SENIOR THESIS FINAL PROPOSAL

The Pennsylvania State AE Senior Thesis

Duval County Unified Courthouse Facility

Jacksonville, Florida

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Construction Management

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Table of Contents

EXECUTIVE SUMMARY

The senior thesis final proposal will serve as a guide basis of the four research analyses for the final thesis report on the Duval County Unified Courthouse Facility (DCUCF). The contents of this proposal were studied for possible improvements sought out for project success and do not reflect current problematic areas. The topics to be carried out in thorough procedural examination include: installation of prefabricated floor planks, incorporation of a structural steel system, integration of a green roof, and addition of a photovoltaic system.

ANALYSIS NUMBER 1: Critical Industry Issue

Prefabrication is a beneficial tactic already used for the concrete paneling exterior enclosure of the DCUCF. Using this wide spread innovation of construction process was able to save time and cost efforts for such a large-scale project. The goal of this analysis is to examine the cost, scheduling, and manufacturing of prefabricated floor planks. Through this introduction of process, results will be compared to see if an all prefabricated concrete structure will be substantially favorable to the construction industry.

ANALYSIS NUMBER 2: Structure Assembly Efficiency through Steel Implementation

The existing structure is composed of concrete beams, girders, and columns for the main structure and steel trusses for the two steep roof systems. With these two different material systems being assembled together, special techniques with welded plates and anchors had to be used. The goal of this analysis is to determine effective steel constructability solutions to link all structural components of the structure. Cost, scheduling, and material layout strategies will be devised in order to obtain proper site logistic strategies.

ANALYSIS NUMBER 3: Energy Utilization from Green Roof Processes

The roofing systems are composed of two metal steep roofs and two concrete flat roofs. The two concrete flat roofs objectives were to aid in achieving LEED Certified requirements through water retention. The goal of this analysis is to sustain the same LEED goals but accomplish a higher rating while maintaining an aesthetically pleasing appearance with Green Roof integration.

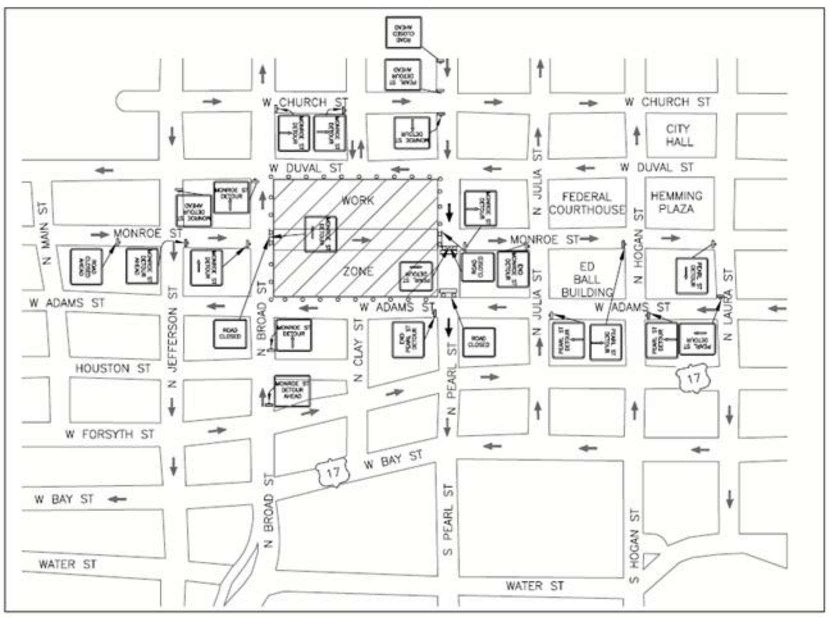
ANALYSIS NUMBER 4: Photovoltaic System Resilience with Energy on the Grid System

The two steep roofs of the roofing systems were used in junction with thermal glazing to maintain direct daylight gain and historical courthouse aesthetics. Through energy consumption rates of the project, predicted values are expected to elevate usage on the grid system currently in the Jacksonville, Florida area. The goal of this analysis is to observe what influences the photovoltaic systems will inflict on the building in three aspects: structural support determination, electrical usage benefactors on the grid system/LEED, and aesthetic contribution elements.

