Aria Health ED Expansion

Philadelphia, PA

Final Proposal

Rev. 1

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Architectural Engineering

Construction Option

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Executive Summary

After performing three technical reports analyzing the Aria Health Emergency Department Expansion project, many aspects of the building presented possibilities for improvement. Throughout this proposal, four analysis areas will be proposed for the purpose of study during the Spring Thesis Project. The areas of sustainable construction, schedule acceleration, constructability, and value engineering will be examined.

Analysis 1 will focus on the implementation and integration of sustainable construction practices, focusing on water reclamation and on-site renewable energy. The Aria Health ED Expansion is currently being tracked as LEED Certified, however this may not be accomplished. There are several opportunities for improvement in sustainability, of which the capture and reuse of rainwater for sewage conveyance and irrigation will be analyzed, in addition to the installation of photovoltaic panels for electricity generation.

Analysis 2 will provide an in-depth look into the modularization and prefabrication of the emergency department treatment rooms. The primary objective of this analysis will be to accelerate the schedule due to the 40 lost work days from inclement weather and permitting issues. It is believed that modularization will not only implement more efficient productivity, but also reduce material waste and site congestion, provide a safer working environment, and improve quality control and quality assurance. A revised site logistics plan and construction sequence will be necessary, along with a revised project schedule.

Analysis 3 is geared toward studying the constructability of the new addition tie-in to the existing hospital, with the goal of producing minimal patient impact and sustaining patient safety and wellbeing. Investigations will consist of increased ICRA requirements, noise control, construction times, and an effort in eliminating construction fumes from entering the hospital outside air intakes. The addition of an effective cross-functional team may be considered, to provide a more collaborative project environment. In an effort to increase communication and collaboration, the possibility of collocation of the team will also be studied.

Analysis 4 will provide a value engineering study pertaining to the energy efficiency of the current building façade, where an alternate façade and operable solar shading devices will be considered. It is anticipated that with the implementation of a more efficient wall construction and solar deflection, cooling costs may be reduced providing for more affordable building operation. An energy model will be constructed, comparing the energy efficiency of the current building façade with the alternate system. This model will then be converted to operating costs, enabling an economic analysis to be conducted.

Through each of the four aforementioned analyses, this thesis will provide valuable insight on improvements in sustainability, energy efficiency, and the integration of innovative construction techniques as they pertain to the Aria Health ED Expansion project.

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Analysis 1 – Sustainable Construction

Problem Identification

The Aria Health ED Expansion project is currently tracked to be LEED Certified, however this may not follow through to completion. There are virtually no sustainable attributes on the project, which could be drastically improved. The objective of this analysis will be to study and integrate sustainable construction techniques to improve the energy efficiency of the Aria Health Addition project in the areas of water reclamation and on-site renewable energy. This implementation will provide sustainable aspects to the building and add value to the owner through self-production of resources and energy.

Background

The primary points associated with the current LEED tracking consist of the Sustainable Sites category, where 22 points have awarding potential. However, there are currently zero LEED points being tracked for Water Efficiency. Hospitals use a substantial amount of water, all of which is currently being supplied through the local water authority in Philadelphia. Aside from water efficiency, the building currently utilizes purchased energy and electricity. With the addition of On-Site Renewable Energy, the hospital could supplement their energy usage with their own energy production. Because hospitals are under operation 24 hours per day, 365 days per year, it is extremely important to understand energy and resource usage. By producing their own electricity and recycling grey water, operating costs could potentially be reduced.

Potential Solutions

There are two areas with which Aria Health could incorporate sustainable construction that could provide the most benefit to the project.

- Water Reclamation and Reuse

  Through the use of a collection and distribution system, captured rainwater from the building roof and parking areas (of which there is plenty) could be utilized to supplement the potable water used to irrigate the site green space. This would eliminate the usage of potable water for this purpose. Captured rainwater could also be used to supplement grey water for toilet flushing and sewage conveyance. This could also drastically reduce potable water consumption. Additionally, high-efficiency filtration systems and a packaged nutrient removal system could be utilized to reclaim water from sinks and showers to be recycled back into the sewage conveyance system. The cost implications of the additional pumps, piping, and other equipment would have to be considered, as well as the specialized labor required to put this system in place.

