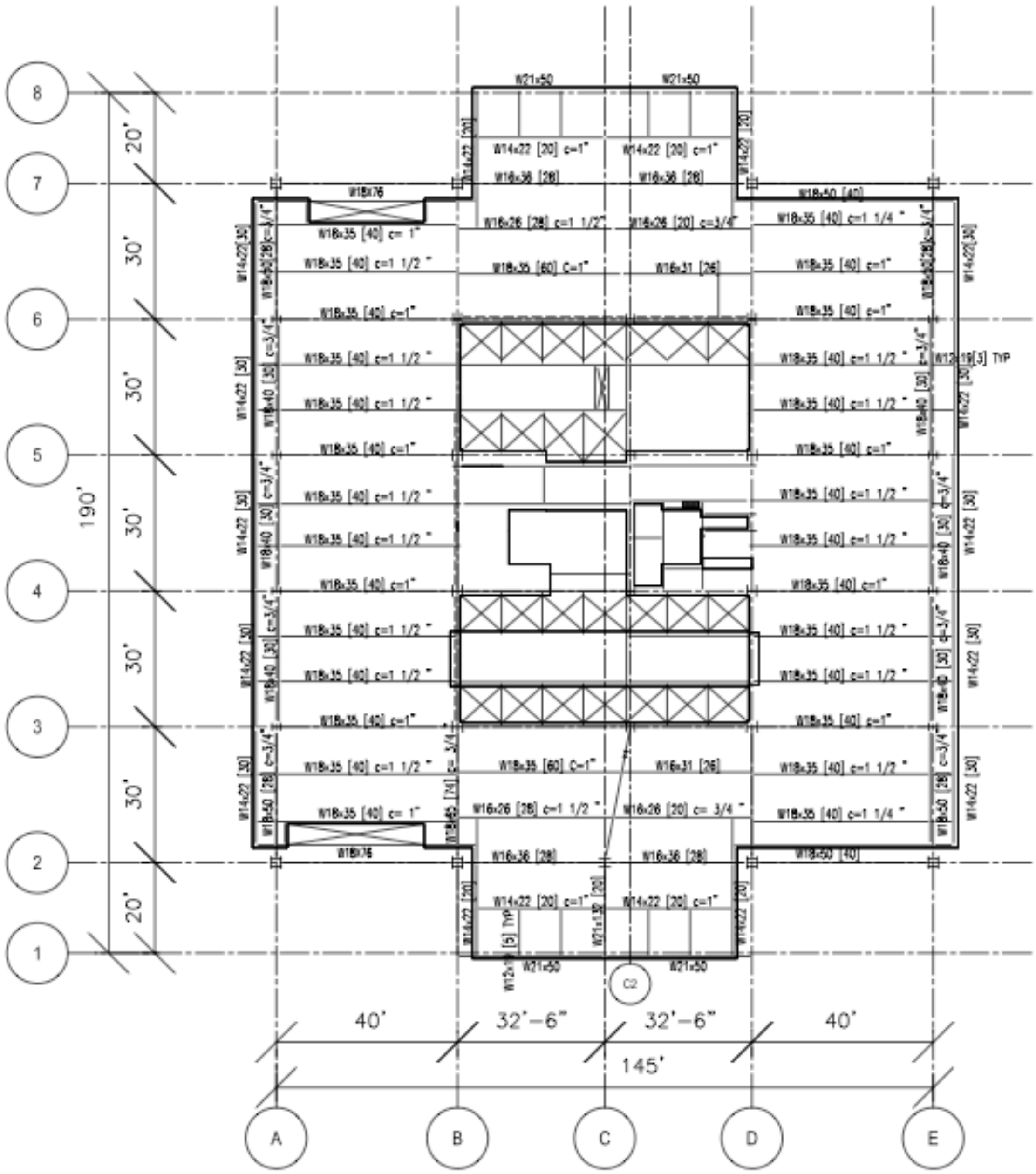


Figure 1: Typical Framing Layouts

The 30" by 30" box **columns**, exposed at the exterior corners of the tower, consist of two 30-inch long flange plates and two web plates inset three inches from the exterior of the column on either side. Each web and flange plate decreases in thickness up the building to adjust to the loads at each level. The yield strength of the plates also varies with tower height, from 50 ksi on the lower floors to 42 ksi on the upper floors. Interior columns are a combination of built-up sections and rolled shapes. Column locations stay consistent throughout the height of the building, spaced with the grid at 30 feet in one direction and 40 feet in the other. Every column is engaged in the lateral system via connections to bracing and outriggers.

