West Village Commons
Towson University
Towson, Maryland

Technical Assignment #3
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-Executive Summary-

Technical Assignment 3 provides insight into areas of research that could be considered for the spring portion of the West Village Commons Thesis project. This report identifies some of the constructability challenges, schedule acceleration scenarios, and value engineering considerations. Over arching problems are identified as well as some technical analysis methods that could be explored to solve these issues. The basis of research can be built off of the areas explored through this report. Several key discoveries were made which will serve as a base for my proposal.

Constructability aspects explored this semester have led to some issues that are or will manifest during the project. The tight construction restraints will have an impact on everything from trash removal and recycling to steel shakeout areas and erection. Traffic flow could become a legal claim from subcontractors as access to the site is severely restricted. While cast-in-place concrete allowed for the project to kick off earlier in the year, it has presented coordination complications and weather problems. As with all owner vendor equipment projects, West Village Commons may have issues with connection coordination issues.

The critical path of the project has several key risks, including exterior enclosures. It is important to create a water tight building during the time allotted so that interior work may begin promptly. MEP work in the basement mechanical room will be a complex coordination issue for the project team as well. The schedule does though allow for acceleration in areas on structural concrete pours and finished floor activities.

Value engineering ideas are currently being developed, but unfortunately many of the new ideas serve more as cost cutting strategies. Choosing a combination of structural steel and cast-in-place concrete added value by allowing the project to open in time for the 2011 school year; a major goal for the owner. Kitchen equipment selection is still underway and could add adaptability to the project.

Many of the constructability issues have lead to changes in means in methods of construction. Even the original infrastructure development has come under scrutiny. There were many factors that went into deciding the types of systems used for the entire West Village area, and several different options could have been used. There was much debate on whether to create a utility plant for west campus, but the initial cost drove the decision not to construct one. Sustainability has become a major edict for Towson University as it tries to become equal to other universities. Many aspects of West Village Commons are sustainable, but many strategies were left on the table. These strategies could have led to lower operating costs. A major focus for my research will revolved around the idea of using Integrated Project Delivery as a construction package, and its effect on some of the problems identified.

-Constructability Challenges-

West Village Commons may be relatively small in stature for a university student center (85,000 gross square feet compared to the 154,000 gross square feet of the HUB/Robeson Center at Penn State University), but difficult process are involved in the construction. This project is just in the beginning stages of construction and not too many issues have occurred. Outlined below are a few of the projected construction issues which were either observed by the project team or analyzed by myself throughout this semester.

Cast-In-Place Concrete

The original structural design of the building called for an all structural steel system, but because Barton Malow was brought on early, they suggest cast-in-place concrete for the north end of the building. An all steel project would require the design to be 100% complete before bidding the structural trades and beginning the work. By changing to a concrete system, the initial excavation, under slab MEP, foundations, and concrete trades (bid package A) would be able to begin earlier. This also allowed for larger plenum heights for mechanical distribution. While the schedule was able to be accelerated to open for the 2011 school year, several challenges presented themselves.

- The structural engineer had to redesign the structural system after more detailed design work was occurring. This may lead to more clashes during the coordination process.
- Cast-in-place concrete will require more intense coordination among the trades for all MEP rough-in, embeds for future trade work, edge of slab details, and connection to the structural steel portion of the south end.
- Rain has been a problem as of late, hindering the ability to pour concrete. This may extend past the allotted amount of weather days causing the schedule to be accelerated later in the project.
- Areas where MEP rough-in or embeds were missed could lead to time consuming rework. There has been a case where a rough-in for an under slab manhole was placed in the wrong area.
- The southern exterior wall on the North end of the building has a drastic radial shape whose central control point lies inside an adjacent building. Field layout for this wall had to be made from an adjacent control point which could push the wall out of tolerance.

The team foresaw the difficulties in a cast-in-place structure and used a detailed BIM model for coordination. A complete concrete model was created that included all reinforcing, embeds, and rough-ins. The model is kept up to date with the amount of concrete poured each day, and then compared to baseline schedule. This helps the project team keep track of the progress. With the rain delaying pours, overtime and weekend work may occur on level 3 and 4 where the concrete work falls on the critical path. Figure 1 shows the areas of the different structural systems.