- On-Site Renewable Energy

  The high roof at the third level of the emergency department addition currently has a large amount of open space available. This could provide the opportunity for the addition of solar paneling to provide supplementary electricity to the purchased PECO electrical utility. Not only would these panels reduce the dependence on bought electricity, but they would also incorporate a fundamental aspect of sustainable construction practices: renewable resources. These panels would reduce the cost of hospital operation expenses, however the initial cost would have to be

compared with the payback period for the photovoltaic panels. An economic analysis would be performed.

- The implementation of solar paneling also provides an opportunity for a breadth in electrical design, where the increased production in electricity would have to be integrated into the building electrical distribution and power.

Analysis Steps

In order to accomplish the objective of integrating sustainable construction techniques, the following analysis steps would be required.

- Analyze the current landscaping design and irrigation layout
- Decide how and where to capture rainwater
- Research rainwater collection systems
  - Determine costs of material, equipment, and labor for collection system
- Layout new irrigation scheme
- Analyze how to incorporate the reclaimed water into the building sewage conveyance
- Research nutrient removal systems and how to reintegrate water back into the system
  - Determine the costs and specialized knowledge required for nutrient removal
- Research solar electricity generation
- Determine adequate photovoltaic panels to produce the desired amount of electricity
  - Determine cost of material, labor, and specialized equipment for installation
- Layout proper amount of solar panels and most efficient locations for solar capture
- Tie photovoltaic panels into building electricity and power distribution
- Provide payback period and economic analysis for each sustainable construction technique implementation
- Provide a LEED analysis complete with the possible points associated with the new sustainable additions

Expected Outcome

It is expected that the implementation of a rainwater collection system could reduce the use of potable water consumption for sewage conveyance and irrigation purposes. It is believed that this supplementary water source could cut back on water purchases and offset the initial cost of construction, with the addition of recycling sink and shower water. A cost and constructability analysis would be performed, as well as how this system would affect the project schedule. The primary purpose of this analysis, however, is to analyze the integration of sustainable construction techniques.

While the initial cost of the solar panel addition could be high, it is expected that the electricity pay back could potentially reduce the amount of electricity purchased from PECO. It is believed that this would add value to the building in the long run, as well as provide a substantial sustainability feature to the project.

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Analysis 2 – Modularization of Treatment Rooms

Problem Identification

The Aria Health ED Expansion project was plagued with 40 total lost work days due to inclement weather and permitting issues in the early stages of the project. In addition to schedule delays, stick-built interiors can cause a congested jobsite, excess waste material, and could further disturb patients residing within the existing hospital. The primary objective of this analysis will be to research modular construction techniques for the purpose of accelerating the project schedule. This will provide an alternative to traditionally built building interior spaces. In addition to schedule acceleration, several other construction issues will also be addressed. Coordination and communication will be vital for multi-trade prefabrication in order for success in the integration of each module to the building structure and systems rough-in. A site logistics plan will be developed, to depict how and where each building module will be brought into site and set in its respective final location. Lastly, a new phasing and sequencing plan will be provided and incorporated into the existing overall project schedule.

Background

The second floor of the emergency department addition is where the clinical services reside, housing the staff areas and patient treatment spaces. There are 43 triage and acute patient treatment rooms, all of which are of similar size. Additionally, each of the rooms have almost identical space layout and features. The rooms are between 11’ and 12’ wide and are approximately 14’ long. They are all complete with a bed, overhead, swiveling light, headwall, as well as a sink and casework. The layout and repeatability of these spaces provide the opportunity for off-site, multi-trade prefabrication to be modularized and installed on site as complete assemblies.

Potential Solutions

The potential solution of modularizing the emergency department patient treatment rooms would provide several benefits to the construction project and add value to the owner in many different areas. Each of the rooms would be prefabricated in an off-site warehouse facility, where each of the respective trades would perform their work to the original code and specification requirements. Building inside a controlled, interior environment would provide a safer working atmosphere, where tradesmen would gain more space for their tools, materials, and lay down areas, all kept out of the elements. This would eliminate the possibility of a weather delays or damage to the end product due to moisture. Quality control and quality assurance may also be improved by constructing in a controlled environment, as tighter tolerances could be achieved. Prefabricating inside an off-site facility would also reduce the onsite congestion of workers, material, and equipment, also providing the added benefit of reduction in waste. Aside from site congestion and safety improvements, modular construction would also provide a very strong acceleration in schedule. These modules could be constructed during earlier phases of the project, while not impacting on-site activities already taking place. The modules would then be transported to site and craned into their respective, final positions within the traditionally built structure of the emergency department.