The main **lateral force resisting system** for the tower of the New York Times Building consists of a centralized steel braced frame core with single-diagonal outriggers on the two mechanical floors (Levels 28 and 51) to engage the exterior columns. The structural core consists of single diagonal bracing in the North-South direction between grids 4 and 5, concentric chevron bracing in both the North-South and East-West directions, and eccentric chevron bracing in the North-South direction between grids 5 and 6. These braced frames surround the elevator shafts, MEP shafts, and stairwells. At this time, the member sizes of the braces have not been disclosed. The core configuration remains consistent from the ground level to the 27^{th} floor, but one line of North-South bracing drops out above this level for the remaining height of the building. The structural engineers also utilized pre-tensioned steel rod X-braces to control drift while preventing the need for larger members. Typical bracing layouts for the tower are shown in Figures 2 through 4.

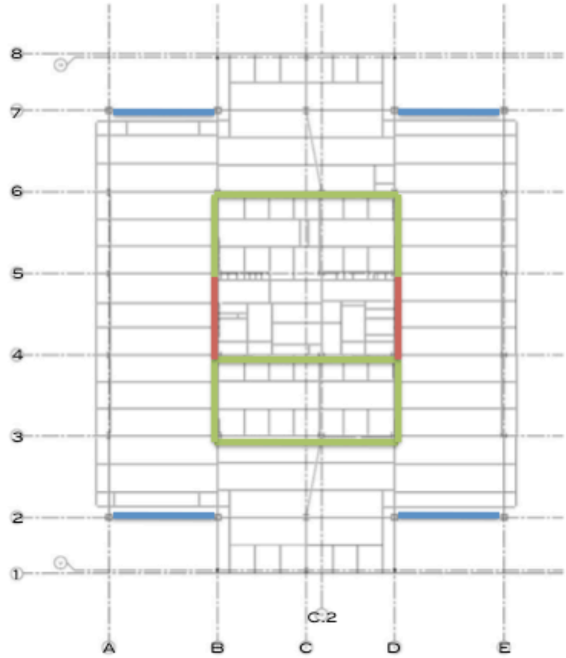


Figure 2: Lateral Layout, Floors 1-27

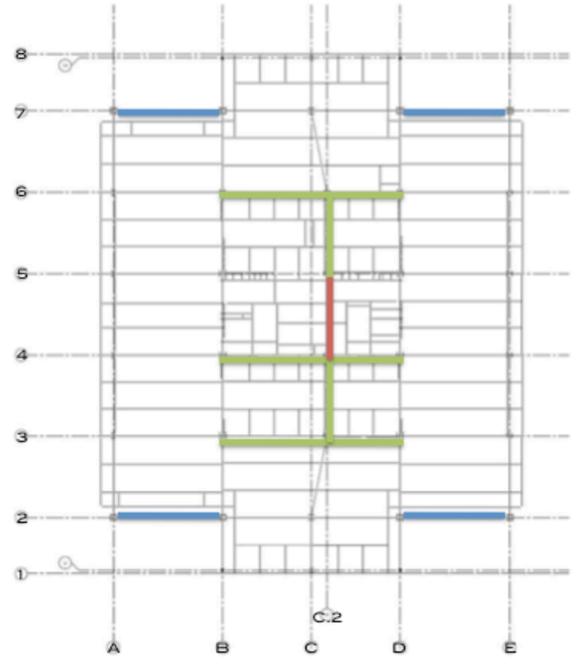


Figure 3: Lateral Layout, Floors 29-50

KEY:

