

FINAL THESIS PROPOSAL

PENN STATE AE SENIOR THESIS

PENN STATE MILTON S. HERSHEY MEDICAL CENTER
CHILDREN'S HOSPITAL
HERSHEY, PA 17033



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EXECUTIVE SUMMARY

The Senior Thesis Final Proposal discusses the analyses to be performed towards the final thesis report on the Penn State Milton S. Hershey Medical Center's new Children's Hospital. The central focus of the three following analyses will be to improve efficiency in the construction industry as well as studying new sustainable technologies. The weight matrix at the end of the report shows how the entire proposal meets the four core requirements of: Critical Issues Research, Value Engineering Analysis, Constructability Review, and Schedule Reduction.

Analysis # 1: Schedule Acceleration through Multi Trade Prefabrication

With the increased congestion inside the building, the potential for accidents, conflicts between trades, and reduction in productivity will be highly likely. The usage of BIM on this project has proven to be very successful in coordinating the MEP systems to avoid on-site system clashes; however, BIM does not coordinate the flow of work of different trades, as all crews will be racing to meet their schedule deadlines causing major congestions. The goal of this analysis is to determine the cost and schedule time benefits of prefabricating patient rooms due to the repetition of the design.

Analysis # 2: Eliminating Inefficiency of Cost Estimating Through 3D Modeling

During the Design and Development of the Children's Hospital project, a total of three 3rd party estimators were hired to estimate the costs of the project as the Architects progressed through the design. In addition, to the three 3rd parties involved, each contractor bidding for the project had to develop and estimate the project costs. The Children's Hospital is a large project with many systems to be estimated and evaluated. The lengthy process of conducting manual hand take-offs on 2D drawings could negatively impact the entire project team during construction. The biggest risk of conducting manual take-offs during construction is when the owner's team decides to change scope of work or add new bulletins. Manual take-offs can greatly hurt the project schedule and costs if not conducted in a quick and efficient manner. The primary goal of this analysis is to utilize 3D modeling software to conduct material Quantity Take-offs and pricing. Software will be used to analyze the benefits of utilizing 3D Estimating techniques in developing accurate and quick estimates. The analysis will compare 3D software estimating techniques to the traditional commonly used manual estimating methods.

Analysis # 3: Viability of Incorporating Solar Photovoltaic Systems

The new facility will require enormous amount of electric loads to run the building. Diesel powered generators provide backup power in the case of power loss. The new project is on the borderline of achieving a LEED Silver Rating and the diesel powered generators are not providing any points to help out. Incorporating a solar photovoltaic system to help reduce the dependency on grid power as well as the possibility to eliminate some diesel generators will provide a great sustainable benefit to the Hershey Medical Center. The Children's Hospital joins with two other buildings with a vast amount of roof space, hence the idea of incorporating PV Panels. The primary goal of this analysis is to perform a design for a roof mounted photovoltaic system and determining the payback period as well as the amount of energy produced. The analysis will determine whether or not a photovoltaic system is viable on the Children's Hospital. This analysis will also satisfy my ***Electrical and Structural Breadth requirements.***



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PROJECT BACKGROUND

| | |
|--------------------------------|---|
| BUILDING NAME | PSU Hershey Medical Center Children's Hospital |
| LOCATION | 500 University Drive, Hershey, PA 17033 |
| PRIMARY OCCUPANY TYPE | Medical |
| GROSS BUILDING AREA | 263,556 SF |
| NUMBER OF STORIES | 5 Stories (Above Grade) / 1 Story (below Grade) |
| CONSTRUCTION DATES | 03/17/2010 - 08/20/2012 |
| CONTRACTED GMP AMOUNT | \$115,726,613 overall |
| PROJECT DELIVERY METHOD | DESIGN-BID-BUILD WITH CM AGENCY @ RISK |

Children's Hospital is the latest addition to the Hershey Medical Center campus. Penn State Hershey, a branch campus for The Pennsylvania State University, owns the new Children's Hospital. Penn State Hershey broke ground in 1966 upon approval from Penn State to establish a new Medical School, teaching hospital, and research centers. Since 1970, Penn State Hershey expanded from 218 acres to 550 acres. Today, the Hershey Medical Campus has carefully planned and constructed state of the art buildings that reflect the steady increase in patient demand for services as well as expanding research and teaching programs. The medical center owns 484 licensed beds, performs 23,230 surgical procedures annually, and receives about 820,000 clinic visits per year. As the only Level I pediatric trauma center between Philadelphia and Pittsburg, the Children's Hospital serves the most populous rural region in the nation, with more than a million children in their referral area.