PROJECT BACKGROUND

The Duval County Unified Courthouse Facility (DCUCF) is located near the heart of Jacksonville, Florida at the intersection of Clay Street and Monroe Street. The construction of this structure will take place over a 798,000 square foot desolate strip of land to help display architectural style and diligence to the Duval County area. An obstacle that this project faces is maintaining a maximum productivity site logistics plan in a high volume community environment. To sustain work efforts and community atmosphere, a plan was devised to reroute transition roads that led to the main stream roads of Clay Street and Monroe Street (Figure 1). This plan helped ease congestion within the project work area boundaries and allowed for effective transportation of site products and services.

Figure 1. Detour Site Logistics Plan



Project sequencing is broken-up into four sectional areas that include center, colonnade, west, and east respectively. The west section of the structure is first constructed then expands to the center and east components. After the basic structure is made, the interior work sequence starts on the outer limits and proceeds to the center portion to conclude with the colonnade section. Each section starts as the preceding section has the basic divisions finalized so multiple portions can be constructed at one time.

The building foundation system is constructed with auger and lateral piles at 125, 56, and 12 tons per pile with pile caps at 42" to 75" in depth. The foundation slab and floor slabs are poured and finished at 5" with 3,000psi concrete. These slabs contain 2-#4 x 3'-0" LG re-entrant bars that are centered at each re-entrant corner. Crack control, typical construction, and expansion joints at walls are best implemented with joints sealants and 1/8" sawcuts. Concrete footings vary with dimensions of 5'-6" x 3'-2", 4'-0" x 3'-2", 3'-0" x 3'-2", and 2'-0" x 3'-0" valuing at 3,000psi concrete strength, dependent on loadbearing calculations.

The superstructure is mainly composed of W 8x29, W 19x29, W 27x29, and W 36x29 beams and joists. These beams and joists are constructed with 4,000psi concrete strength and follow a symmetrical pattern that are erected within the given parameters of four sections. A lateral bracing system is used to best resist in calculated live and dead loads. Concrete columns range from 16"x24" to 24"x28" with 10 to 20 bar at 50ksi. Sixteen shear walls exist within the structure and are designed for 4,000psi which withhold loading on elevator shafts and stairwells. Load bearing walls shall be constructed with Type II hollow concrete masonry units with ASTM C270, Type "S" mortar. This wall system is composed of masonry control joints, two vertical wall joint reinforcements, dowels, and masonry bond beams. All cells are filled with vertical reinforcing solid. Concrete masonry wall connection to precast concrete beam shall use a bolt connection on a steel plate with one-inch clearing to deck above. Precast paneling is used for a nicely finished façade. The panels have a concrete strength of 5,000psi at 28 days with 3/8" diameter reinforcing.

The steep roofing system is supported by steel beams of W 16x31, W18x40, and W 18x50. These beams help transfer loads from the metal roof back down to the ground using chevron and lateral bracing efforts. The assembly of a steep roof can be referenced in Figure 2. A flat roofing system is displayed on the west and east sections of the building (Figure 3). This system is made up of limestone aggregate concrete at 4,000psi with 1-1/2 " deep metal decking and sloped pits for water drainage.