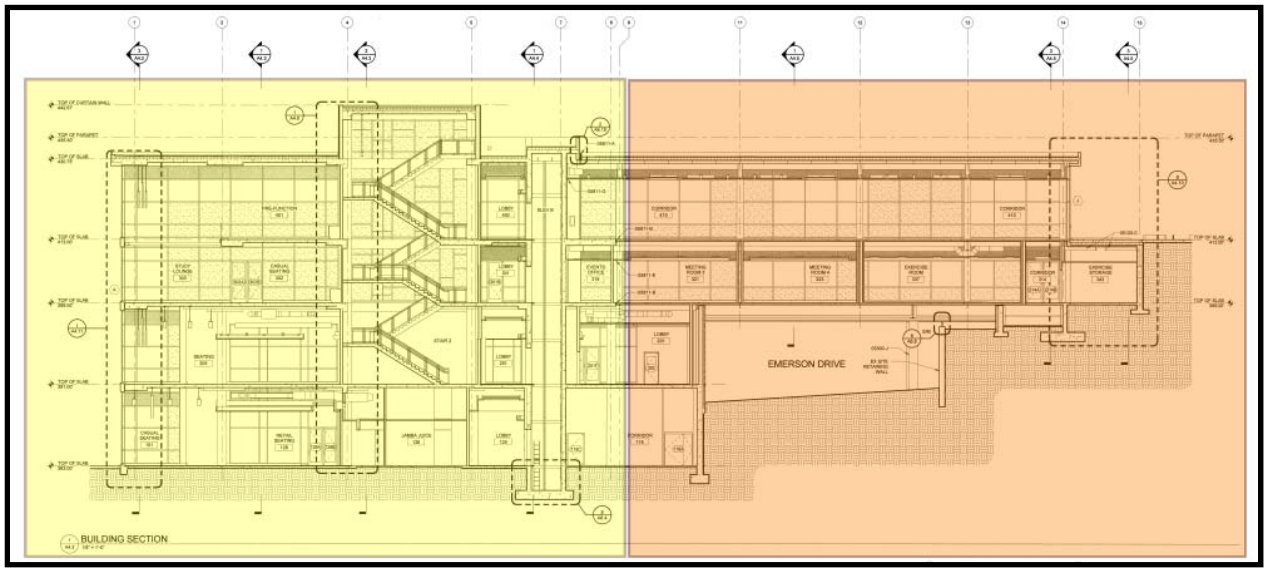

Figure 1: Building Section showing different structural components. The yellow section is the north end made of structural concrete and the red section is the south end made of structural steel.

Owner Vendor Coordination

The kitchen equipment and various restaurant establishments are all owner provided, but the rough-ins are installed through the subcontractors. This allowed the owner to save money by purchasing the equipment themselves, and allows them to make some changes to the type of equipment later in the project. Some of the constructability problems occur with an arrangement of this type.

- Complicated MEP distribution systems to serve the kitchen equipment must be closely coordinated. The project also has a total of 7 air handlers and 13 exhaust fans requiring a large amount of electrical work and distribution systems.
- Changes in kitchen equipment type and locations must be analyzed to determine its impact on connections, duct work, conduits, etc.
- The contractor must rely on the owner to help coordinate the vendors' equipment connections and the designed MEP Layout. Final owner vendor equipment fit out has a 30 day duration and lies on the critical path.

The contractor has a project member on staff in charge of keeping track of all the owner vendor equipment issues. From sleeve locations in the cast-in-place concrete to conduit connections to the individual equipment, the project engineer responsible must track coordination issues throughout. Equipment was included in the BIM model to help ensure exact locations for rough-ins. It is important to keep a good relation with not only the owner's project manager, but the vendor as well.

Tight Construction Site/Traffic Flow

One of the biggest issues facing the construction team, as was described in detail in Technical Assignment 2, is the site logistics. The project team has very little to work with, and must be aware of the active campus surroundings.

