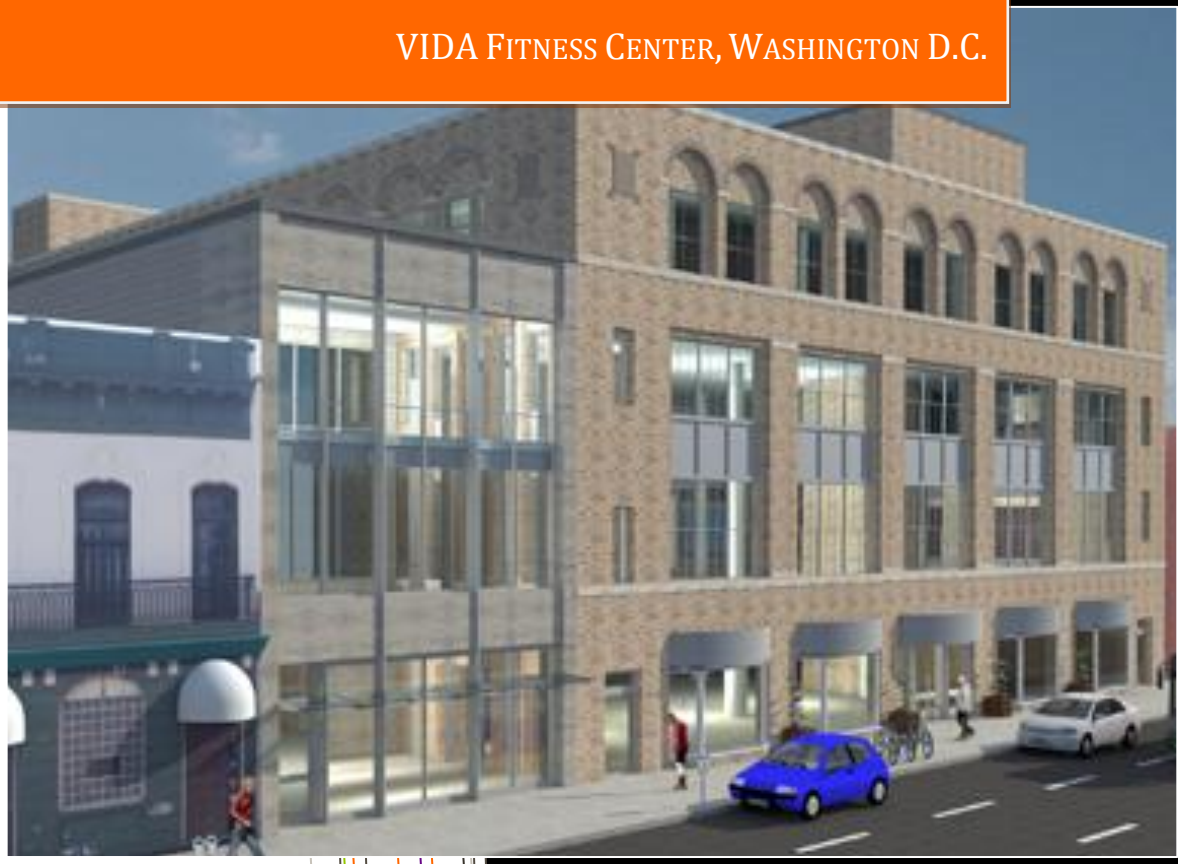
2011

TECHNICAL ASSIGNMENT THREE

VIDA FITNESS CENTER, WASHINGTON D.C.



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Construction Option
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VIDA™ FITNESS

EXECUTIVE SUMMARY:

The following technical assignment is a comprehensive report analyzing key facets of the VIDA Fitness project that affect the project execution. Owner David von Storch is launching his new flagship building at 1612 U Street which will include the largest of his VIDA Fitness Centers, along with a new high end restaurant, Aura Spa, Bang Salon, and office space for his company, Urban Adventures. The 60,370 square foot project includes a 10,920 square foot, three-story addition and the renovation of an existing 49,450 square foot building.

Located in the center of D.C., the restraints of a restricted site and tight schedule coupled with unforeseen hurdles that come with renovating a 100+ year old building created a unique and challenging project for Forrester Construction. In addition, the expansion began construction while the building was still occupied, as the existing Results Gym remained open and still had an active lease. When the gym closed and construction consumed the entire facility, parts of the building began to open in phases. Bang Salon was first to open, followed by two separate phases of the VIDA Fitness Center, with plans for the restaurant and spa to open in May 2012.

The main purpose of this technical assignment focuses on identifying potential research topics to later be evaluated and presented in the thesis proposal. The Project Manager on the VIDA Project, Seth Glinski, aided in much of the analyses and discussions presented in this technical report. Included in these discussions were the top three constructability challenges that surfaced on the project. These challenges were installing the monumental stairwell, operating under the constraints of a congested site associated with a zero lot line project, and making the building enclosure water-tight. Each challenge has been thoroughly discussed, along with the measures taken to solve each issue. Also detailed in this report are schedule acceleration scenarios implemented on the VIDA Project that cut the overall project schedule in half. Several proposed value engineering topics are outlined along with why each was or was not considered for the project. A summary of the 2011 PACE Roundtable breakout sessions focused on critical industry issues follows these thoughts and introduces new potential research ideas for the future thesis proposal.

A section devoted to outlining the major problematic facets on the VIDA Project concludes this report; four possible technical analysis research options provide potential solutions to many of the issues discussed. These four technical analyses include integration of sustainability to decrease utility consumption, worker morale and the effects it has on task productivity, quality improvement and cost reduction through material handling, and chilled beam integration with the mechanical system. If approved, these four analyses will become breadths for generating a project proposal for this project.