- EXTERIOR X-BRACES
- CONCENTRIC & ECCENTRIC CHEVRONS
- SINGLE DIAGONAL BRACES
- OUTRIGGER

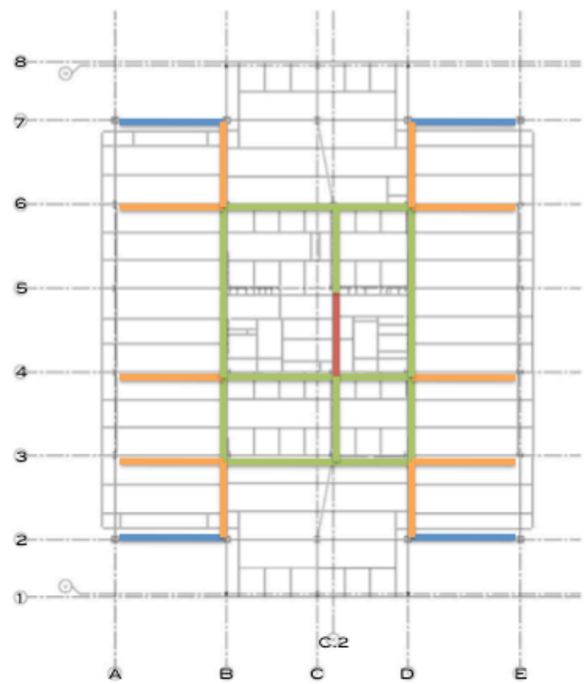


Figure 4: Lateral Layout, Mechanical Floors 28 & 51

Problem Statement

In the existing structure, the two-story outriggers on the 51st floor share space with the mechanical equipment. This space has the potential to bring in more revenue to the owner as a rentable penthouse floor. In addition, the exposed pre-tensioned X-braces on the exterior add extra cost to the system with their detailed connections. After investigating an alternate lateral system that eliminates the top floor outriggers and the exterior braces, I found that this system is a feasible alternative and is worth further consideration.

The New York Times Building structure was also designed with some attention paid to the effects of a blast, but it was not analyzed according to code regulations that took effect after September 11th. I would like to analyze the structure's compliance with up-to-date progressive collapse guidelines.

Proposed Solution

The alternate steel braced-frame system analyzed in Tech 3 will be used as a basis for an optimized and reconfigured lateral system. A single outrigger and mechanical floor will be investigated, and the location of this level will be optimized according to which location provides the lowest drift and period. In addition, a belt truss will be considered, if necessary, to enhance the performance of this system. ETABS will be used as part of the MAE requirements to analyze the lateral system and optimize the layout and configuration of frames in the core, in accordance with 13th Edition AISC Steel Construction Manual and using IBC 2009 and ASCE 7-05 loads. Rigid diaphragms will be used to model floors, and column and beam members will be modeled in three dimensions to include the effects of flexure, shear, axial, and panel-zone deformations in all directions, as learned in the Computer Modeling of Building Structures masters class. Inherent and accidental torsion and P-Delta effects will be also included in the analysis. Plans will be reviewed frequently to ensure the new bracing layout does not conflict with any openings. In the later stages of the analysis, a Revit model of the building will ideally be used to double-check these layouts.

To evaluate the new, optimized location of the outriggers, it will also be necessary to look at the viability of moving the mechanical equipment to the roof and outrigger floor. The existing mechanical floors in the tower are not necessarily organized according to the floors they service; this will make it easier to rearrange the lateral system and possibly allow for a more consolidated mechanical layout. The members on the roof will also be analyzed for an increase in loads.

Progressive collapse resistance will be analyzed according to the 2009 Department of Defense Unified Facility Criteria Alternate Path Method, using the 2003 GSA Progressive Collapse Analysis and Design Guidelines, ASCE 7-05, and the New York Building Code regulations. Key members will be designed to comply with these regulations and provide redundancy to the structure. In addition, special attention will be paid to the twenty-foot cantilevers on either side of the building. These are potential weak points, as they are not supported by gravity columns at the ground level. Alternatives will be recommended for better progressive collapse resistance if the existing system is not sufficient. Connections will also be redesigned using information acquired from MAE class Steel Connections, where necessary, to accommodate the increased loads resulting from creating horizontal and vertical ties and possible tensile forces.

Finally, foundations will have to be analyzed for changes in loading according to the combined IPD/BIM proposal. Changes in dead loads will affect individual floor framing, as well as have an impact on seismic calculations. These factors will all be accounted for in the final report.

Structural Solution Method

The general IPD/BIM Timeline will be followed as a basis for the semester schedule. A more specific task sequence is outlined below for Phase III, the bulk of the structural proposal.

1. Reconfiguration & Optimization of Lateral System

   a. Model braced-frames in ETABS and determine most efficient layout
   b. Check layout for compatibility with floor plans and stacking diagrams
   c. Optimize sizes of frame members
   d. Evaluate impact on other systems using BIM
2. Analysis of Structure for Progressive Collapse Resistance
   a. Research code requirements and Alternate Path Method
   b. Apply method to structure, looking at key members
   c. Analyze cantilever for tie forces
   d. Update sizes of members to reflect analysis
   e. Design connections for updated loads
3. Impact of IPD Developments on Structure
   a. Phase I: Façade gravity and lateral load updates
   b. Phase II: Cogeneration gravity load updates and vibrational check
   c. Phase IV: Distribution coordination with lateral system

CONSTRUCTION MANAGEMENT

From interactions with team members to date, it is becoming more apparent that the construction management team member will play more of a construction agent/ project architect role in addition to providing constructability, cost, and scheduling advice. An organized management plan and workflow will be required once the interdisciplinary teams formally begin to work together on a daily basis.