- The site fence is up tight to the construction footprint, not giving much room for exterior façade work or areas to set up scaffolding. The beginning of the exterior work occurs during the harshest of winter months (January through March) and lies on the critical path (total duration of 4.5 months).
- Limited shakeout areas require day of delivery for structural steel, reinforcing bars, façade materials, MEP Equipment, etc. Most of the larger materials are picked up right off the trucks and put in place.
- Emerson drive is the only path on and off the site, and it is a narrow road that will not allow two way traffic. Most of the delivery trucks must turn around, back in, and drop off materials. This will impede progress and does not allow a logical flow of work. Legally subcontractors could claim that this causes delays in work, leaving the contractor liable for claims.
- Subcontractor parking is close to a half mile away, and with no room for trailers, all tools must be transported to site every day.
- Elevator A will serve as the only material hoist way forcing contractors to coordinate material movement among each other.
- There is only one large dumpster for debris removal.

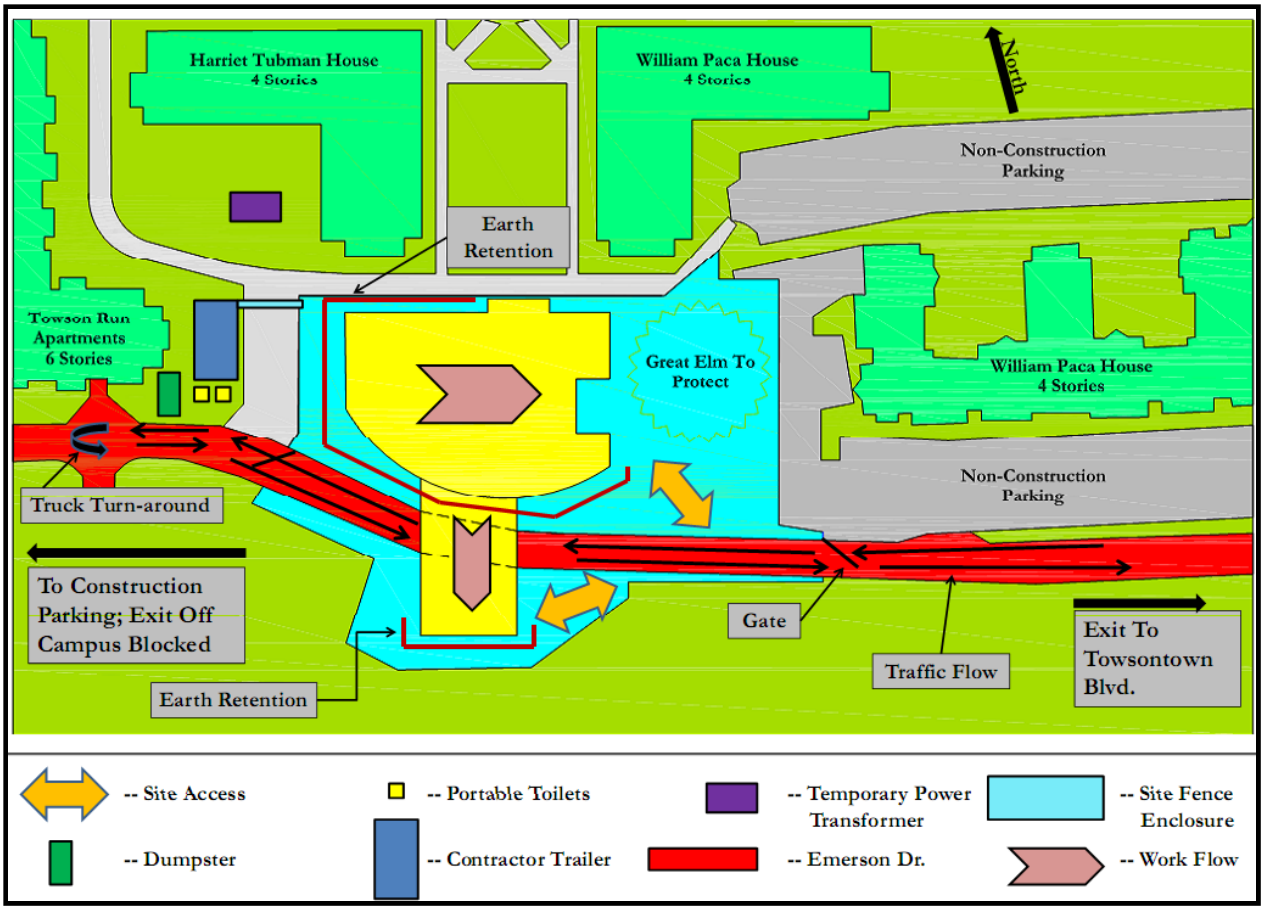

Figure 2: Site Plan depicting tight construction constraints

The site logistics will prove to be an issue throughout the duration of the project. Figure 2 above shows the difficult site constraints the team is experiencing. Construction of the tower crane proved difficult; with the site completely occupied by the lay down of the separate pieces, no other construction could occur that day. Subcontractors will need to vehemently coordinate major deliveries with the site superintendent and the construction schedule. The subcontractors will have to submit weekly reports on deliveries and lay down needs to the superintendent so as not to create a site that impedes the flow of construction. To help with material movement, parts of the façade can be left off, and material can be lifted into the building utilizing boom lifts and cranes. The contractor also decided to use a trash removal company that would separate recyclable debris and weigh it for LEED purposes.

-Schedule Acceleration Scenarios-

Critical Path Items (in order)

- Review and Accept Exterior Studs Submittals
- Level 3 to 4, Concrete Structure (includes removing shoring)
- Fabricate and Deliver Exterior Studs
- Level 1 and 2 Exterior Studs and Sheathing (north, west, east, and south)
- Level 3 to Roof Exterior Studs and Sheathing (north and west)
- Level 1 and 2 Brick Veneer, east side, Column Lines 1.5- 5 and 9-10
- The East Curtain Wall, Frame and Glaze
- All Basement MEP Room
    - CMU Walls
    - Overhead Ductwork
    - Overhead Hot Water Piping
    - Electrical Conduit Rough-in and connections
    - Boiler connections
    - Chiller Controls
- Level 1 Interior Masonry Walls
- Level 1 Drywall, Column Lines A-G
- Level 1 Lighting, Column Lines A-G
- Level 1 Flooring, Column Lines A-G
- Level 1 Work to Complete List
- Level 2 Masonry Walls
- Level 2 Overhead Duct Risers
- Kitchen Health Inspection
- Final Vendor Installation
- Owner Furniture
- Final Acceptance and Flush out