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CONSTRUCTABILITY CHALLENGES:

Monumental Stairwell

The monumental stairwell in the center of the gym is a signature statement of all VIDA Fitness Centers: an exposed steel stairwell that disconnects at every floor and raises five floors to the roof penthouse. The uniqueness associated with a custom designed stairwell with no standard sections created several challenges regarding its constructability.

Existing stairwells accessing Floors 1-4 were located at the NW and SE corners of the building and one accessing only Floor 2 was located in the first floor lobby. Because of this, a hole had to be saw-cut into the elevated slab on each floor to allow for the construction of the new monumental steel stairwell. Due to the unique stairwell that differed in both shape and access points at each floor, the shapes of the slab cuts varied per floor. Figures 1-4 below demonstrate the varied slab cuts made for the installation of the monumental stairwell. Originally estimated to take approximately two days per floor, this process stretched to over four weeks (averaging five days per floor), delaying an already extremely tight schedule.

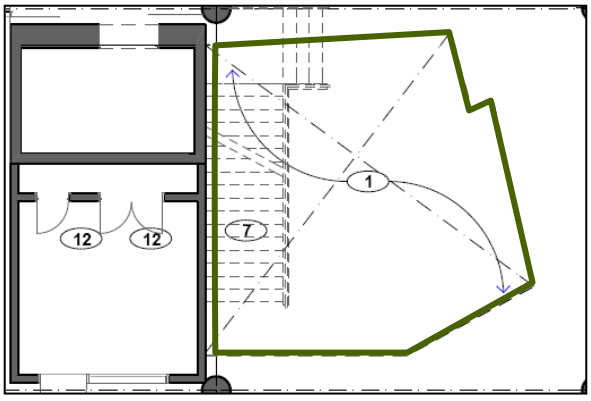

Figure 1: Second Floor Slab Demolition Plan, Courtesy of Core Architects

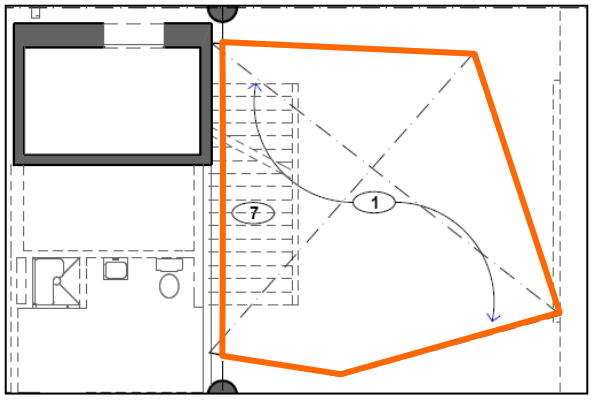

Figure 2: Third Floor Slab Demolition Plan, Courtesy of Core Architects

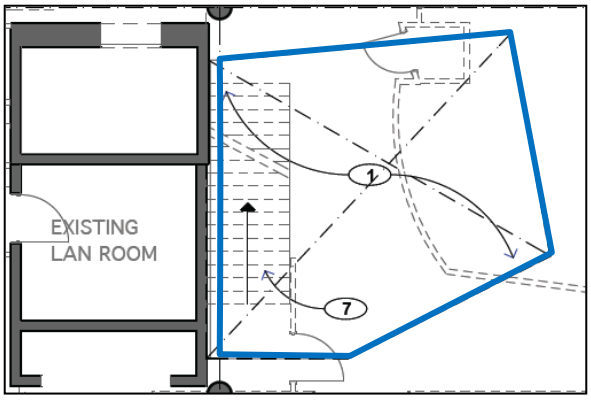

Figure 3: Fourth Floor Slab Demolition Plan, Courtesy of Core Architects

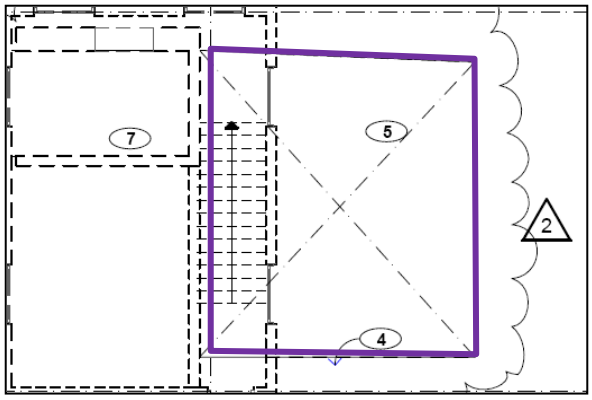

Figure 4: Roof Slab Demolition Plan, Courtesy of Core Architects

The process of cutting and removing the slabs had to be thoroughly sequenced before commencement, as saw-cutting a floor slab can be dangerous for numerous reasons. Though the size of the opening varied per floor, each was approximately 450-500 SF in size. After shoring was placed and new steel was installed around the opening on the fourth floor, the opening in the roof slab began to be cut in sections and lowered to the ground with a crane. This process continued down through the second floor, creating a five-floor opening exposed to the outside via the roof.

Due to early delays in the slab-cutting, the project team met with the steel fabricator and the Owner to discuss ways of shortening the monumental stairwell schedule. One of the solutions reached was to leave the opening in the roof slab uncovered to prevent tedious time spent on removing, placing, or securing a cover. Because this part of the project took place during May and June, there was little weather to worry about. The Owner also agreed to this because all of the exposed floors had been gutted, and only the concrete structure was left unprotected.

