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University of Pittsburgh
CHEVRON ANNEX

PITTSBURGH, PENNSYLVANIA

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EXECUTIVE SUMMARY

The purpose of this proposal is to discuss four analyses that will be performed for the University of Pittsburgh's Chevron Annex project. Background research will be performed, as well as examining the potential solutions, expected outcome and the steps that will be performed to achieve the technical analysis/research.

Analysis 1: Integration of Tablet PC's in the Field

The Chevron Annex did not utilize any new or unique methods of technology during construction. It is suggested that the project team implement different forms of technology in the field to increase the productivity of the workers. Items such as Tablet PC's and smart phones will also be used to close out the job, as well as filling out the punch list. Applications and programs applicable will also be recommended. These programs will help increase the overall productivity of the project. It is estimated that the implementation of new and innovative technology in the field will have a drastic effect on the overall time savings related to the superintendent.

Analysis 2: Re-Design/Re-Sequence of the Facade

The installation and phasing of the exterior skin caused a number of problems during the construction of the Chevron Annex. A re-sequencing of the installation of the façade systems, as well as a re-design of the architectural eyebrow will be completed in this analysis. Members of the project team will be interviewed to determine the problems and challenges faced during the installation of these systems. The re-sequencing of the façade systems will decrease the overall schedule, thus decreasing the labor costs involved with the installation.

Analysis 3: Commissioning of Laboratory Spaces

The Chevron Annex developed some complications when it came time to turn on the mechanical equipment for the testing and balancing of the systems. Throughout this analysis, the commissioning process will be researched and analyzed to determine the most efficient way to commission. Additionally, it will be suggested that the USGBC implement a LEED recertification for sustainable buildings in order to ensure they continue to run as expected.

Analysis 4: Addition of a Green Roof

The Chevron Annex's roofs were typical TPO roofs that did not use any innovative solutions to help increase the efficiency of the building. It is suggested that these roofs be changed to a green roofing system. This change will reduce the storm water runoff, reduce the building's heat island effect and reduce the mechanical loads imposed on the building. A green roof will also make the building more environmentally friendly, as well as providing money savings to the owner in the long run.

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PROJECT BACKGROUND

The Chevron Annex is an addition to the University of Pittsburgh's Chevron Tower and Ashe auditorium. The construction of the Annex started on November 20, 2009 and was completed in September 2011. The facility is a two phase project located in Pittsburgh, Pennsylvania that included a renovation to the existing auditorium, as well as a three story vertical addition above that is approximately 35,000 square feet. The Chevron Annex was a $25 million design-bid-build project that was bid as a multi-prime job. Burchick Construction was the General Contractor that was awarded this project, and is also the sponsor for this thesis.

Included in the project are spaces which encompass a number of functions. The first floor and mezzanine level consist of a main lobby, computer lab, auditoriums and lounge area. The second and third floors are similar to each other and are devoted to chemistry labs and student desk areas. A few offices and other rooms are also scattered throughout the floor. The fourth floor of the new addition is a mechanical space that houses most of the mechanical equipment.

The façade of the building is a combination of a number of systems. Some of these systems include terra cotta, metal panels, louvers and glazing. Additionally, a sunshade system is integrated into the curtain wall and an aluminum cladded eyebrow (Figure 1) accents the southwest corner of the façade.

Figure 1 Aluminum Cladded Eyebrow

Additionally, the Chevron Annex is currently in pursuit of a LEED Gold rating. Being certified as a LEED Gold building will help acknowledge the building in its attempt to implement strategies for better environmental and health performance, as well as adding another LEED certified building to the University of Pittsburgh's campus.

The schedule was the main concern of this project because the University needed to turnover certain areas of the building once the students returned to class. Another area that was a risk for the completion of the project was the ongoing changes that were requested by the University. Constant change orders were developed; however, there was no additional time added to the schedule. Overall, the Chevron Annex had several problematic features that were previously identified in Technical Report 3. These problems are expected to be solved throughout the analysis of four technical areas during the Spring 2012 semester.