Risks To Project Completion

It is quite normal to have enclosures on the critical path of the schedule and West Village Commons is no different. It is vital that the work is not only completed efficiently, but all procurement, fabrication, and deliveries are on time. There is very little room for the work to be installed, and delivery of material will have to be made when it is being put in place. This could cause delays in the actual installation of the material. It is also important that the curtainwall subcontractor

and the exterior sheathing contractor pay great attention to detail when creating their shopdrawings; an extended review period could delay the start of fabrication.

The basement MEP room is one of the most complicated coordination areas of the entire building. There is a lot of ductwork, piping, and mechanical equipment that needs to be placed in a small area. There are 2 boilers, 1 chiller, 6 pumps, and an air-handler in addition to massive ductwork and mechanical piping that all needs to fit together. Not only is this on the critical path, but a delay in the basement MEP room could force other mechanical activities down the line onto the critical path (including commissioning).

Concrete currently is having an effect on the project schedule due to the rain delays. As stated before, the rain delays are hindering concrete pour sequences. The 3rd and 4th levels lie on the critical path, and because very few trades are working during that phase of construction it has a huge effect on the project duration. Any delay could also force other activities onto the critical path.

Level 1 interior work, whether the activity is on the critical path or not, is all connected. Delays in the activities on the critical path will have an effect on the surrounding areas. Increasing work load or adding extra labors to speed this area up could cause work obstruction issues. This area should be a major focus for construction in terms of coordination, but the only remediation to delays could be overtime work. Because there are a lot of trades working at once, it will call for multiple trades working overtime causing a major increase in labor costs. Kitchen Vendor Coordination will also be risky as they are not under contract with Barton Malow. If kitchen equipment connections change at the time they are bought from when they were originally designed, delays/change orders for rework for electrical connections will occur. This has occurred on other Barton Malow jobs and could occur on this one as well.

Schedule Acceleration and Costs/Techniques

The most current critical path schedule made some changes from the original. First of all it should be noted that the original critical path schedule had several more procurement activities on it. The project team seems to be stretched pretty thin lately, as Barton Malow is currently undergoing a change in document software. This is taking some of their project members off the project several days a week. The new critical path schedule has far less procurement activities on it, and this may be one of the reasons. Should the project fall behind in some aspects there are several areas that could be potential for acceleration.