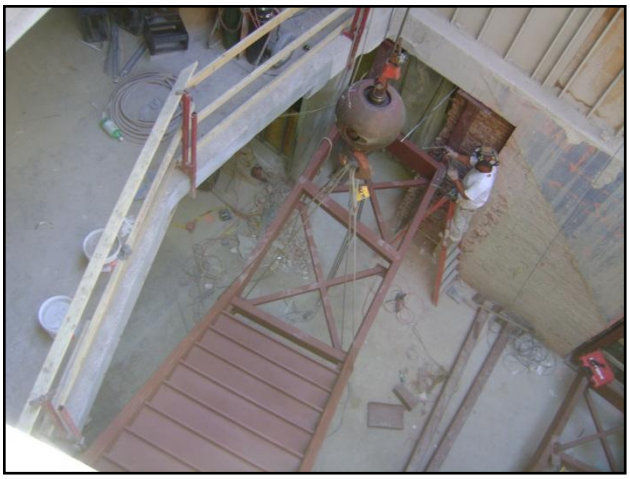

Figure 1: Stair Section Suspended by Crane through Slab Cut; Picture Taken by Clara Watson

The second idea for increasing the speed of the project was to prefabricate the stairwell in sections to save time and allow for ease of construction. The number of prefabricated sections varied according to floor, due to the unique nature of the stairwell and the fact that it disconnected at every level. There were up to four sections on each floor, which were each lowered through the hole in the roof slab, suspended, and tack-welded into place (shown in Figure 5). This process began on the first floor and moved upwards through the building. Prefabricating the sections allowed for quicker installation and erection of the stairwell on each floor level.

Though these ideas did increase the overall productivity on the monumental stairwell, the steel subcontractor fell behind schedule due to a lack of manpower, delayed steel deliveries, and an underestimate of the duration for each stage of the installation. The steel stairs were originally scheduled to take five days per floor, which included the railing installation and the landing installation, both of which were not a part of the prefabricated sections. They ended up taking almost triple this amount of time, and were not installed in the original sequence intended. When late pieces of the railing did arrive, they were erected quickly and carelessly, causing several pieces to fail Quality Control Checks (QCC) and necessitating replacement. This, in turn, delayed the stairwell's schedule even more, because each piece was custom made in the steel fabricator's shop.

Because the project management team was not receiving straight answers from the steel subcontractor regarding the monumental stairwell's schedule, meetings were held to discuss how best to address the situation. As a result of the meetings, the project management team met with the vice president of the steel subcontractor weekly and the stairwell's schedule was reviewed with the steel subcontractor's foreman daily to ensure the adjusted schedule was met.

The project management team also met with the Owner to decrease the delay in the stairwell's schedule and to discuss the finishes applied to the stairwell. Originally, all finishes were designed to differ per floor, but due to long lead times and a tight schedule, the Owner agreed to allow the treads of each stair to be finished with tile and the railings to be finished with a silver paint. A view showing all floors of the completed stairwell can be seen in Figure 6.

Figure 2: Monumental Stairwell; Photo Taken by Clara Watson

Overall, the monumental stairwell posed several challenges throughout its construction, all of which had negative effects on the stairwell's schedule. For each arising problem, the project management team met with appropriate parties to determine the best course of action and best solution.

Zero Lot Line Project

Because three sides of the structure's boundary walls were located on the property line, this project was considered to have a zero lot line. The South boundary was the only side not located directly on the property line, and this was offset only 10 feet from the property line. As this project was located in downtown D.C., space was limited and it was logical to build on the property line to create more functional space for the original building tenant. This mindset is practical for the operations stage of a project but makes site logistics, parking, deliveries, storage, and material handling extremely difficult to manage on site. The lack of available site space and the fact that the Owner needed a sales trailer also meant that the project team was unable to procure an office trailer and instead was forced to move their office several times throughout the project, depending on available areas inside of the building.

A public space permit was acquired for the front of this project because of the small Owner's trailer and dumpster that were kept in the front of the building for part of the construction process. Only six parking meters existed in front of the building, and during construction hours of 7AM-7PM, Forrester Construction had permits for this parking lane and the first lane of traffic in front of the site. These spots were reserved for deliveries, lifts, cranes, and Superintendent, Project Manager, and Assistant Project Manager parking. This congested parking and delivery area can be

Figure 3: Congested Site Parking; Picture Taken by Clara Watson

seen in Figure 7. All other construction workers were required to find parking either on neighboring streets or in the parking garage up the street.

Due to the residential area behind the building, another permit allowed for construction in the alley behind the building between the hours of 7AM-7PM, as long as the alley was not permanently blocked. Any construction vehicles that needed to be in the alley had to be manned at all times, and all dumpsters had to be live-load only. This ensured that the alley could be cleared quickly for any residential neighbors needing to access the area. Temporary road blocks were also placed at the three alley entrances and two laborers were stationed full-time to monitor the alley and ensure only permitted vehicles (and local residential traffic) accessed the area. A picture of a chiller lift depicted in Figure 8 was taken out of a fourth floor window and shows the extreme congestion and close proximity to neighboring residential buildings in the rear alley.

Figure 4: Chiller Lift in Rear VIDA Alley, Picture Taken by Clara Watson

Figure 5: Tower Crane Located in Center of New Addition, Picture Courtesy of Luis Ortiz

Another innovation to combat the challenges associated with a zero lot line was to locate the tower crane used in the beginning of the project directly in the new addition's construction area. The addition was constructed around the tower crane, which allowed the crane to remain on-site overnight, rather than parking another type of crane in the front of the building between the hours of 7AM-7PM. The tower crane and its location within the new addition are shown in Figure 9.