Several interdisciplinary team management strategies are currently coming to prominence in the industry. Two schools of thought will need to be evaluated and compared prior to the beginning of next semester: The *BIM Project Execution Planning Guide* created by the CIC research group at Penn State, and the *Integrative Design Guide to Green Building* by the consultancy 7group.

One school of thought with respect to the integrative design process is to work independently by discipline and then collaborate with other disciplines at predetermined points in the project timeline. Given the. An alternative phase-based approach to analyzing the NYT building will be a taken with respect to group workflow.

Several theories regarding the management and structure of the decision making/ analysis process of integrated design teams using BIM have come into prominence. Both the *BIM Project Execution Planning Guide* and portions of the *Integrative Design Guide to Green Building* suggest that the various design and construction disciplines work together semi-independently on the building as a whole and gradually begin to work more cohesively as the project progresses, coordinating each of their individual work with one another at established collaboration points. Due to the scale of many projects, the fact that in many cases the design and construction disciplines can be located very far away from one another, and that many individual (discipline specific) firms are highly dependent on the design/ performance of their system, the gradual cohesion of teams over time is a logical approach.

However, the configuration of the BIM Thesis teams is remarkably different. All of the design and construction team members are in one location- this allows for a slightly different approach to the integrated design process. Due to the background of architectural engineering students, it is quite possible that any student in an interdisciplinary team is capable of engaging in an informed design or construction discussion regarding an area of specialty outside of their own.

Based on this, it is possible that an integrated, sequential task-based problem solving method can be used. In this problem solving method, all interdisciplinary team members work on the same problem at the same time and strive to reach a common goal identified by the group. Ideally, the varied specialties and backgrounds of the team members will lead to different perspectives in solving the problem as a team, and this will ultimately lead to a solution that benefits all parties. For example: The team agrees as a whole that the cogeneration plant in a current design is not as optimized as it could be and evaluates changes to the system, receiving input from all team members in the initial design process.

In contrast, the traditional approach would be for each team member to have their own personal, discipline driven goals and merely interact with other team members as their own goals required the input of someone with a different specialization. For example, a mechanical student realizing that the cogeneration plant is undersized, increases the size of the equipment and then notifies the structural student that the loads have increased and the structural system should be changed accordingly.