Figure 2. Steep Roof System

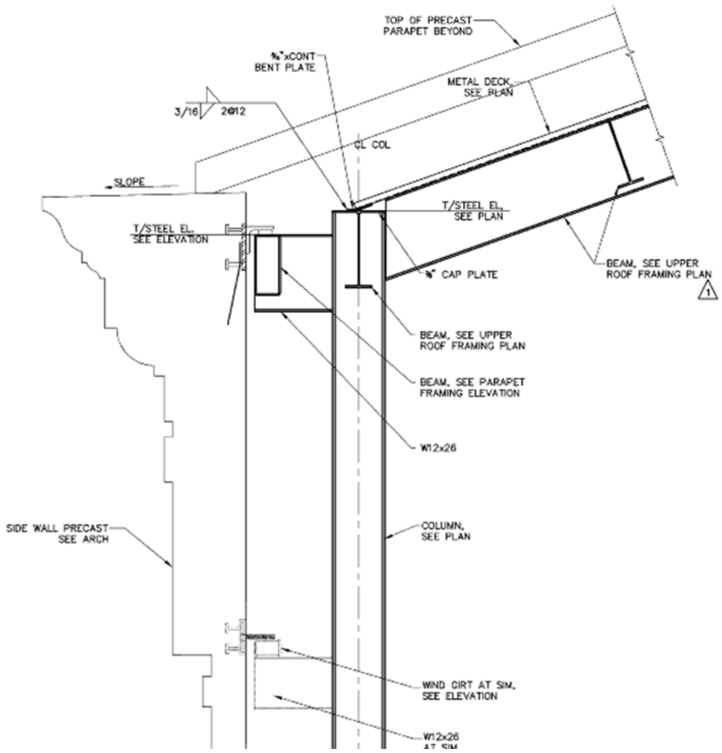
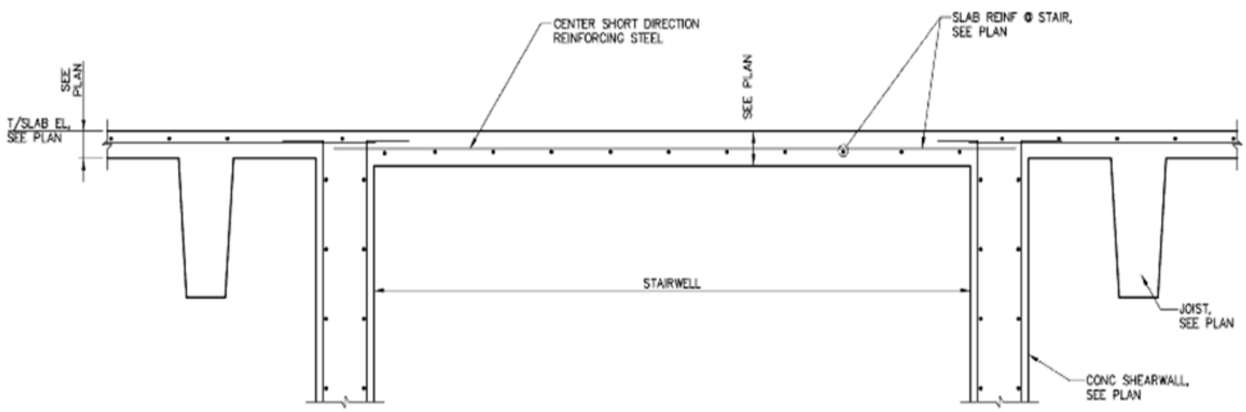


Figure 3. Flat Roof System



The DCUCF is awarded with the rating of LEED Certification. Efforts of sustainability are reached through recycled content of materials, regional materials, certified wood, low-emitting materials, site disturbance, construction waste management, and construction indoor air quality management. Recycling of material in the office and outside the office was urged to help promote "green" awareness. The office recycles aluminum and plastics and uses "green" cleaning products to aid in the environment. The field keeps track of steel and cardboard recycling divisions with the subcontractors. At one point wood recycling units were dispersed throughout the site until the recycler business loss occurred, and no other wood recycling businesses could be located within a 500 mile radius. Adhesive control limits ranged with VOC contents of 30 g/L to 775g/L that were within target of LEED requirements.

ANALYSIS NUMBER ONE: Uniform Prefabrication Engineering

REVISION IDENTIFICATION

Prefabrication is a newly used innovation service used to accelerate the schedule while promoting cost efficiency for the Duval County Unified Courthouse Facility. Since this project was of great size capacity, work processes were expected to fall out of range for the requirement of time and money established by the Duval County officials. To keep this project on "the drawing table" during a downfall economy for Jacksonville, Florida's budget, prefabricated concrete panels were manufactured for the exterior enclosure. Taking this same procedure and applying it to prefabricated concrete floor planks is predicted to seek out the same benefits. From this investigation, special considerations will be noted for flooring construction methods for a quicker and proper turn-over.

RESEARCH GOAL

The goal of this analysis is to perform detailed design aspects for the structuring of the prefabrication of concrete floor planks to fit an average of a 30'x28' bay spans for an earlier and equipped substantial completion.