Detailed site logistics plans encompassing parking, deliveries, storage, and material handling presented an additional solution to the tight site conditions. Due to the short project schedule and large number of workers and trades on-site, both active work zones and material storage areas changed daily. This made it even more critical for the Superintendent to ensure work and storage areas were thoroughly considered and that one did not impede the other.

Considering the challenges posed with a tight site and expedited schedule, this site layout functioned well at this stage of the project. Pedestrian traffic was not hindered and the flow of construction vehicles was as logical as it could be given the space. The project management team

worked with the neighbors to ensure that local residents and business owners were not impeded by the construction and did their best to critically plan any task that could affect the site logistics.

A Water-Tight Enclosure

Figure 6: New Roof Constructed Over Existing Roof, Picture Taken by Clara Watson

It is difficult on any project to ensure water-tightness, but was especially challenging on this project due to the unique nature of the existing building's roof. A swimming pool, accessed through the fifth floor penthouse, was installed on this main roof. This level also contains a bar, fire pits, and cabanas for guests. To ensure the addition of the pool did not infringe too heavily on the floor-to-floor height below it, a new roof was constructed approximately three feet above the existing roof (shown in Figure 10). This increased the ceiling height on the fourth floor below it enough to place the building's main mechanical room in the area under the pool.

The new accessible roof was finished with pavers and turf grass elevated on pedestals above the rubberized asphalt roof membrane (shown in Figure 11 below).

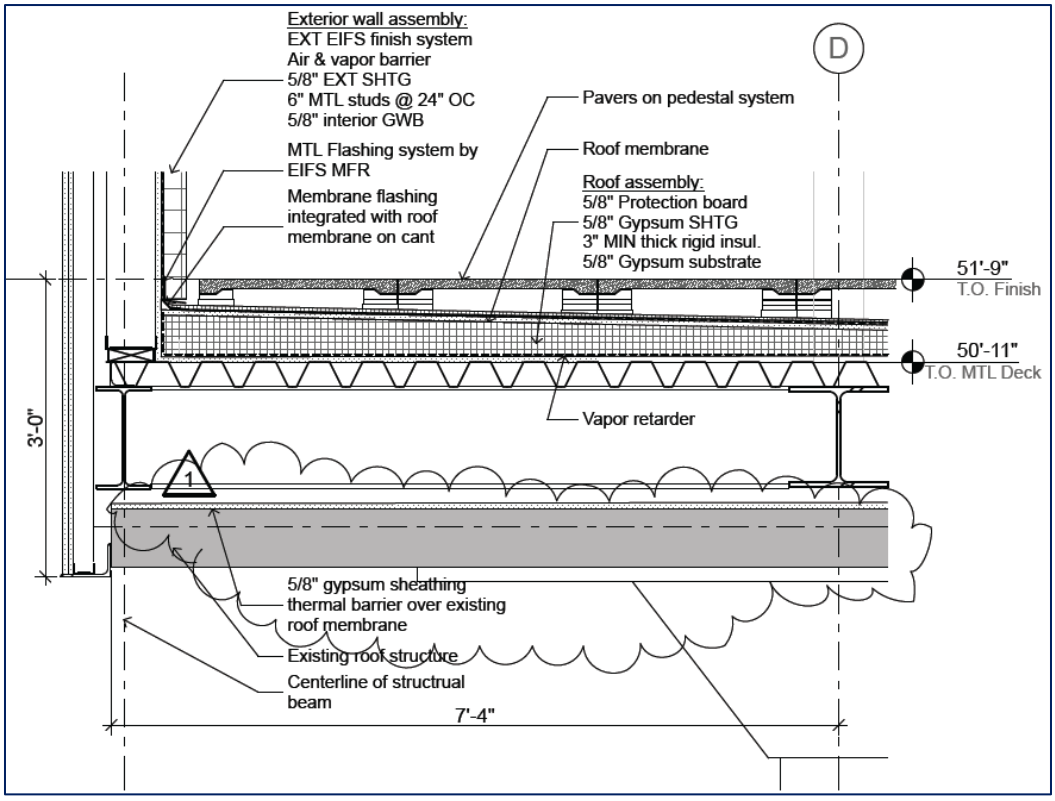

Figure 7: New Roof Detail, Courtesy of SvS Architects

Because the project was turned over to the Owner in phases, finishes on the inside of the building were taking place while the roof was still under construction. Though the monumental stairwell opening in the roof slab was protected by the penthouse, at this stage of the project the windows had not been installed and water leaked through their openings despite measures taken to temporarily seal them from the elements. Water also pooled on the original existing roof before construction on the new roof had been completed (shown in Figure 12). The existing roof was not level or water-tight and allowed for a great deal of water to enter the building in various locations, a fact that was of great concern due to ongoing finish installation inside of the building.

Figure 8: Pooled Water on Existing Roof; Picture Taken by Clara Watson

When the new roof was nearing completion, numerous penetrations were made where core drilling was required to allow for piping or conduit to the roof bar or restroom. These core drilling locations were difficult to seal, because if one leaked, water penetrated through the new roof onto the old, uneven one. It would then flow to a low spot on the old roof and find its way into the building. This movement of water along the old roof made it difficult to pinpoint where water was entering the roof from the outside and prolonged the process of ensuring a water-tight shell. To make matters worse, the scuppers were originally cut too high in the parapet wall and did not properly allow water to exit the roof; this caused pools of water that would increase in size until finding an opening into the building.