- The concrete structural work on the 3rd and 4th levels could move to a six day a week schedule or work 10 hour days. This would be a plausible idea, even if it were to build in some time later in the schedule. There would only be one trade contractor working overtime, as opposed to a schedule acceleration later in the project that could require multiple trades working overtime. The costs would obviously be paying time-and-a-half labor rates and any overhead for the General Contractor's extra time.

- The curtainwall currently has a prefabricated frame and separate glazing. Time could be saved if the frame and glazing was a packaged unit for installation. Larger panels of curtainwall could be prefabricated to decrease the time spent picking sections up. There will be an added factory cost for the extended manufacturing process, and there could be a larger time frame to build the panels. Because Baltimore uses unionized labor, a faculty member at Penn State thought that a complete frame and glazing system could cause labor disputes.

- The exterior studs and sheathing is a major portion of the critical path. Prefabricating panels of studs and sheathing may help decrease the time spent on construction. There will be added fabrication times and an increase in delivery costs, but the time saved could decrease the project duration or help catch the project up from delays. There will also need to be additional design details. Because of the impact this may have on the engineering, this idea may only be appropriate if it is made earlier in the preconstruction phase, and not as a recovery method.

- The flooring trades, ceiling grid, and other finish trades could be accelerated if they performed some of their work during off hours, such as night hours, as opposed to normal business hours. There would be absolutely no one in their way, as all of the other trades would work during normal business hours. They could also work in areas that would not be accessible during the day due to other trade work. There may be a differing labor rate for work during non-business hours, but it could keep some of the finishing activities from being delayed by previous issues.

- It is important to note the level of focus that floor 1 interior work will need. Other than working overtime, there is little cost effective means for recovering time in that area. Schedule recovery would have to be found elsewhere in the project, as placing too many men on that floor could impede traffic and hurt work progression. Coordination among the trades and the superintendent will have to be meticulously planned out.

-Value Engineering Topics-

Because West Village Commons is in its earlier stages, many of the value engineering topics under discussion were not available for this assignment. Some of the initial ideas that were taken into consideration as well as some ideas that I have seen used on similar projects are described below. Please note that I have not been able to contact the architect or design engineers for their input on value engineering. Also note that the value engineering topics are either labeled "enhance" or "detract" with regards to the overall value of the project.

- **Concrete and Structural Steel System (Enhance)** – The original design of the structural system was to be all structural steel. The majority of projects in the Baltimore area are steel so it was natural for this project to follow suit. When Barton Malow was brought on in the preconstruction phase, they suggested using concrete for the North end as stated before. Towson University had plans to open this commons in time for the 2011 school year to help serve those students moving into the West Village area of campus. If structural steel were to be used, the project would have to be 100% designed to be bid out to the subs (according to the Barton Malow project team). A cast-in-place concrete structure allowed for a larger plenum height giving ample room for mechanical coordination. With more room to work with, the contractor was able to begin excavation, under-slab MEP, foundations, and structural concrete before final design was complete (breaking the project into two bid packages). This also allowed for larger ceiling heights in some locations where overhead MEP was less dense. The schedule was then made to be able to accommodate the strict completion date. This had several impacts elsewhere:
    - MEP Rough-in and embed coordination (stated earlier)
    - Possible delays due to weather
    - Longer structural duration (though this was more than made up by beginning earlier)
    - Multiple subs performing similar trades; could affect systems integration
    - Additional design time to change structural system
    - Additional details where concrete meets structural steel
    - Less need for steel shakeout areas

  This proved to be an extremely well-suited solution to the completion goal though it may have increased coordination efforts and cost.

- **Lighting Fixtures (Detract)** – Currently Towson University is considering a change lighting fixtures throughout the building. There are some architectural lighting features throughout the building that had an added cost. The ornamental stair case was to be a marquee feature of the project with special lighting to highlight it. Currently the owner believes that the cost outweighs the benefits and they may be cut out. Unfortunately this will deplete the project of some visual value.