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Analysis Steps

For the purpose of achieving schedule acceleration through the use of modular construction practices, the following steps will take place to ensure a comprehensive analysis complete with adequate research performed.

- Research current modular construction practices and multi-trade prefabrication
- Decide the most efficient way to break up the interior rooms (i.e. single room, 2 room, or 3 room modules)
- Research safety improvements made possible by modularization
- Look into possible facility types for constructing inside
- Analyze productivity increases comparing between on-site and off-site construction
- Research transportation techniques from off-site warehouse location to emergency department site
- Research how modularization can decrease waste and site congestion
- Analyze the cost impact of off-site construction, including reduced waste in labor and material, but with the addition of transportation
- Provide a revised construction schedule showing the impact of modularization within the framework of existing overall project schedule
- Conduct interviews with industry professionals versed in modular construction (i.e. Southland Industries and Whiting-Turner)
- Research possible case studies such as the Muhlenberg College dormitory project by Whiting-Turner that employed modular construction practices to build 5 buildings in 3 months
- Provide a newly revised site logistics plan to portray the delivery of treatment room modules
- Construct new construction sequencing plan
- Provide crane analysis to account for rigging capacities and swing radii
- Provide analysis of the installation issues associated with prefabricated units

Expected Outcome

It is expected that the modularization of the triage and acute patient treatment rooms would provide an accelerated schedule and safer, more efficient production level. The cost impact would have to be calculated, in order to analyze whether modular construction is economical, along with the added costs associated with transportation to site and crane rigging. A detailed analysis would be required for the constructability of putting the modules into place and whether this would impact other on-site construction activities. It is believed the prefabricating and modularizing these spaces would provide a safer, faster, and more efficient construction project.

Critical Industry Research

As new, innovative construction practices evolve, the benefits have to be weighed with the risks and drawbacks of each new idea. The construction industry continually strives to improve efficiency and accelerate schedule, as time is money when it comes to the private business sector. The issues of trade coordination and collaboration is an ever-existent issue in construction, where communication is key. Modularization provides many possible benefits, however it proves to be a critical industry issue as the micro economic impact must be examined. The debate whether it is a more economical to prefabricate

assemblies or entire buildings versus traditionally built construction project is prevalent. The research to be conducted within this thesis may possibly provide some insight on the viability of the modularization topic. The goal in performing this research will be to prove or disprove the efficiency, productivity, and cost benefits of modular construction and how they pertain to the Aria Health ED Expansion project. The intended audience for the analysis will be Turner Construction Company, Aria Health Systems, and those wishing to learn more about multi-trade prefabrication and modularization.

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Analysis 3 – Tie-in to Existing Hospital and Minimizing Patient Disturbance

Problem Identification

The new emergency department at the Torresdale Campus for Aria Health Systems is a new addition that will be tying into an existing, fully operational hospital. This provides many unique challenges that base build construction projects do not need to consider. The most important issue of which, consists of minimizing patient disturbance of within the existing hospital. This analysis will focus primarily on the constructability issues present in the addition to the existing hospital, with the goal of providing an efficient building tie-in that also minimizes patient disturbance.

Background

As with any hospital project, clinical care and patient wellbeing is of utmost concern for the building owner. With the challenge of an addition tie-in to an existing hospital, these concerns become even more amplified. With that in mind, the possibility of analyzing the measures taken during the construction phases of the project and how they affect the patients residing within the existing hospital has been considered. It is extremely important that patients are as comfortable as possible during their extended stay in a hospital, but above all else, the safety and wellbeing of those patients is paramount.