Several actions were taken to prevent water infiltration and address the water if it did enter the building. Any water infiltration from rainy weather leaked directly onto the extremely expensive athletic rubber flooring, bamboo flooring, or onto the even more expensive gym equipment. To prevent this from happening and to immediately address the situation if it did, laborers were assigned on rainy days to walk around looking for any leaks to address directly. One particularly bad storm that occurred before the new roof was completed resulted in a significant amount of pooled water on the existing roof. Pumps were immediately set up to remove the water from the existing roof, though much of it had already penetrated the old structure and leaked onto the floors below. Though the athletic rubber flooring had been protected with construction paper, the paper did nothing to prevent the flooring from

Figure 9: Roof Leak After a Severe Rain Storm; Picture Taken by Clara Watson

getting wet. The largest leak is shown in Figure 13 and portrays soaked construction paper and a full 32-gallon trash can catching the leak. Every roof penetration was sealed twice, and all penetrations were checked on rainy days to confirm water-tightness. These measures taken eventually led to an entirely waterproof enclosure.

SCHEDULE ACCELERATION SCENARIOS:

Project Critical Path

A Critical Path Method (CPM) schedule details what activities are vital to the successful completion of the project; these activities have zero float time and must be executed on their early start and early finish dates or the entire project schedule will be delayed. The main critical path activities are listed below in Figure 14 and are considered to be the greatest risk activities on the project because of their effect on the overall schedule.

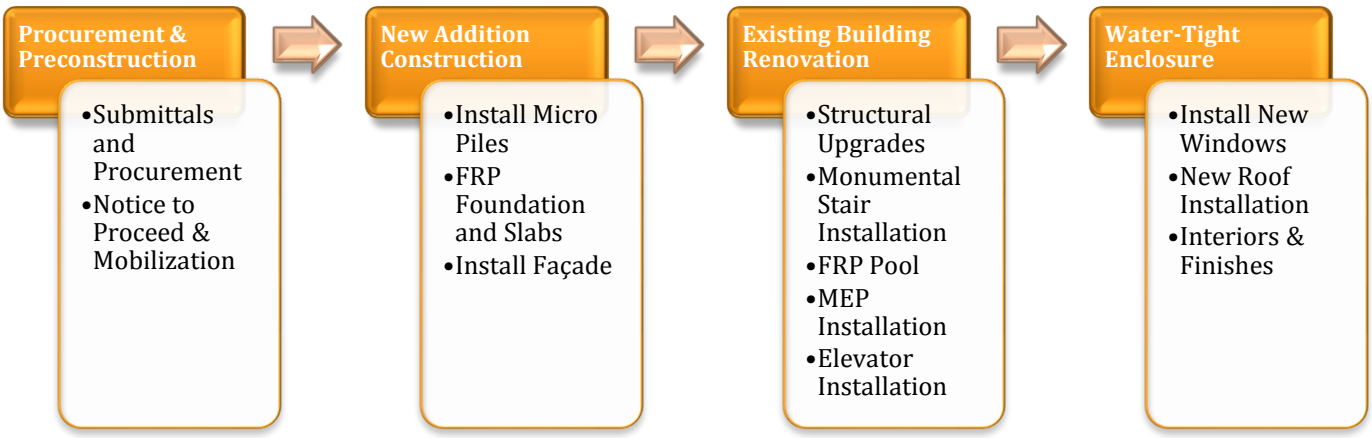

Figure 10: Project Critical Path Activities

Should one of these activities be delayed, it will cause a chain reaction, delaying those succeeding it, until the entire project schedule has been lengthened. To prevent this, each of these activities was closely observed. If one of the activities began to fall behind schedule (such as the monumental stairwell installation), steps were immediately taken to get both the activity and project back on schedule.

High-Risk Activities

Though all of the CPM activities are considered high-risk activities to the project schedule, the greatest risk activity for this particular project was the process of getting the HVAC and mechanical system functional to allow the gym to open in the hot summer months. Long lead times on mechanical equipment only complicated this already difficult process. The installation of the monumental stairwell was also a high-risk activity, as the gym could not open without its completion and it too involved long lead times for the prefabricated steel.

Schedule Acceleration Techniques

Because the Owner of the project wanted the Fitness Center opened during the summer months, the originally established project schedule was cut nearly in half when utilized for the project. To achieve this goal, several acceleration techniques were implemented to decrease long durations and ensure all activities fit into the tight schedule.

In order to expedite the schedule of the new addition, construction began on the addition while the existing building was still occupied, as the existing Results Gym remained open and still had an active lease. This facilitated the construction on the new addition to begin approximately four months ahead of schedule, allowing for most of the new concrete structure to be erected prior to the original construction start date. This schedule acceleration technique had zero cost and no other negative implications associated with it as the land was already owned by David von Storch and there was no existing building.

The project Owner, David von Storch, already owned the existing building and was simply leasing out portions of it; as such, he was able to evacuate the fourth floor before the lease end date because at the time, his own company, Urban Adventures, was the tenant of that floor. This allowed construction on both the roof and the fourth floor to also begin ahead of the scheduled start date. The slab opening for the roof pool was cut and the remaining portions of the fourth floor were demolished in preparation for the renovation. Construction on these two levels was able to start approximately two months sooner than it would have had the Owner not vacated the fourth floor early, though it did cost the Owner approximately $90,000 in rental income from that floor alone.