- **3rd and 4th Floor Lighting Control (Enhance)** – The 3rd and 4th floor on the south end "bridge" section of the building will serve as large multipurpose rooms that can be divided by movable partitions. The owner wanted a way to control the lighting (as well as audio/visual displays) depending on the orientation of the room. Advance lighting controls automatically calibrated with the movable partitions as well as natural light sensors were added to give total control of the room. They are also hooked up to the visual displays and projectors to determine light levels during presentations and videos.

- **Floor Material (Detract)** – The current floor finish schedule has tile, carpet, and stone as materials to be used in different areas. The cost of the stone and some of the carpet may need to be decreased by either selecting a different type of flooring or using less quantity of some types. The stone flooring is especially expensive and may just change to tile. Again this will lower the architectural value of the project but will help keep costs down.

- **Hot and Cold Water Piping (Enhance)** – Because the building will be mixed-use and possibly changed throughout the lifecycle of the facility, protection of mechanical piping from damage became a facilities management goal. The project could have saved money by using PVC pipe distribution of water, but decided to use a copper system instead to protect from unintentional damage from cosmetic renovations…i.e. driving nails through walls or removal of wall panels. The durability of copper piping is better than PVC.

- **Kitchen Equipment (Neither)** – As the design of the building nears completion and the owner fine tunes the needs of the facility, changes in model type and quantity of the kitchen equipment is changing as well. Analysis into what type of food as well as amount of food will be available for students is currently under review by Towson and its kitchen designer Ricca Newmark Design. This could either add cost or subtract cost depending on the course of action decided on. Cost analysis will also have a huge role into what type and size of equipment is selected. The outside food vendors are already contracted to move in so their equipment is set in stone. Selecting equipment that can be upgraded easily or swapped out in the future is also a concern, but can add value to the future of the building. This luxury can add adaptability and flexibility down the road for the commons building.

- **Sustainability (Detract and Enhance)** – There are two LEED points that were not considered cost effective for this project. The first is "Sustainable Sites 6.1 – Stormwater Design Quantity Control. The project decided not to pursue a rain collection system for the reason of cost. This system could have controlled the amount of run off this building produced by capturing and harnessing rainwater for grey water uses. One reason for not using a collection system was because the project already gained points for water reduction through low-flow plumbing fixtures. The other LEED points that may have contributed to

not only the sustainable aspect of the project but also its building use cost would have been to increase the energy performance. The project is pursuing 4 points in "Energy and Atmosphere 1 – Optimize energy Performance" when there are a possible 10 points. When talking with Howard Hughes from Facilities Management, the boiler and chiller could have been selected on a more sustainable criteria, but they worried about durability.

West Village Commons did though pursue many of the material and resource points as well as thermal comfort points. A goal for the project was to make the West Village Commons a welcoming facility for all students, and comfort was an attribute of high importance.

- **Air Handling Units (Enhance)** – Towson University's older buildings on campus have had problems with mechanical system failures due to their age. They also have a large amount of back maintenance issues yet to be resolved. This forced two decisions on the design intent. The first was to have a viable model that could be used to keep up-to-date records of all the mechanical systems with operation and maintenance records built in. At the end of the project Barton Malow will be able to integrate O&M manuals to the model so that facilities management will be able to use the model for upkeep of the project.
  The other interesting feature was brought on due to mechanical failure issues of other buildings. On extremely cold or warm days, a mechanical failure would cause a building to be shut down for days or even weeks while the situation was resolved. West Village Commons though has seven different AHU's. This not only accommodates the drastically different zones (kitchen areas versus study areas) but also gives back up if there is a failure. The other AHU's could pump more air to make up the loss of one system failing, preventing a total shut down of the building. This has some implications though:
  - Increased cost in mechanical systems
  - Decreased cost in efficiency of the system
  - Increase in the volume of distribution ductwork and piping

-Problem Identification-

West Village Commons is still in the early stages of construction and many problems have not come to light as of yet. Many of the issues are speculative at this time. Regardless, below are some of the issues that may become a concern during the project.

- **Communication Issues** – One of the biggest concerns of the project team regards communication with the design team. There has been a less than healthy streamline of communication between the architect and the contractors. Barton Malow is only allowed to open lines of communication with the architect; not with the design engineers. This inevitably delays responses to field issues and RFI's.

- **Structural System** – The structural concrete option allowed the contractors to begin construction earlier. Currently rain delays are causing problems with scheduled pours. There is also the need to intensely coordinate differing trades for embeds and MEP sleeves.