Possible Solutions

With the safety and wellbeing of the patients in mind, the number one goal for the project team is to produce zero impact on the patrons in the existing hospital. To do this, great care and planning must go into the construction phase of the project, with emphasis on the renovation of interior space within the original hospital footprint. Infection Control Risk Assessment, or ICRA, is one area where specific measures are taken to ensure that no construction debris or dust enters the existing hospital. This harmful material could potentially infiltrate the patient areas, causing bacteria or viral infection among patients susceptible and vulnerable to attack. It is possible that a higher level of ICRA measures could further withstand these destructive and harmful organisms. In addition to ICRA, noise control could be a potential area for improvement, analyzing acoustical dampening techniques, or predetermining times during the day when construction activities could take place. Another area of possible solution is to take measures toward eliminating the infiltration of fumes, odors, or smoke from entering the outside air intakes for the existing hospital. This is very important, as these airborne substances could negatively affect patients with breathing difficulties or who are sensitive to airborne infections.

Ensuring a minimal impact on patient safety and wellbeing may necessitate a look at the possibility of assembling a cross functional team, starting with the building owner. Communication and collaboration between the construction manager, the subcontractors, and the owner could decrease the amount of patient disturbance before it occurs. A potential solution for this could be assembling a collocation site office, where subcontractors, construction managers, and facilities personnel reside in the same room. Problems could be solved quickly and more efficiently in this fashion, as opposed to setting up formal meetings or phone conversations. The idea of collocation could also provide a more efficient means for addressing constructability concerns associated with the addition tie-in. This would be extremely beneficial to the project team considering the complications with systems and interior integration to the existing hospital.

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Analysis Steps

For the goal of providing an efficient building tie-in to the existing hospital while minimizing patient disturbance, the following analysis steps will be performed.

- Interview hospital personnel to see how construction materials or debris would negatively affect patients if infiltration did occur
- Research heightened ICRA requirements for existing hospitals
- Analyze air flow within the existing hospital for positive pressurization to ensure air is blowing out of the hospital and not inward
- Survey how the construction activities are currently affecting those within the hospital and what they would like to see done differently
- Analyze where the existing hospital outside air intakes are drawing air and minimize construction activity in those areas
- Analyze power outage procedures and measures taken for patient safety
- Research acoustical dampening techniques and analyze the constructability and viability of these materials and installation practices
- Research collocation and interview industry professionals that have experience in this area (e.g. Barton Malow Company)

Expected Outcome

It is expected that greater measures could be taken in order to ensure zero impact on patient safety and wellbeing during the emergency department addition project. A construction project that takes place in or around an existing hospital is a difficult task, therefore more detailed requirements may be necessary. Renovation work inside the existing hospital has not yet taken place, therefore it is believed that after analyzing these options, minimal patient impact could be achieved while providing an efficient building tie-in.

Analysis 4 – New Façade with Operable Solar Shading

Problem Identification

The building entrance, complete with curtain wall and a substantial amount of fenestration, faces the southern exposure where the majority of sun light and solar gain enters the building. This high amount of solar infiltration could potentially cause for a higher cooling load, resulting in higher cooling costs and a larger mechanical system. The principle objective for this analysis will be to undertake a value engineering analysis of an alternate façade that may be more energy efficient, reducing cooling costs with the capability of retaining more heat during the winter months.

Background

As a value engineering issue, the possibility of changing the building façade provides several opportunities to add value to the Aria Health ED Expansion. This idea will not be implemented with the primary idea of cost cutting, rather improving the energy efficiency of the building enclosure. Building façades can leak and expel energy that could otherwise be used inside. With an improvement in sunlight deflection and tighter wall construction, the addition at Aria Health could perform more efficiently.

Possible Solutions

A possible solution to the problem of increased solar gain to the southern exposure is the addition of operable, external solar shading devices. Also, a new façade could be analyzed for higher R-value wall construction for the purpose of retaining heat in the winter months and assisting the cooling system in the summer months by limiting leakage. The shading devices would reduce the solar gain on the building, which would decrease the cooling load and the associated costs of operating the HVAC system. This would provide an opportunity for a breadth topic in mechanical design, where a resizing of the building mechanical system would be necessary.

A building energy model would also be constructed, comparing the energy efficiency of the new building façade and the façade as it is currently designed. This could potentially show the owner the benefits of operable shading devices and how they could be used to reduce cooling costs. This energy model would then be used to calculate and estimate operating costs for the building, and an economic analysis would be performed to prove viability. The initial cost of construction may be higher with the installation of an alternate façade, however the added value could be substantial enough to be worthwhile.