Another practice used was to switch the work crews over to five day work weeks of 10-hour days (instead of the originally scheduled 8-hour days) and leave Saturdays for any overtime work needed. (Due to the close proximity of a residential area located behind the Fitness Center, construction was permitted from 7AM-7PM Monday through Saturday only.) To prepare for these increased work hours, Forrester bought fifty, 10-hour days from each subcontractor and also scoped a contingency of $150,000 for any overtime work needed on Saturdays. This helped to ensure that the subcontractors kept to the project schedule and that they would work overtime to catch up if they did fall behind. It also prevented any subcontractors from complaining about not being able to afford to pay their workers overtime.

Another method implemented to shorten the project schedule was to expedite deliveries of materials with long lead times. This was used for most of the mechanical equipment installed on the project, along with the nana wall on the new addition that will eventually be the storefront to the future restaurant. The cost of accelerating these deliveries nearly doubled the delivery price in some cases. Though it greatly increased the cost, the Owner was willing to pay for the expedited deliveries in order to stick to the project schedule.

The last main schedule acceleration technique created by the project management team and agreed to by the Owner was to open the completed building in phases. Von Storch typically likes to throw grand opening parties for all of his new business ventures, but was willing to postpone this one until the entire building had been completed. In order to maximize cash inflow, each portion of the building was opened as it was completed. Bang Salon was first to open, followed by two separate phases of the VIDA Fitness Center. The main cardio and equipment portion of the Fitness Center opened first (Floors 1-3), followed later by the completed studios, penthouse, pool, and both accessible roofs (Floor 4 and roofs). The future restaurant and spa are planned to open in May 2012 and will begin construction next year. There were no direct costs associated with opening the building in phases, though the Owner made approximately $100,000 a week after the first phase of

VIDA was opened, money that would not have been made if the opening was postponed until the second phase was complete.

Though many of the aforementioned schedule acceleration scenarios did increase the overall project cost, in the case of this particular construction project, the schedule was more of a critical factor than cost. The Owner believed all of these acceleration techniques to be beneficial in order to stay on track with the strict project schedule and open the Fitness Center in the summer of 2011.

VALUE ENGINEERING TOPICS:

Value engineering is a method often implemented on construction projects by the designers, project management team, or a combination of both. This method focuses on optimizing the final product for the Owner or minimizing cost and is accomplished by altering construction processes, materials, or functions. In the case of the VIDA Fitness project, the project management team met with the designers and Owner to discuss possible facets of the project that could be designed, constructed, or implemented for a better result or a lower price. The Owner evaluated all of the proposed value engineering concepts and chose which ideas to implement based on the effects on the schedule, budget, quality, and project goals.

Implemented Value Engineering Concepts

The spa-like feel of every VIDA Fitness Center is created by interior designers and the Owner by utilizing extremely high-end finishes with many custom features. However, value engineering discussions resulted in changing several of the finishes due to the tight schedule and in the interest of saving money. Triarch coatings were originally specified for the monumental stair, exposed column, and exposed ceiling finishes, but were changed to a silver acrylic paint, saving approximately $67,000 but still retaining the same durability and visual appeal.

Another design change brought about by value engineering was substituting PVC piping for the originally designed cast iron piping for the below-grade sanitary lines and above-grade waste and vent lines. The copper domestic water lines were changed to CPVC (used only for water lines) which not only saved money on the material change, but also eliminated the necessity for insulation on water piping. Though there are often concerns with traditional PVC use when used underground in lieu of cast iron because breakage due to crushing can more easily occur, the plumbing subcontractor was careful during the backfill process not to damage any of the new lines. Cast iron is occasionally chosen over PVC because of its ability to insulate noise. Using PVC in its stead did not create any noise problems because the lines were buried and eventually covered with a new SOG. With the exception of these two characteristics, the corrosive properties of each type of pipe and other material attributes are relatively comparable and still ensured the Owner's needs were met while saving approximately $55,400 on material costs.

The signature wall behind the monumental staircase stretches five floors from the first floor to the roof penthouse and is lit from the sides to showcase the staircase. This signature wall was originally designed to be finished with custom wood Interlam Panels but the finish was changed through the value engineering process to a ceramic tile with a unique wave texture. Not only did this decrease the material cost, but the lead and installation times were both shortened, allowing the scaffolding to be removed almost a month before originally scheduled (shown in Figure 15). This change saved the Owner approximately $188,560 in both material and installation costs but still provided an attractive finished product.

Another cost savings came from value engineering the foundation system of the new building addition. Steel, grout-filled micro piles with pile caps and grade beams were used in lieu of the originally designed spread footing foundation system utilizing deep excavation and underpinning. This foundation change resulted in the removal of the allowance for unsuitable soils, as deep excavation was no longer necessary. This redesign saved approximately $77,300, but had no other significant effects regarding Owner project goals.

Figure 11: Scaffolding and Signature Wall Installation; Picture Taken by Clara Watson

Because the existing building's roof was to remain and a new roof was to be constructed over it, significant insulation was not imperative. It was for this reason that the typical extruded polystyrene tapered insulation specified for the roof was redesigned to a single flat layer, adding sloped decking to ensure proper drainage. This value engineering change saved the project approximately $32,500 but had little effect on any other project variables.

Due to the additional dead load of a pool on the roof of the building, several of the existing concrete columns were originally designed to be stripped down to their outer surface of spiral ties and rewrapped with carbon fiber after additional reinforcing had been added. This was redesigned instead to be a concrete jacket, which added approximately 10 inches over the originally designed carbon fiber method to the diameter of the columns. The Owner was willing to sacrifice the loss of space to realize the $17,350 cost savings.