- **Owner Vendor Coordination** – Kitchen equipment will be purchased later in the schedule, but the initial connections are planned during the engineering design phases. Making sure that the drawings are changed and coordinated with up-to-date kitchen equipment will prove to be a challenge. Because the vendors are not contracted with Barton Malow, they have more pull in dictating when they are on site and how long their durations will last.

- **Mechanical Systems** – The project has a total of seven different air handlers, creating a complex distribution system. The east side of Towson's campus has thermal plant responsible for heating and cooling the campus, but the distribution would be over a mile long if it were to continue to West Village Commons. These seven air handlers take up space scattered throughout the building, but it is believed that it was a better solution than two or three larger units. This allows greater control and greater back up if there were to be a failure. The down side though is that the initial cost will be greater and the commissioning/balancing will be more complex. Also Howard Hughes of facilities management believes that the boiler used in the West Village Commons is not as efficient as other models, but may prove to be more durable.

- **Lack of West Campus Utility Plant** – As stated before there is no west campus thermal plant as there is on the east side of campus. It is important to note that the residential halls would be completed through a public-private relationship with developers. This was decided for several reasons, according to Dennis Bohlayer of Towson's facilities management:

- The combination of the residential units and private development meant little need for a central plant providing thermal (steam hot water, chilled water) utilities. The project economies pretty much force developers to use electric through-the-wall units (PTACs—packaged terminal air conditioners) as the least first cost alternative. Heating and cooling of the common spaces could economically be handled by building equipment.
- After PTACs, there really wasn't enough thermal load from the buildings to justify the expense of building another central plant and the distribution system to each building.
- There really wasn't much real estate left for a central plant footprint.
- The University couldn't really justify building a central plant on its own for the future build out of West Village….which could stretch out over 20 years.

A central plant though could bring many benefits to West Village such as:

- More efficient production of thermal conditions occur in mass production equipment – larger units require less horse power
- Less mechanical equipment needs in buildings and fewer larger pieces of equipment
- Ability to connect future buildings to the distribution system
- Reliability against mechanical failures and the shutting down of buildings due to redundant capacity – Less back up units needed
- Long-term cost benefits and long-term functionality of equipment
- Less mechanical distribution in tight ceilings (but more buried throughout the campus) – could reclaim valuable building space
- Quieter
- Availability of cogeneration and renewable energy
- Production of thermal conditions could be sold to tenets of the surrounding privately owned apartments

- **Electrical Connections** – During the infrastructure planning, there was a "hurry up" decision made to allow Baltimore Gas and Electric (BGE) to run electrical connections for the West Village area. The project was already running behind schedule, and a quick decision needed to be made. The simplest decision was to turn the work over to BGE as opposed to run connections from the campus core. The result was higher electrical rates.

- **Sustainability Responsibilities of Contractor** – This project will be the first LEED project for Barton Malow out of their Baltimore office. There are strict requirements for LEED whose responsibility lies with the contractor, such as "Construction Waste Management," "Recycled Content," "Regional Materials," and "Certified Wood."

- **Sanitation Line** – Howard Hughes of facilities management believes that the location of where the sanitation line exits the building could be a problem if a break in the pipe or a clog occurs. Currently the line runs below the main entrance to building which could cause a shutdown of the whole facility if something were to happen.

- **Tight Construction Site** – As reiterated throughout the project, the site constraints and site access will prove to be an issue through all phases of construction.

-Technical Analysis Methods-

One of the biggest root issues for any project can usually be traced back to the project delivery method. That does not mean that every problem on site is because of project packages, but some methods are better than others. My over arching theme for my research in the spring – the idea that ties my research together – revolves around the idea of an Integrated Project Delivery (IPD). I would like to see how a single contract tying all prime team members together, at design inception, could have had an effect on West Village Commons (and possibly the entire West Campus area). I would like to use the major themes of IPD to show how my breadths may have been made possible, and show the possible impacts those changes could have. The following are strong topics that could be related to IPD.