A constructability and schedule analysis would also be required to see how the addition of these shading devices would affect other trades, as well as any increased construction time. Lay down areas and on-site fabrication of the system would be considered and added to a revised site logistics plan for the project.

Analysis Steps

In order to properly perform a value engineering analysis for the exchange of an alternate building façade and the addition of operable solar shading devices, the following steps will be necessary.

- Research operable shading devices and identify specifications
- Evaluate performance characteristics of alternate façade and solar devices
- Research new façade and wall construction with the intent of a more efficient wall construction with higher R-value

- Analyze cost and schedule impact of the new building façade
- Analyze the energy efficiency of the building as is and with the new façade and construct building energy model comparing old façade with the new façade
- Resize the mechanical system to fit the new façade and shading design
    - This could possibly include the downsizing of the chiller, cooling tower, ductwork, and process piping
- Perform constructability analysis for the connection of the new façade and solar shading devices
- Analyze productivity and time needed for the installation of new façade and shading devices
- Provide new site logics plan and phasing requirements for the installation of the alternate façade

Expected Outcome

It is expected that a new operable shading system would decrease the cooling costs of the building, in conjunction with a newly constructed façade. These results would be quantified through operating costs and an economic analysis and presented in a building energy model. It is believed that although initial construction costs may increase, the value added to the project would be greatly improved.

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Conclusion

The four analyses that have been described will provide several substantial benefits to the emergency department addition at the Torresdale Campus for Aria Health Systems. Whether it be adding value to the project by integrating sustainable construction practices or improving the building energy efficiency, accelerating the project schedule through innovative construction techniques, or studying the constructability of building tie-in and systems integration with minimal patient disturbance, the research and analyses conducted will provide insight on the overall construction industry, as well as the emergency department addition project. This thesis will aim to improve the way the Aria Health project has been conducted while taking an in depth look at some of the construction's most prevalent issues.

Suggested Grading Breakdown

Analysis 1: Sustainable Construction – **25%**

- Includes breadth in electrical design

Analysis 2: Modularization – **35%**

- Critical Industry Research Topic

Analysis 3: Building Tie-in – **15%**

Analysis 4: Alternate Façade – **25%**

- Includes breadth in mechanical design

Appendix A

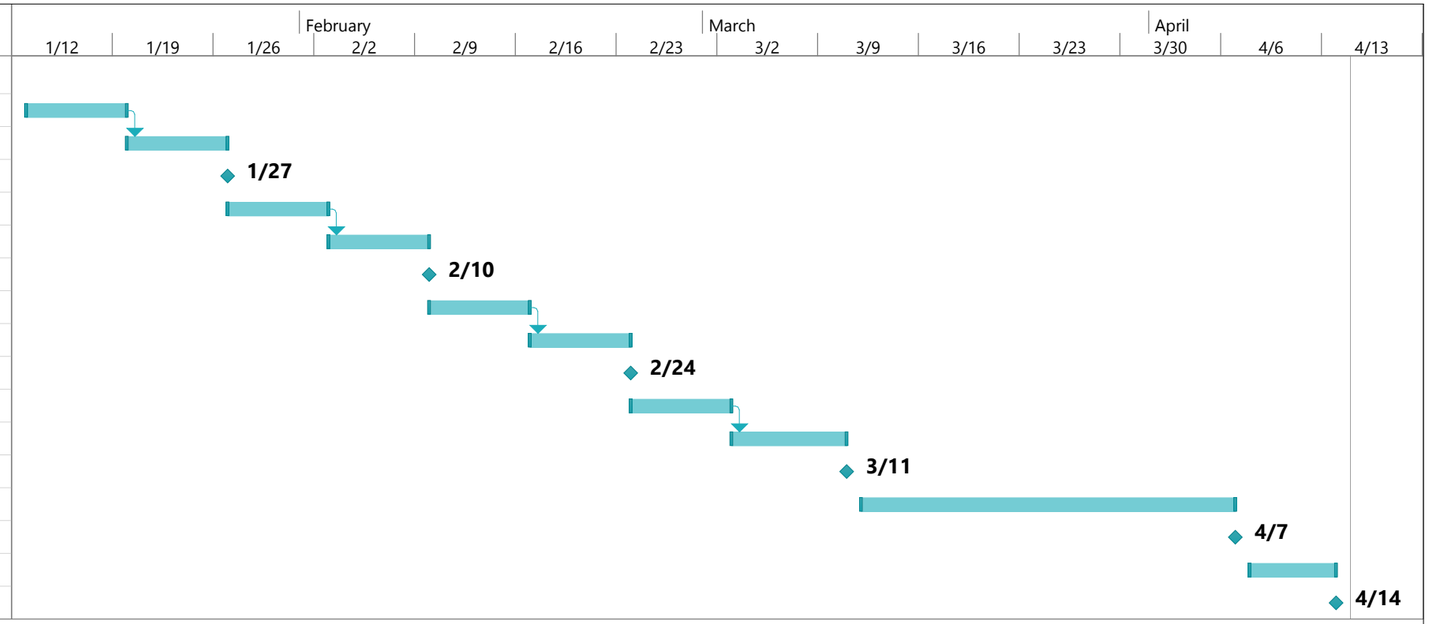
Breadth 1 – Solar Electricity Integration