TECHNICAL ANALYSIS 1 – INTEGRATION OF TECHNOLOGY IN THE FIELD

PROBLEM IDENTIFICATION

The Chevron Annex did not utilize any new or unique methods of technology during construction. This was a concern during the project because the field office was located a quarter mile west of the project; which made it difficult for the superintendents to keep track of their documents. Additionally, there was a considerable amount of time that was wasted walking between the site and field office. This time could have been utilized better, thus increasing the quality control and supervision of the project. There was also a lack of communication amongst the project team, which could be resolved with the implementation of new and innovative technology in the field.

BACKGROUND RESEARCH PERFORMED

There is an increasing interest and use of technology throughout the construction industry. Companies are spending a critical amount of time and money trying to utilize different types of technology to help them gain an edge on other companies. The different forms of technology that will be analyzed include Tablet PC's, smart phones and RFID tags/sensors. These forms of technology are offering construction users new ways to speed up communication, obtain client approvals, complete inspections, arrange logistics and manage other complications in an industry that is highly mobile. The amount of information a superintendent needs to efficiently increase the productivity of the company will also be looked into. It is suggested that effective uses of technology will prove to save time and money throughout the project. Applications and programs, such as Latista and Vela, for Tablet PC's and smart phones will also be recommended.

METHODOLOGIES

In order to follow through and perform this technical analysis, the following steps are necessary:

- Perform detailed research on the different types of Tablet PC's; while comparing the different costs, uses, etc. of the construction Table PC.
- Perform detailed research on the time and cost savings that can be established when implementing the use of technology.
- A case study will be used to evaluate cost savings on the Chevron Annex, while comparing the initial costs of investment to the payback period.
- Industry professionals that have implemented different forms of technology will be interviewed.
- Applications and programs for Tablet PC's and smart phones will also be analyzed.
- Faculty and staff of Penn State will be interviewed to get informed of new technologies available for Tablet PC's and smart phones.

POTENTIAL SOLUTIONS & EXPECTED OUTCOMES

Implementing these different forms of technology into the field has several advantages and disadvantages associated with them. For instance, the learning curves involved with a new form of technology in the field can cause some problems; so ways to bypass this problem will be suggested. A specified form of technology will also be issued to each member of upper management, and will be used to record work hours, quantity reports, quality control and other forms of documentation used throughout the project. These items will also be used to close out the job, as well as filling out the punch list. Applications and programs applicable for Tablet PC's and smart phones will be recommended and these programs will help increase the overall productivity of the project.

It is estimated that the implementation of new and innovative technology in the field will have a drastic effect on the overall time savings related to the superintendent. Implementing these items will decrease the number of trips and amount of time spent traveling between the site and field offices. This frees up much of the superintendent's time, allowing him to stay on site and oversee the project for longer. Tablet PC's and smart phones will also increase the amount of accuracy when recording work hours and quantities of materials. This accuracy will also benefit the estimating department by creating a more accurate internal history of actual labor hours.

TECHNICAL ANALYSIS 2 – RE-DESIGN/RE-SEQUENCE OF THE FAÇADE

PROBLEM IDENTIFICATION

The installation and phasing of the exterior skin caused a number of problems during the construction of the Chevron Annex. Because the roofing and curtainwall contractors were separate primes, difficulties were encountered when figuring out which items were owned by which contractor. In addition, the interdependencies of each of the façade systems created confusion and issues during installation.

Phasing and sequencing of the façade was another problem encountered. A limited number of scaffolding systems were used to install the different façade systems, which created some problems related to space and staging. Additionally, constructing the architectural eyebrow that is located on the southwest corner of the building consumed much of the schedule and manpower. This feature was built and attached on-site out of structural studs. The finishing and waterproofing of this item held up other trades on the façade, pushing back the start dates for the façade systems.