The construction schedule for the Penn State Hershey Medical Center Children's Hospital is relatively straight forward despite the complexity of the project. L.F. Driscoll officially signed their CM @ Risk GMP contract with the Penn State Hershey Medical Center on 3/8/2010 and broke ground on 4/5/2010 and is scheduled to be completed on 8/20/2012. Having an almost complete set of drawings prior to construction has been a great success for L.F. Driscoll due to their ability to schedule activities and plan logistics early prior to breaking ground. This led the CM to not expect any major additions in the scope as they have already considered the new Bulletins to be issued with two new shell space fit-outs. Shortly after receiving an official Notice to Proceed on 3/17/2010, L.F. Driscoll mobilized with three Construction Trailers at the Job Site's main gate access area.

The site for the new Children's Hospital is surrounded by 2 major buildings. Just north of the Children's Hospital lays the existing Cancer Institute Building that directly joins with the new Children's Hospital. On the west side the Children's Hospital joins with the existing Main Hospital Building. The new Children's Hospital



[IMAGE 1 PSU HMC Campus Map](#)

is the latest addition to the expansion of the medical center's state of the art health care. The site has been disturbed during the construction of the Cancer Institute and some foundation elements have been already in place by the previous contractor. Among the major issues with the building site are vehicular access, tower crane operations, and the Main Hospital's Helicopter paths.

To complete the construction of the \$115 million state of the art facility, Hershey Medical Center contracted with L.F. Driscoll, Co LLC as the Construction Manager at Risk with a GMP contract. The Construction Manager is in direct contractual agreements with the subcontractors on-board. The general liability insurance is covered by L.F. Driscoll under a Contractor Controlled Insurance Program (CCIP). The project substantial completion of the Children's Hospital is scheduled to be on 8/20/2012.



[IMAGE 2 New Children's Hospital at the Penn State Milton S. Hershey Medical Center \(courtesy of Payette Associates\)](#)



ANALYSIS #1: Schedule Acceleration through Multi Trade Prefabrication

PROBLEM IDENTIFICATION

With the sophistication of all interior fit-outs and rough-ins, the Children's Hospital will encounter major issues such as lack of space for different trades to be working in as well as insufficient material lay down areas. With the increased congestion inside the building, the potential for accidents, conflicts between trades, and reduction in productivity will be highly likely. The usage of BIM on this project has proven to be very successful in coordinating the MEP systems to avoid on-site system clashes; however, BIM does not coordinate the flow of work of different trades as all crews will be racing to meet their schedule deadlines causing major congestions.

RESEARCH GOAL

The goal of this analysis is to determine the cost and schedule time benefits of prefabricating patient rooms due to the repetition of the design.

METHODOLOGY

- Research and gather information on the work associated with a single patient room to determine the items to be prefabricated.
- Research and determine the cost and time associated with the current stick built construction method.
- Research and determine the cost and time associated with prefabricating the patient rooms in an off-site facility.
- Compare and contrast the two methods to determine the cost and schedule time benefits of prefabricating the patient rooms.
- Research and locate the nearest facility able to prefabricate the patient rooms.
- Determine the means and methods to crane pick the prefabricated units as well as the costs associated with truck deliveries.
- Perform a brief analysis determining how Building Information Modeling (BIM) and 3D estimating could potentially aid prefabrication as well as eliminating inefficiencies.



RESOURCES

- AE- CM Faculty at Penn State.
- Applicable Literature.
- Current project schedule and estimates.
- Case Studies of previous projects utilizing prefabrication.
- L.F. Driscoll Project Team.
- Industry Professionals.

EXPECTED OUTCOME

This analysis will thoroughly investigate the feasibility of prefabricating all patient rooms on the 3rd and 4th floor of the Children's Hospital. The expected results are believed to significantly cut down the interior fit-out schedule time as well as reducing major congestions within the fit-out floors. On the other hand, costs are expected to be higher due to extra costs associated with storing the prefabricated units in an off-site facility in addition to the transportation costs to deliver the units on-site.