METHODOLOGY

- Research typical span requirements for prefabricated concrete units
- Reference/calculate additional systems to support floor planks
- Note later installation objectives needed for floor placement
- Contact manufacturer to see if units can support special cut-outs for placement
- Research transportation requirements of units
- Calculate manpower of crews for assemblies
- Evaluate schedule for trade coordination for new "dual" activity relationships
- Perform estimates of new savings for restructuring

RESOURCE AND TOOL APPLICATIONS

- Turner Construction Project Team
- Prefab Manufacturing Company
- Professional Documentations and Readings
- Structural Engineer
- AE Faculty
- Industry Professionals
- PACE Seminar Contacts

EXPECTED OUTCOMES

From detailed research and design experiments, the prefabricated floor planks are expected to bring the schedule ahead of the previously stated schedule. Trades are predicted to be contributing work at the same time as floor planks are constructed since the floor layouts will be accessible to work on. This comes from the lack of waiting for the current cast-in-place concrete to cure. Cost estimates are foreshadowed to be lower since a constant rate for manufacturing is expected and the usage of the same crew from the exterior enclosure. Structurally, the building should support additional components to connect the concrete floor planks but are expected to add more loading transformation.

ANALYSIS NUMBER TWO: Structure Assembly Efficiency Through Steel Implementation

REVISION IDENTIFICATION

The current superstructure is constructed with concrete components with a steep roof system made-up of steel members. The assembly to connect these divisions uses extensive means of welded plates with anchor bolts. This process takes a surplus of manpower from constructing welds and additional metal connections. Coordination between the concrete and steel erection is initiated and requires more time for installation and is task dependent on trades after these activities.

RESEARCH GOAL

The goal of this analysis is to conduct a cost/manpower estimate of a preliminary steel based design for efficient project work productivity.

METHODOLOGY

- Research economic steel-to-steel connections with bracing
- Size and assign beams to fit current framing standards
- Test typical bay and apply to rest of structure
- Test strength of beams
- Research Fireproofing methods to meet Florida codes
- Analyze structure for existing loading conditions
- Check façade for connection capabilities to new design
- Analyze the viability of new structure

RESOURCE AND TOOL APPLICATIONS

- Professor Dr. Hanagan
- Professor Dr. Boothby
- Professor Swagata Banerjee
- Turner Construction Project Team
- Structural Engineer
- AE Structural Software
- Professional Documentation/Readings
- Industry Professionals

EXPECTED OUTCOMES

Performing extensive research, the newly composed steel system is expected to yield positive results for construction connections to the superstructure and roof divisions. As a result, additional savings in cost for using steel beams over concrete beams is sought from lowered manufacturing rates. Utilizing tier lifts and drops, will support schedule acceleration, material staging, and site logistics improvements for site workability. It is believed that the AE structural software will help provide the most economical loading simulation for the steel beam and column schedule for the project.

ANALYSIS NUMBER THREE: Energy Utilization from Green Roof Processes

REVISION IDENTICATION

The two flat roof system is devised for water retention to support the LEED Certification. This support received minimum points for the LEED rating system from the dewatering holes surrounding the perimeter of both roofs. A system then retrieves the water for redistribution throughout the building. For maximum point retrieval, a Green Roof integration would be implemented.

RESEARCH GOALS

The goal of this analysis is to achieve maximum LEED accredited points for water retention and redistribution using a Green Roof while offsetting construction cost to the life cycle cost process.

METHODOLOGY

- Research Green Roof background
- Test square footage ratio for cost analysis to apply roofing system
- Acquire accessibility design to Green Roofs for maintenance
- Test additions to see if structure can support loading
- Perform Takeoff to seek life cycle costs
- Check LEED rating for accomplishments

RESOURCE AND TOOL APPLICATIONS

- Updated LEED Checklist
- AE Faculty
- Professional Documents/Readings
- CostWorks Takeoff
- Industry Professionals

EXPECTED OUTCOMES

The expected outcome of this analysis is to achieve maximum points to receive a LEED Silver rating for water redistribution. The life cycle cost is predicted to outweigh the additional construction cost presenting a great incentive to the owner of the project.

ANALYSIS NUMBER FOUR: Photovoltaic System Resilience with Energy on the Grid System

REVISION IDENTIFICATION

The energy consumption rate for the Duval County Unified Courthouse Facility is extended over the average consumption rate on the power grid of the area. The product idea of using photovoltaic systems was presented but not supported for construction due to budget limits. This project is expected to have a long life cycle so sustainable design considerations should be implemented to reduce future problematic issues for the Jacksonville, Florida area.

RESEARCH GOAL

The goal of this analysis is to provide essential detail of photovoltaic (PV) systems to the owner to reduce energy consumption cost and power grid exhaustion.