- **Integrated Project Delivery Impacts**
  - The project obviously has relational issues between the contractor, engineers, and architect. I would like to explore the components of an IPD project and if West Village Commons is a good candidate. Some issues worth researching are contract types (AIA versus ConsensusDoc), insurance possibilities, bonding capabilities, communication streaming, design responsibilities, BIM aspects, project goals as a means of profit, dispute resolution, and where IPD fits in today's economy.
  - IPD would allow the contractor to bring subcontractors in at an earlier period. I would like to analyze costs and benefits of bringing a contractor and subcontractors on during the design phase, and possible schedule accelerations of the critical path.
  - My IPD analysis will feed into my other breadths and show how the delivery method could have impacted decisions made during design and construction.
  - This will require research from industry leaders on the cutting edge of IPD, including Victor Sanvido of Southland Industries (who I have had previous conversations). Exploring reports on IPD as well as the few true IPD projects completed will help give me an idea of all the components and themes behind IPD.

- **Structural System Analysis**
  - When Barton Malow came on during the design phase as a construction manager, they offered the idea of using cast-in-place concrete. This decision had an impact on the rest of the project but allowed construction to occur earlier. With IPD, a steel subcontractor could have been brought in during the design phase, eliminating a lot of the procurement phase. Basically the design would include all connections and details while the structural engineer designed the system.

- I would analyze whether the decision to use a concrete structure, which takes more time to construct, would still be a logical choice. Or would the time saved in steel erection of an all steel structure allow money to be saved. Bringing in a steel subcontractor in during design may have allowed construction to begin earlier as well.
- I would also like to analyze a complete concrete structure and how IPD may have an impact on the construction speed and costs.
- For this analysis, I will design a few typical bays for an all concrete structure (where steel is currently utilized) and a few typical bays for an all steel structure (where concrete is currently utilized). I will extrapolate these bays throughout the building. I will evaluate the cost differences as well as the schedule difference.
- Using three 4D models, I would like to demonstrate visually the differing speeds at which the three options may provide. If possible, I would like to add a 5th dimension to the model by adding costs.
- Research will include third year structural classes, my third and fourth year construction management classes (specifically 4D modeling and schedule creations), and consultations with current industry members for concrete durations and steel placement.
- The main focus for this analysis is to too tie in the costs of deciding what system to use with the timing of bringing in contractors. IPD allows for more team members to have an opinion in the matter. It will be interesting to see if there is a difference in project schedule and costs.

- **Sustainability Analysis**
  - Sustainability is a major goal for Towson University, which is highlighted throughout West Village Commons, but many of the cost benefits were missed with this project. The major cost benefits with a sustainable project can be achieved through optimizing energy performance.
  - I would like to research the sustainable impacts on energy saving techniques that a constructor may have had during the earliest design phases of the project. This includes materials chosen, the type of mechanical systems utilized, the distribution means, kitchen equipment selection, the control systems chosen, and additional systems that could be added to harness energy savings.
  - The analysis will include initial costs versus energy savings costs and the time it would take to pay initial costs.
  - Again the main focus will be how IPD would allow construction experiences and knowledge to drive decisions during design.
  - Research for this analysis will include second and third year mechanical classes, reports released by the Environmental Protection Agency, United States Green Building Council, and prominent university research (such as Penn State and

Colorado State), and industry leaders in green technology.

- **Cost Benefits of a West Campus Utility Plant**
  - Towson University debated the advantages and disadvantages of a utility plant to serve the expansion onto West Village. While there are reasons not to use a central plant, there are many reasons to have.
  - The analysis will include the initial costs of designing and constructing a utility plant, campus location of the plant, building loads of current and future buildings in West Village, research into sustainable and efficient energy sources (including cogeneration equipment and geothermal energy sources), construction costs of a west campus distribution system, and lifecycle of not only the plant itself but maintenance of the distribution system. I will also consider the revenue generated from energy costs sold to tenants in surrounding apartments.
  - Plans to create a central commons building occurred when there was very little expansion onto west campus. The over arching theme would be to see how using project goals and constructors knowledge may have driven the idea of utilizing a central plant. Could IPD (whether for West Village Commons or for the entire area) have an impact on early decisions made?
  - Research for this analysis will include second and third year mechanical classes, similar university central plants (such as University of Maryland Baltimore County or the United States Naval Academy), Towson University facilities management, and the Barton Malow project team for Morgan State University (which is currently contracted to build a central plant for their campus expansion).