ANALYSIS #2: Eliminating Inefficiency of Cost Estimating Through 3D Modeling

PROBLEM IDENTIFICATION

During the Design and Development of the Children's Hospital project, a total of three 3rd party estimators were hired to estimate the costs of the project as the Architects progressed through the design. In addition, to the three 3rd parties involved, each contractor bidding for the project had to develop and estimate the project costs. The Children's Hospital is a large project with many systems to be estimated and evaluated. The lengthy process of conducting manual hand take-offs on 2D drawings could negatively impact the entire project team during construction. The biggest risk of conducting manual take-offs during construction is when the owner's team decides to change scope of work or add new bulletins. Manual take-offs can greatly hurt the project schedule and costs if not conducted in a quick and efficient manner.

RESEARCH GOAL

The primary goal of this analysis is to utilize 3D modeling software to conduct material Quantity Take-offs and pricing. Software will be used to analyze the benefits of utilizing 3D Estimating techniques in developing accurate and quick estimates. The analysis will compare 3D software estimating techniques to the traditional commonly used manual estimating methods.

METHODOLOGY

- Conduct a survey to be sent out to multiple contractors utilizing 3D estimating software to see the overall benefits and challenges associated with this technique.
- Different 3D Software will be researched to identify the one with the most beneficial features.
- Upon selecting the ideal 3D software to be used, a specific building system will be selected as the benchmark for the study.
- Using RS MEANS COSTWORKS, the system will be estimated utilizing the traditional material take-off technique.
- The same system will then be estimated utilizing 3D software to extract the materials take-offs.
- A comparison will then be conducted to determine the optimal solution to estimating efficiently.
- Perform final analysis explaining how 3D estimating can potentially eliminate inefficiencies during the construction of the Children's Hospital.



RESOURCES

- RS MEANS COSTWORKS 2010.
- Multiple 3D Software available in the AE Computer Labs.
- Applicable Literature.
- Estimating team at L.F. Driscoll, Co LLC.
- Industry Professionals to conduct my survey.

EXPECTED OUTCOME

This analysis will determine the answers to whether or not 3D estimating will be beneficial. It is expected that using 3D estimating techniques will efficiently decrease the time required to assemble an entire estimate. It is also expected that this technique will help eliminate estimation busts that occur on some projects were upon bid award the team discovers that a major system has not been accounted for. Utilizing this technique will prove nothing but faster and more efficient estimating compared to traditional methods.



ANALYSIS #3: Viability of Incorporating Solar Photovoltaic Systems

**** See APPENDIX A for Structural and Electrical Breadth Topics***

PROBLEM IDENTIFICATION

The Children's Hospital project at the Penn State Milton S. Hershey Medical Center is a state of the art facility with high end patient care systems. The new facility will require enormous amount of electric loads to run the building. Diesel powered generators provide backup power in the case of power loss. The new project is on the borderline of achieving a LEED Silver Rating and the diesel powered generators are not providing any points to help out. Incorporating a solar photovoltaic system to help reduce the dependency on grid power as well as the possibility to eliminate some diesel generators will provide a great sustainable benefit to the Hershey Medical Center. The Children's Hospital joins with two other buildings with a vast amount of roof space, hence the idea of incorporating PV Panels.

RESEARCH GOAL

The primary goal of this analysis is to perform a design for a roof mounted photovoltaic system and determining the payback period as well as the amount of energy produced. The analysis will determine whether or not a photovoltaic system is viable on the Children's Hospital.

METHODOLOGY

- Develop a solar study on the Children's Hospital to determine the optimum angles and directions of solar energy for PV panels.
- Research photovoltaic panel technologies and manufacturers to determine the most applicable system available.
- Select the most applicable system and determine the marginal power able to be produced over the given area of the roof and the possibility of eliminating one of the diesel generators.
- Analyze the existing structure of the roof to determine the viability of installing the PV panels without redesigning the structural system.
- Develop a brief cost analysis determining the financial benefits and the payback period.