Value Engineering Concepts not Implemented

Because the Forrester Construction project team has worked closely with this particular Owner in the past, they were able to select and offer value engineering concept proposals and ideas they knew would be appealing to him. Consequently, all but one of the proposed value engineering ideas was accepted by David von Storch. The sole value engineering concept that was rejected was an idea to change the designed post-tensioned concrete beams and floor slabs on the new addition to either cast-in-place or precast concrete alternatives. Though both of these alternatives would have been significantly less expensive than the post-

Figure 12: Post-Tensioning Installation on the New Addition; Picture Courtesy of Luis Ortiz

tensioned structure, both would have increased the elevated slab thickness due to the integration of rebar for structural support. These thickened slabs would then be unable to line up directly with the floor slabs of the existing building, resulting in a step where the two slabs met. Deciding this would be too much of an eyesore, the Owner opted to keep the originally designed post-tensioned system that would allow for thinner floor slabs that directly lined up with the existing building. Installation of this system is shown in Figure 16.

CRITICAL INDUSTRY ISSUES:

PACE Roundtable

The 20th annual Partnership for Achieving Construction Excellence (PACE) Roundtable titled, "Building Innovation into Practice: Keeping What Works" was held at the Penn Stater Conference Center on November 8-9, 2011. This year's discussion was centered on the ideas of balancing the winning of new work in the present economy through new innovations while still maintaining core industry practices and implementing both new ideas and technologies. Attendees were permitted to choose two of the following six break-out sessions conversing on critical industry issues:

Sustainability / Green Building	
Session 1A: Energy Management Services	Session 2A: Learning Systems for Training a Sustainable Workforce
Process Innovation	
Session 1B: Assembling / Procuring an Integrated Team	Session 2B: Integrated Decisions for High Performance Retrofit Projects
Technology	
Session 1C: BIM Services for the Owner - The Role of the Design and Construction Professional	Session 2C: Strategies and Opportunities for Taking BIM into the Field

Because both Sustainability and Building Information Modeling (BIM) have previously been briefly analyzed and due to the parameters regarding the VIDA Fitness Project, both Process Innovation sessions were chosen for attendance in order to gain possible research ideas for future thesis analyses. Two panel discussion boards followed these sessions: the first was an industry panel discussing "Differentiation in a Down Economy" and the second was a combined industry and student panel that conferred on "Hands-On Learning in Design and Construction". Finally, focus groups comprised of an industry professional and a few students met to discuss potential thesis research topics given the previously discussed critical industry issues.

Session 1B: Assembling and Procuring an Integrated Team

Integrated Project Delivery (IPD) is a hot industry issue that is often brought to light when analyzing methods for creating a unitized and cohesive project team that works together to improve the project as a whole, rather than for individual gain. The type of multi-party contract

involved with IPD promotes shared risks and rewards which work to focus the IPD team to develop organized project goals. IPD focuses on early involvement of essential participants that can include key subcontractors, project team members, designers, or owners, among others. These participants make up the IPD team and collaborate throughout all stages of the project (from conceptual to operation) to enhance the project outcomes. This can include value engineering enhancements, waste reduction, constructability improvements, efficiency increases, or an overall increase in value. Because it is new to the Architecture, Engineering, and Construction (AEC) industry, IPD still meets many barriers when considered for execution on a project.

Many states require certain construction projects to be publicly bid by law or require certain delivery methods to be used, such as Design-Bid-Build, which negates any attempt for utilizing IPD. Behavioral barriers also cause difficulty for IPD operation because it is easy to revert back to what is known rather than try a new delivery method. This obstacle is particularly challenging as the construction industry is rife with those that are convinced the traditional methods and processes are the best way to go.

One of the main topics that must be addressed with IPD use is how to intentionally attract the right firms for the project. Matching subcontractor experience to the project type and complexity is necessary for this, as is finding a subcontractor that is willing to perform both project work and business in an integrated fashion.

When BIM was introduced into the industry, contractors could simply utilize the process on their projects and show the project owners the positive results associated with its utilization. In contrast, IPD cannot merely be used to demonstrate its benefits to the owner, but rather the owner must be brought on to the idea in the beginning stages of the project. This creates an entirely new set of challenges that involve the owner's attitude towards IPD enactment. Trust is a challenge that must be overcome when introducing IPD to the AEC industry, as project owners often have difficulty with their confidence levels in hired A/E firms. This, coupled with the fact that there is no insurance product for IPD contracts (and, therefore, unknown risk) makes owners wary when considering IPD as a delivery method. It is, therefore, imperative to sell owners on the idea of IPD and educate them not only on the process involved with its application, but also on the benefits provided to the owner and other involved parties.

Though several mentioned topics in this session proved to be uniquely interesting, two main research ideas were developed for the procurement of an integrated team on the VIDA Fitness Project. The first asked the question if integration could be implemented at key points or with specific contractors to improve the project's communication and cohesiveness or if it instead had to be completely integrated over the entire project duration. The second research idea asked how educating the project owner on IPD not only aided in its implementation but also improved the performance of both the project and IPD teams.

Session 2B: Integrated Decisions for High Performance Retrofit Projects

This topic of discussion began where the first left off and utilized its principles as a basis to develop a deeper understanding of the implementation of integrated decisions, specifically on retrofitted projects. The discourse began by analyzing the varying challenges that originate with employing an integrated approach to a renovation project. Early involvement by all of the integrated team (including but not limited to the involved subcontractors, project team, designers, and owner) is more critical in this type of project than with typical new construction because of the challenges that arise with unknown existing conditions or coordination issues that must tie into existing systems.