BACKGROUND RESEARCH PERFORMED

Scope review and pull planning meetings will be suggested to solve the communication issue relating to the interdependencies of the façade systems. Other scaffolding systems will be looked into in order to create more space for trades on the building's exterior. Also, a safety plan will be developed once a scaffolding system is chosen to ensure all project participants are safe during the installation of the façade systems. The architectural eyebrow will also be analyzed in detail to determine the best way to install this feature, while decreasing the schedule. The new design may increase the overall weight of the feature, which will require a model of the structure. This model will help determine if the structure is strong enough to hold the weight of the eyebrow's new design.

METHODOLOGIES

In order to follow through and perform this technical analysis, the following steps are necessary:

- Perform research of different scaffolding systems and analyze which system will be best for the Chevron Annex.
- Members of the project team will be interviewed to determine the problems that were encountered during the construction of the façade.
- Review and analyze the multiple façade systems and determine the best way to sequence the installation of these systems.
- Analyze the initial design of the architectural eyebrow and determine a way to prefabricate this feature in order to decrease the amount of time installing it.

- A model of the building's structure will be performed using etabs once the eyebrow is re-designed.
- OSHA regulations will be reviewed to determine the information necessary for a fully functional safety plan.
- Job photos, provided by Burchick Construction, will be reviewed to develop an understanding of the actual phasing of the facade.

POTENTIAL SOLUTIONS & EXPECTED OUTCOMES

The phasing of the façade will be re-sequenced to increase the productivity of the crews. The appropriate scaffolding system will be chosen, as well as a simplified safety plan will be created. Scope review and pull planning meetings will be held to solve the communication issue relating to the interdependencies of the systems.

The architectural eyebrow will also be re-designed to try and reduce the schedule, as well as reduce the amount of congestion on the site. The existing structural stud design will be replaced with a new pre-fabricated design. By prefabbing the eyebrow as one finished unit, it will simplify the installation and decrease the schedule. Additionally, it will be suggested that this re-design be done through a joint solution with the Design Team to alter the overall assembly. The re-design of the eyebrow will also allows activities that are linked to the eyebrow installation to begin sooner than anticipated. Due to this re-design, the structure may be able to be altered and will be determined by modeling the structure through etabs.

Following the re-sequencing of the facade and preliminary design of the architectural eyebrow, it is expected that the overall schedule duration will be decreased. Also, the labor costs involved with the façade will be decreased. Due to this decrease in schedule, the façade installation will be more organized and detailed, reducing the number of conflicts related to the systems' difficulties.

TECHNICAL ANALYSIS 3 – COMMISSIONING OF LABORATORY SPACES

PROBLEM IDENTIFICATION

Laboratory spaces have extreme cautions relating to the cleanliness and precision of the areas. The Chevron Annex developed some complications when it came time to turn on the mechanical equipment for the testing and balancing of the systems. The owner insisted on the laboratory spaces being completely dust free before any of the systems could be turned on; however, there were still long lead items that needed to be installed that produced dust and debris. This interrupted the owner's occupancy date, resulting in schedule complications. Additionally, the existing Chevron Tower was in an extreme negative air condition; which tended to suck the dirt from the project into the existing tower, making the job more difficult with cleanliness.

BACKGROUND RESEARCH PERFORMED

A better understanding of the commissioning process will be gained throughout this analysis. The coordination needed will be determined, as well as the verification and testing that is involved with the commissioning will be understood. Documentation and training for the future facility management staff will also be determined. Reasons why this commissioning process was so complicated will also be discovered.

In addition to the commissioning, the pre and post occupancy efficiencies of LEED Certified building systems and controls will be analyzed. LEED Certified buildings will be analyzed with respect to their building systems' efficiencies before occupancy and during occupancy. How the systems actually perform during occupancy as compared to the expected performance will be analyzed. It will be suggested that the USGBC incorporate some sort of re-certification for LEED Certified buildings to confirm that the buildings are performing to the requirements after certification. Re-Certification of LEED Certified buildings will help ensure that occupants and owners are conforming to the requirements put in place in order to be LEED Certified.