RESOURCES

- AE Faculty at Penn State.
- Applicable Literature.
- Manufacturers of PV Panels.
- Case Studies of previous projects utilizing photovoltaic.



EXPECTED OUTCOME

This analysis will thoroughly investigate the viability of applying photovoltaic system on the Children's Hospital. Although it is not expected that the photovoltaic system would support the entire building electric loads, it is however expected to effectively reduce the dependency on grid supplied power. It is expected that the building structure will be able to support the additional roof dead load incurred by installing PV panels. It is also expected that the financial analysis will prove that this system will be financially affordable and worth the payback period.



WEIGHT MATRIX

Table 1 below depicts a weight matrix representing the amount of time and effort to be dedicated for each analysis in the different core investigation areas. The four main core areas of investigation include: Critical Issues Research, Value Engineering Analysis, Constructability Review, and Schedule Reduction.

| Description Analysis | RESEARCH | VALUE ENGINEERING | CONSTRUCTABILITY REVIEW | SCHEDULE REDUCTION | TOTAL |
|----------------------|------------|-------------------|-------------------------|--------------------|--------------|
| Prefabrication | 5% | 5% | 15% | 15% | 40 |
| 3D Estimating | 15% | - | - | 10% | 25 |
| Photovoltaic System | 10% | 10% | 15% | - | 35 |
| TOTAL | 30% | 15% | 30% | 25% | 100 % |

Table 1 Weight Matrix for Distribution of Core Areas of Investigation

TIME TABLE

As an effort to ensure the ability of staying on task and meeting project goals, a basic timetable has been developed depicting the expected schedule of work to be performed during the spring of 2011 semester for each analysis. See APPENDIX B for the preliminary schedule developed for the spring semester.

CONCLUSION

The Children's Hospital project at Penn State Milton S. Hershey Medical Center is on track to be the next successful project for the university. The primary goal of this thesis is to improve and propose new techniques and ideas on the overall project. Through an in-depth analysis, it is believed that prefabricating repetitive patient rooms will help the project team shed away a significant amount of time during the interior fit-out activities. It is also believed that pursuing methods of 3D estimating could effectively save time during the project to carefully analyze Value Engineering ideas and newly distributed Bulletins. Finally, the proposed thesis analysis will also study sustainability ideas to be proposed for the Hershey Campus. Photovoltaic Panels may have high upfront costs; however, this analysis is expected to justify the reasoning of selecting this system.

This proposal is intended to be a working submission with expected revisions based on feedback from the AE faculty and thesis consultants.

APPENDIX A: BREADTH TOPICS



BREADTH TOPICS

As a senior thesis requirement to fulfill the Penn State Architectural Engineering BAE program, the following topics will investigate into two other disciplines within the AE Department that have been studied over the course of the AE Major.

STRUCTURAL BREADTH: Contributes to Technical Analysis 3

The current roof of the new Children's Hospital consists of a (2" deep, 20 gage composite metal deck with a 4-1/2" thick topping slab reinforced with 6x6 W2.1XW2.1 WWF). As per contract there will be no equipment housed on the roof structure due to aesthetic reasons. The remainder of the superstructure consists of a structural steel framing system with elevated deck slabs and a deep foundation system.