METHODOLOGY

- Investigate photovoltaic system applications and LEED contributions
- Locate local PV suppliers and manufacturers
- Calculate quantities of PV systems to apply to steep roofing systems
- Test photovoltaic system impact on the structure
- Test photovoltaic system energy savings
- Compare savings to average power grid impact
- Calculate the life cycle cost of the photovoltaic systems

RESOURCE AND TOOL APPLICATIONS

- Professional Documentation/Readings
- Structural Engineer
- MEP Contractors
- AE Faculty
- Industry Professionals

EXPECTED OUTCOME

After finishing a proper procedural analysis, it is expected that the installation of PV panels will reduce the energy consumption of the structure. Additional energy storage will provide energy sellback to help offset construction costs. The power grid therefore will not be as accountable for this large scale project energy usage and providing some LEED accredited points.

ANALYSIS WEIGHT MATRIX

A weight matrix is used to illustrate the performance base of analysis for each of the four primary areas of study. Figure 4. shows the percentages assigned for the predicted effort and time management for each of the analyses provided in a semester long guideline.

Figure 4. Weight Matrix Percentages

Primary Analysis	Research	Value Engineering	Constructability Review	Schedule Reduction	Total
Prefabricated Floor System	-	10%	10%	5%	25%
Steel System	-	5%	10%	10%	25%
Green Roof System	10%	5%	10%	-	25%
Photovoltaic System	10%	5%	10%	-	25%
Total	20%	25%	40%	15%	100%

TIMETABLE

***Reference Appendix B for the Spring Semester Timetable Schedule**

For successful time management and productivity tracking, an initial semester timetable schedule was created.

CONCLUSION

With thorough research and theoretical simulations, an economical perspective summary can be gained from referencing this technical analysis proposal. An investigation for uniform project prefabrication will be observed within the limits of the preconstruction phase therefore recognizing schedule and cost efficiencies. A steel system evaluation will produce site assembly productivity accomplishments while also aiding in the turnover process. Green roof systems are expected to boost sustainable feature ratings along with promoting “green” practices for the surrounding community. Lastly, the application of photovoltaic systems will aid in power grid independency which will result with lower energy costs to provide practical sustainability.

The intent of this proposal is to serve as a primary guidance factor for the overall senior thesis presentation and is subjected to change when commentary is received and analyzed from the thesis consultants.

APPENDIX A – BREADTH TOPICS

BREADTH TOPICS

Each breadth topic corresponds to a previously mentioned technical analysis that is indicated accordingly. The breadths are subjected to individual analysis to test substantial knowledge of specific architectural engineering options that have been acquired over an academic career period.

STRUCTURAL BREADTH

***Corresponds to Technical Analysis Number One, Two, Three, and Four.**

Technical Analysis Number One

Designing a prefabricated floor plank system to substitute the existing cast-in-place concrete flooring system will require a detailed loading examination. Each plank will have to be tested for strength durability and loading in relation to exhibiting drilled holes for floor placement activities. With expected supplementary support systems to be added to accommodate for proper floor plank connections, internal and external loading will be utilized for these components by hand calculations and software devices. An expected structural analysis will be conducted of the durability and strength for welding additional components to bisect the average 30'x28' bay.

Technical Analysis Number Two

Switching from a concrete configuration structural system to a steel system will require loading calculations of steel members. Bracing methods to offset dead and live loads must be employed since a steel member acts differently under same loading conditions as a concrete member.

Technical Analysis Number Three

The integration of a Green Roof to both flat roof systems will contribute to dead loads of this product and live loads for product maintenance. The concrete columns and beams must be analyzed to see if they can resist buckling, shear, and tension loading that will be presented.

Technical Analysis Number Four

Depending on sizing and weight requirements, the PV system may impose a greater applied force to the structure of the building. Influences of weather and climate could impact this system's force by accumulating over a period of time which affects the steel trussed and is transferred all the way down to grounding mechanisms.

MECHNICAL BREADTH

***Corresponds to Technical Analysis Number Three**

An analytical mechanical test must be performed in order to evaluate energy conservation predicted from the Green Roof system. First, a test has to be led to note what energy performance values that the existing equipment exhibits. Second, a performance test must be obtained from the Green Roof to display a comparison of savings. Using mechanical energy software, a demonstration of thermal characteristics will be explored to see if sustainable expectations can be met.