METHODOLOGIES

In order to follow through and perform this technical analysis, the following steps are necessary:

- Suggestions will be made to help owners benefit and prepare for eventual LEED recertification.
- The MEP Coordinator of the project team will be interview to determine the major problems that occurred during the testing and balancing of the systems.
- Various books and magazines dealing with the commissioning of buildings will be referenced to gain a better understanding of the process.

- The documentation needed for the commissioning process will be organized using a Tablet PC, smart phone and RFID tags/sensors.

POTENTIAL SOLUTIONS & EXPECTED OUTCOMES

A commissioning team and coordination plan will be developed to ensure an efficient and coordinated commissioning process. The documentation needed for the commissioning of the building will also be analyzed and organized using Tablet PC's, smart phones and RFID tags/sensors. A re-certification of LEED certified buildings will also be suggested to the USGBC for the future. Suggested solutions will be made to the owner on how to prepare for the future re-certification of LEED certified buildings.

An increase in the amount of coordination of the mechanical systems will be accomplished through the effective knowledge and use of the commissioning process. The different forms of technologies suggested in Technical Analysis 1 will also be put to good use by using them for the documentation and training that is needed for the commissioning process and turnover of the building to the owner. Owners will also be forced to ensure that their buildings are conforming to the requirements put in place in order to be LEED certified.

TECHNICAL ANALYSIS 4 – ADDITION OF A GREEN ROOF

PROBLEM IDENTIFICATION

The Chevron Annex's roofs consist of a new Thermoplastic-Polyolefin (TPO) system that is placed over protection board on three inch taped insulation with air barrier and gypsum board sheathing. This is all placed on top of metal decking supported by the building's steel frame. This roofing package was bid separately, which caused some complications when installing the transitions and flashing to the façade systems.

BACKGROUND RESEARCH PERFORMED

Throughout this analysis, the primary costs involved with the existing roof and new green roof will be compared. Valuable information related to green roof technology will also be provided. The building's structure will also be analyzed to determine whether additional framing will be needed to support the additional weight of a green roof system. Additionally, the change in mechanical loads and costs associated with the heating and cooling of the building will be analyzed. The amount of LEED points received from implementing a green roof will also be determined.

METHODOLOGIES

In order to follow through and perform this technical analysis, the following steps are necessary:

- Research various types of green roof systems.
- Assess the cost and schedule implications of a green roof addition.
- Calculate any energy and cost savings involved with adding a green roof.
- Evaluate the constructability issues associated with the green roof.
- Model the building in etabs to determine if any changes are needed to the structure.

POTENTIAL SOLUTIONS & EXPECTED OUTCOMES

A green roof is proposed to replace the existing TPO roof. The green roof system that is most suitable for the location and type of building will be chosen. Necessary changes to the structure will be made, as well as any changes to any other building components. Changing the original TPO roof to a new green roof will help reduce storm water runoff, reduce the building's heat island effect, and reduce mechanical loads. A green roof will make the building more environmentally friendly, as well as provide money savings to the owner in the long run. However, the schedule involved with the installation of the roof will

be increased, as well as the material and labor costs involved. These costs will eventually be countered by the long term energy savings to the owner due to the extended lifecycle and overall thermal efficiency of the building.

ANALYSIS WEIGHT MATRIX

Four core areas of investigation will be accounted for during the four technical analysis methods. The four areas of investigation include research, value engineering, constructability review and schedule reduction. The figure below displays the weight percentages expected to be related to the core areas of investigation.