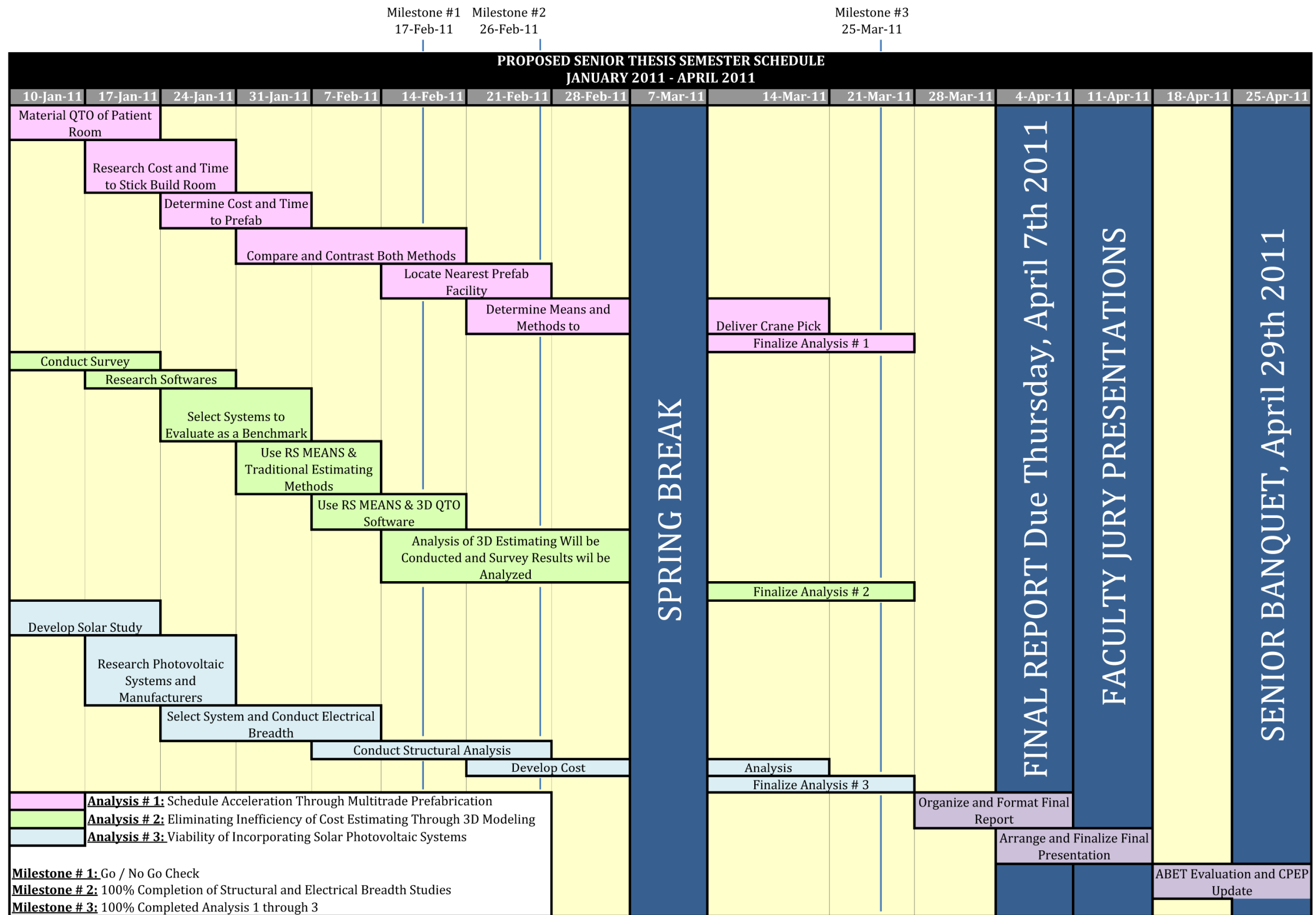
Technical Analysis 3 proposes a new sustainable source of energy i.e. Photovoltaic Panels. With the addition of numerous panels on the roof of the Children's Hospital, it is necessary to evaluate the structural system of the facility to ensure the applied loads can be sustained without causing catastrophic structural failures. The slabs will be evaluated to determine the whether or not the entire system can be securely tied down. The structural steel beams and columns will also be evaluated in order to verify if the new dead loads can be supported. In the case the structural system fails to support the added loads, an analysis will follow with the required member sizes to safely support the new system.

ELECTRICAL BREADTH: Contributes to Technical Analysis 3

In order to determine the savings and benefits of implementing a photovoltaic system, it is essential to be able to calculate some parameters. The main goal will be to determine whether or not it is possible to eliminate at least one diesel generator. Research will be done to select the optimum batteries and solar panels via a load calculation of the power produced by the diesel generators. The amount of solar panels will be calculated based on the product data given by the solar panel manufacturer. In the case that a diesel generator is not able to be eliminated due to insufficient roof space, an investigation will be conducted to determine a system utilizing high electric loads to be solely powered by solar panels. Finally, the cost implications of installing this system will be analyzed to determine if it is feasible and cost effective system to be added on the Children's Hospital.



APPENDIX B: TIME TABLE



ANALYSIS # 4 WAS DROPPED PER DISCUSSION WITH ADVISOR