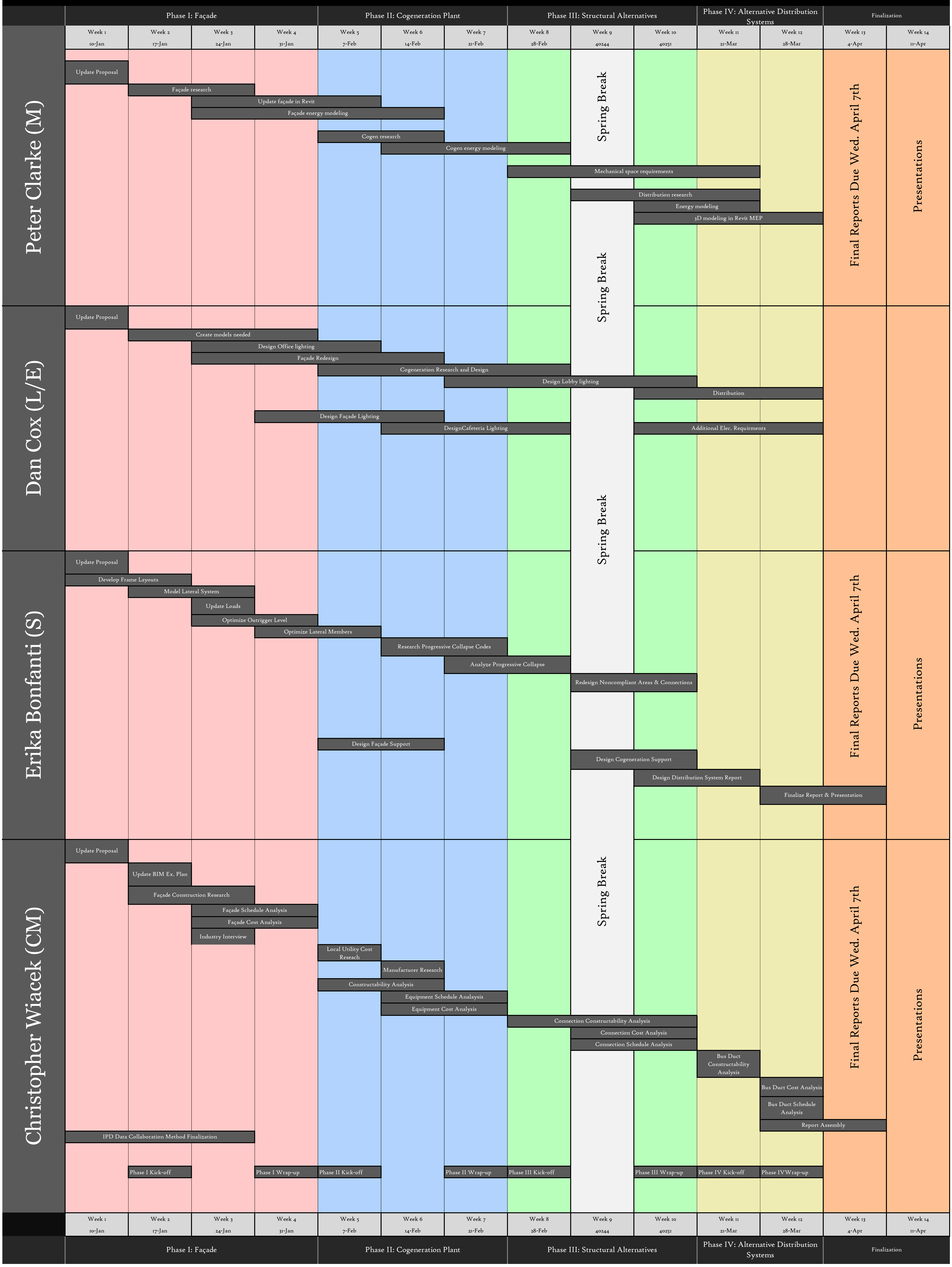
TEAM SCHEDULE

Please refer to the team timetable on the following page.

It is important to note the differences between phases and individual schedule activities when reading this schedule. Throughout the course of the semester, each student will have a varying level of individual work required by their specific AE discipline in addition to the IPD team tasks- these tasks are represented as individual activities on the schedule.

In an effort to ease the collaboration process, overarching phases have been created to focus the group at any given time. While it is highly likely that there will be other individual tasks occurring during a phase, the phase determines the phase will determine the core focus of the group. The schedule has been designed to approach each phase in a sequential fashion, but there is significant preparation and finalization that occurs for some team members well outside of the target phase- e.g., significant research will be completed by the structural student prior to the beginning of Phase III: Alternative Structural Systems.

IPD/ BIM Thesis Team II Spring 2010 Schedule



WEIGHT MATRIX

The following are targets for the total amount of work time that each team member will put into each phase. Also included is an approximate breakdown of how much time will be spent on each phase.

Mechanical	Research	Analysis	Modeling
Phase I: Façade Redesign	30%	60%	20%
Phase II: Cogeneration Plant Redesign	30%	50%	30%
Phase III: Alternative Structural Systems	10%	10%	80%
Phase IV: Alternative Distribution Systems	40%	40%	20%

Structural	Research	Preliminary Phase III Work	Analysis	Optimization
Phase I: Façade Redesign	7%	80%	8%	10%
Phase II: Cogeneration Plant Redesign	10%	80%	0%	10%
Phase III: Alternative Structural Systems	14%	30%	30%	26%
Phase IV: Alternative Distribution Systems	0%	0%	50%	50%

Lighting and Electrical	Research	Analysis	Compilation of Data
Phase I: Façade Redesign	20%	70%	10%
Phase II: Cogeneration Plant Redesign	30%	50%	30%
Phase III: Alternative Structural Systems	10%	10%	80%
Phase IV: Alternative Distribution Systems	40%	40%	20%

Construction Management	Team Coordination	Constructability	Economic Analysis	Compilation of Data
Phase I: Façade Redesign	20%	20%	40%	20%
Phase II: Cogeneration Plant Redesign	20%	15%	45%	20%
Phase III: Alternative Structural Systems	20%	45%	15%	20%
Phase IV: Alternative Distribution Systems	20%	30%	30%	20%

Overall Team Project Weighting	Percentage of Total Project
Phase I: Façade Redesign	30%
Phase II: Cogeneration Plant Redesign	30%
Phase III: Alternative Structural Systems	20%
Phase IV: Alternative Distribution Systems	20%