Description	Research	Value Engineering	Constructability Review	Schedule Reduction	Total
Integration of Tablet PC's in the Field	5%	10%	10%	5%	30%
Re-Design/Re-Sequence of the Façade	5%	5%	15%	10%	35%
Commissioning of Laboratory Spaces	10%		10%		20%
Addition of a Green Roof	5%	10%			15%
Total	25%	25%	35%	15%	100%

TIMETABLE

In order to stay organized throughout the Spring 2012 semester, a preliminary semester schedule was created. This schedule, found in **Appendix C**, will allow a significant amount of time for the completion and review of the analyses methods.

CONCLUSION

Overall, this analysis will help increase the efficiency of the construction process related to the Chevron Annex. Integration of technology in the field and re-sequencing the trades will both help the overall schedule of the project. Additionally, the commissioning and addition of a green roof will help with the building's overall and life time performances. If these methods of construction and new technologies would have been introduced to the project, the owner would have seen a reduction in schedule and a decrease in the overall cost of the building.

APPENDIX A – CRITICAL ISSUE RESEARCH METHODS

Through research based on the experience at the 2011 PACE Roundtable and discussing critical industry issues, an analysis was formed around this topic. The critical industry issue that will be pursued through a technical analysis is the commissioning of laboratory spaces. The commissioning of a building was a subtopic discussed during the energy management services breakout session. This topic, as well as the potential for future re-certification of LEED certified buildings was analyzed in Technical Analysis 3.

It is thought that through detailed coordination and scheduling meetings that this problem could have been avoided. In order to fully analyze this problem, the schedule will be reviewed and adjusted accordingly. Multiple laboratory spaces will be also be analyzed from a number of areas of interest. The type of systems used, timing of commissioning and parties involved will be evaluated to determine the best possible solution for the phasing of the systems.

In addition to the commissioning, the pre and post occupancy efficiencies of LEED Certified building systems and controls will be analyzed. LEED Certified buildings will be analyzed with respect to their building systems' efficiencies before occupancy and during occupancy. How the systems actually perform during occupancy as compared to the expected performance will be analyzed. It will be suggested that the USGBC incorporate some sort of re-certification for LEED Certified buildings to confirm that the buildings are performing to the requirements after certification. Re-Certification of LEED Certified buildings will help ensure that occupants and owners are conforming to the requirements put in place in order to be LEED Certified.

APPENDIX B – BREADTH TOPICS

The demonstration of at least two breadth topics in Architectural Engineering are required to be analyzed in one or more of the four analyses topics. For the technical analyses already described, the following breadth topics will be discussed:

STRUCTURAL BREADTH – TECHNICAL ANALYSIS #2 & TECHNICAL ANALYSIS #4

When analyzing the exterior façade of the building, a re-design of the architectural eyebrow is recommended. A pre-fabricated unit will be suggested to decrease the duration and congestion of the project. This re-design will change the amount of stress on the structure of the building and will require an analysis of the structure through a model of the building. Once the model is developed, it will be reviewed to determine if the structure will need to be changed. If the structural system needs to be changed, some of the potential solutions include:

- The addition or subtraction of steel beams or columns to the design
- Increase or decrease the size of the existing beams or columns