In conjunction with analysis 1 and the photovoltaic panel additions to the third story roof at the Aria Health ED Expansion project, breadth 1 will provide an electrical design for the integration of solar power to the building. After choosing the appropriate solar panels, the amount of electricity generated will be calculated to determine how much of the building load will be supplemented. The design will incorporate how the panels will be tied in, sizing the feeder wiring, conduit, panel boards, and A/C converters. This will provide an in-depth understanding of electrical engineering for buildings. A schematic diagram of the system integration will be performed to show how the added power distribution. After each of the components have been designed, a cost analysis will be conducted to determine the increase in price.

Breadth 2 – HVAC System Resizing

As a supplement to analysis 2 and the study of an alternate façade, it is believed that the addition of operable solar shading devices will decrease the cooling load on the building due to solar gain. With a more energy efficient wall construction and less sunlight entering the building, the current mechanical system will be resized to fit the new cooling load requirements. This will include a study of the building chiller, cooling tower, boiler, and associated piping, along with a look at decrease the size of ductwork. A revised mechanical system design schematic will be completed to show new sizes. This breadth will provide insight to mechanical system design and integration. A detailed cost analysis will be performed to quantify the savings in material and equipment.

ID	Task Mode	Task Name	Duration	Start	Finish
1		**Appendix B - Spring Schedule**			
2		Research Analyis 1 Information	6 days	Mon 1/13/14	Sun 1/19/14
3		Perform Analysis 1	6 days	Mon 1/20/14	Sun 1/26/14
4		Analysis 1 Complete	0 days	Mon 1/27/14	Mon 1/27/14
5		Research Analysis 2 Information	6 days	Mon 1/27/14	Sun 2/2/14
6		Perform Analysis 2	6 days	Mon 2/3/14	Sun 2/9/14
7		Analysis 2 Complete	0 days	Mon 2/10/14	Mon 2/10/14
8		Research Analysis 3 Information	6 days	Mon 2/10/14	Sun 2/16/14
9		Perform Analysis 3	6 days	Mon 2/17/14	Sun 2/23/14
10		Analysis 3 Complete	0 days	Mon 2/24/14	Mon 2/24/14
11		Research Analysis 4 Information	6 days	Mon 2/24/14	Sun 3/2/14
12		Perform Analysis 4	6 days	Mon 3/3/14	Mon 3/10/14
13		Analysis 4 Complete	0 days	Tue 3/11/14	Tue 3/11/14
14		Review and Revise Analyses	19 days	Wed 3/12/14	Sun 4/6/14
15		Final Report Complete	0 days	Mon 4/7/14	Mon 4/7/14
16		Construct Final Presentation	5 days	Tue 4/8/14	Sun 4/13/14
17		Final Presentation	0 days	Mon 4/14/14	Mon 4/14/14



Project: Appendix B - Spring Sc
Date: Sun 12/15/13

Task		Project Summary		Manual Task		Start-only		Deadline	
Split		Inactive Task		Duration-only		Finish-only		Progress	
Milestone		Inactive Milestone		Manual Summary Rollup		External Tasks		Manual Progress	
Summary		Inactive Summary		Manual Summary		External Milestone			