ELECTRICAL BREADTH

***Corresponds to Technical Analysis Number Four**

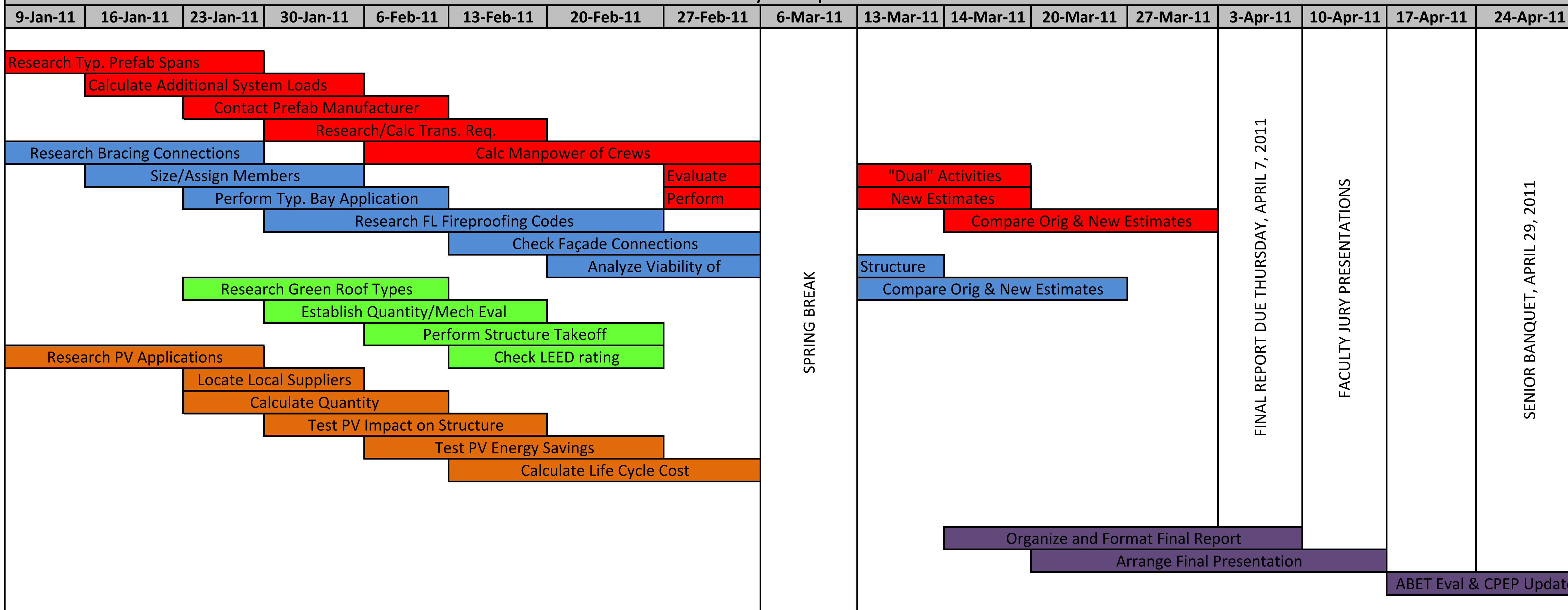
The current primary electrical system consists of four utility transformers at 2500kVA which is supplied from the J.E.A. Utility Service on the public power grid. A comprehensive look at the electrical component requirements of the equipment will be needed for the analysis. New energy savings from the photovoltaic system will be studied to compare the cost efficiencies over its life cycle. Additional power for resale back to the company will also be taken into account for distribution as a lifetime going profit under constant conditions.

APPENDIX B – SPRING SEMESTER TIMETABLE SCHDULE

SENIOR THESIS FINAL PROPOSAL 12/10/2010	Duval County Unified Courthouse Facility							Darre'll Alston Construction Management Dr. Rob Leicht
	Milestone 1 1/31/2011		Milestone 2 2/18/2010		Milestone 3 3/4/2010		Milestone 4 3/25/2010	

Thesis Semester Schedule Proposal

January 2011-April 2011



Analysis 1: Uniform Prefabrication Engineering
Analysis 2: Structure Assembly Efficiency through Steel Implmentation
Analysis 3: Energy Utilization from Green Roof Processes
Analysis 4: Photovoltaic System Resilience with Energy on the Grid System

Milestone 1: Complete all Steel Sizing/Load Calcs
Milestone 2: Finish Mechanical Evaluation of Green Roof
Milestone 3: Collect All PV Findings
Milestone 4: Gather All Results and Findings and Begin Final Preparations