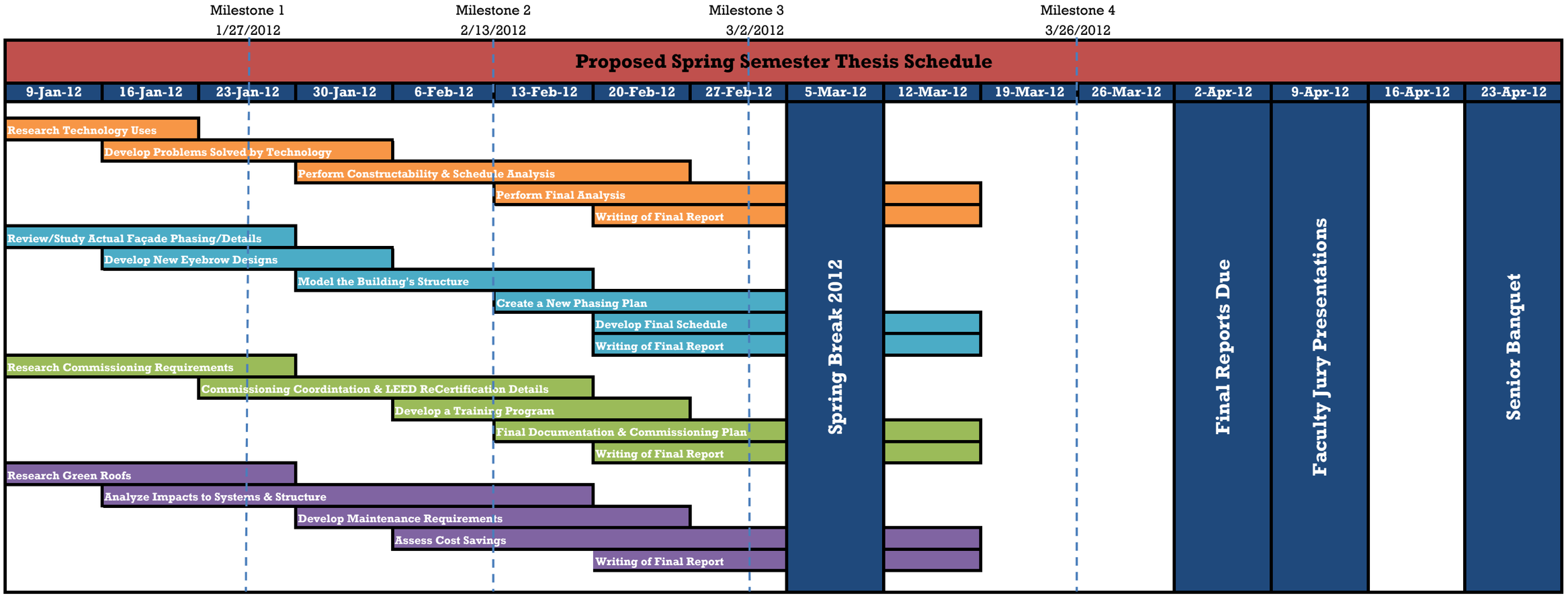
Additionally, Technical Analysis 4 involves replacing the TPO roofs with a green roof system. This analysis will also require an analysis of the existing structure to determine if it can support the load of the new green roof system. If required, additional supports will be added to the building's existing roof. Also, different size beams, columns and decking may be required for the roof of the new Chevron Annex. If a change in the structure is required, the cost and schedule impacts will also be analyzed.

MECHANICAL BREADTH – TECHNICAL ANALYSIS #3 & TECHNICAL ANALYSIS #4

Technical Analysis 3 deals with the commissioning of laboratory spaces and the implementation of LEED recertification. This analysis will require the knowledge of mechanical systems, which will be demonstrated through a mechanical breadth. A better understanding of the commissioning process will be gained throughout this analysis. The coordination needed will be determined, as well as the verification and testing that is involved with the commissioning will be understood. Documentation and training for the future facility management staff will also be determined. Reasons why this commissioning process was so complicated will also be discovered.

Technical Analysis 4 will also have a mechanical breadth. This analysis involves replacing the TPO roofs with a green roof system. A calculation of the reduction in the total heating and cooling loads will be performed. These loads will be compared against the designed loads, while the cost savings associated will also be determined. The amount of LEED points received from implementing a green roof will also be determined.

APPENDIX C – SPRING SEMESTER PRELIMINARY TIMETABLE



Milestones	
1	Chevron Project Team Interviews Complete
2	All Appropriate Research Complete
3	All Analyses in Evaluation Stages
4	All Analyses Complete & Final Report Ready for Formatting

	Analysis 1	Integration of Technology in the Field
	Analysis 2	Re-Design/Re-Sequence of the Façade
	Analysis 3	Commissioning of Laboratory Spaces
	Analysis 4	Addition of a Green Roof