Building reconnaissance is critical in preventing major problems from arising due to any unforeseen conditions and is also extremely beneficial for determining the scope definition for proposed replacement of certain building systems. Pre-condition surveys are an advantageous way to aid in this prevention process and can be accomplished with such tools as laser scanners. BIM models can also be valuable to the integrated coordination process when designed and used for 3D coordination and/or clash detection.

One industry professional proposed a unique idea to aid in the integrated scope defining process: both hiring a balancer and testing on the first day of design could influence the decision on what systems or pieces of equipment needed to be replaced. This balancer could work as part of the integrated team towards the ultimate IPD project goals and provide unique insight on in-depth subjects that would often be overlooked by other team members. An example provided during the breakout discussion expounded upon overlooked costs to maintain equipment that is to remain during project renovations.

The dialogue revolving around hiring a balancer as part of the integrated team lead to the discussion on how to map integration on a particular construction project; who should be included on the IPD team along with what is critical to each included party must be considered with the integration process. A “design manager” or leader of the IPD process will lead these discussions along with others that range from critical systems to the project owner to what must be input by each party into the IPD process.

This further look into integrated decisions with a focus on renovation projects brought to light other research topics that could be evaluated for thesis analyses. The first research idea asked how information flow during the construction phase of a project could be negatively or positively affected by the execution of IPD. The second research idea questioned what the unknowns or safety factors were in traditional Design-Bid-Build designs that would be eliminated with IPD use. Along with this thought was the question of how the elimination of these safety factors could affect the cost, schedule, or quality on a project.

Industry Panel: Differentiation in a Down Economy

Like many of the discussions involving today's market and its effects on the construction industry, the industry panel detailed how, because so many subcontractors are desperate for work, they are bidding projects with minimal profit margins. Usually done with lump sum bidding, this, in turn, negatively affects projects when subcontractors attempt to capitalize on change orders or other avenues they view as potentials for making money.

Construction Management (CM) firms and General Contractors (GCs) are also suffering from the economy and most are pursuing work in other venues that is typically out of their field. One of the industry professionals on the panel board gave hope to the job-seeking students by declaring that 18 months after the economy turns around the construction industry follows with its own turn around, and 18 months after this, CMs and GCs could start "earning cheese".

Because economy discussions often involve cutting costs (which is a key issue for many projects), potential research topics were generated from the industry panel's conversation regarding the economy. The first topic explained that because of the economy, lump sum bids were used for subcontracts on many construction projects (including the VIDA Fitness Center). With this in mind, it queried how this increase in use of a contract type has affected cost and quality on projects and whether this varies by project location (as does the severity of the negative economy). The second research idea considered how the current economy affects owner's decisions made on projects regarding cost, quality, and schedule, and whether this varies according to type of owner and funding (i.e., public or private project).

Industry Contacts and Advisors

Both through the breakout sessions and general discussions, several industry contacts were made that provided insight on research analysis ideas and could later prove extremely helpful when examining specific topics. These industry attendees included: Mr. Michael Arnold with the Diocese of Pittsburgh, Mr. Richard Fiore with Leonard S. Fiore, Mr. Steven Lee with Benchmark Construction, Mr. Thomas Shumaker with Holder Construction, Mr. Tyler Swartzwelder with Gilbane Building, and Mr. Doug Wenger with Benchmark Construction. These contacts combined with The Pennsylvania State University Architectural Engineering professors and the Forrester Construction VIDA Project Team can provide great insight and knowledge on thesis analyses later examined.

PROBLEM IDENTIFICATION:

The analysis of the project constructability challenges, schedule acceleration scenarios, value engineering topics, and critical industry issues coupled with the Project Manager interview aided in the identification of several problematic features on the project. These problem areas are discussed below and could later be pursued for further research with a detailed analysis of both building systems and construction techniques.

Sequencing Between New and Renovated Spaces

Trade and activity sequencing is vital to all construction projects, but can prove to be challenging depending on the unique nature of parameters provided by differing project types. Sequencing on projects that include renovations and new additions (such as the VIDA Fitness project) creates difficulties when considering the sequences between the new and renovated spaces. The schedule for this project included multiple phased turnover dates that permitted overlapping areas of construction and phased building occupancy. The idea behind this tactic provides many benefits to both the Owner and project team, including a shortened project schedule, decreased overall cost, and increased revenue from opening sooner. Phasing the occupied and construction areas did, however, generate challenges associated with trade coordination and construction worker traffic. Certain subcontractors on this project would often be working in multiple areas and would improperly allocate their manpower or materials between areas, causing a delay for the following trade or activity. Foot traffic paths were also hindered when phases of the building opened to the public; workers were forbidden to use the monumental stairwell and instead had to traffic and carry materials through the two existing stairwells which were often blocked by ongoing construction.

Monumental Stairwell Schedule Delays

Due to its unique nature, the steel monumental stairwell constructed at the center of the building caused several constructability issues and scheduling delays. Saw cutting the openings for the stairwell varied in size and shape per floor and took two and a half times longer than what was originally estimated by the subcontractor. Prefabricating the stairwell in sections saved installation time, but though the schedule was well planned and the process was thoroughly sequenced, this too took more than twice as long as originally estimated by the steel subcontractor, who guaranteed finish dates that were never met and made little effort to gain back any lost time on the project schedule. The opening of the first phase of VIDA depended upon the completion of this stairwell, which made it a critical challenge throughout the first phase of the project.

Site Congestion with a Zero Lot Line Project

As previously discussed, the zero lot line parameter on this project created significant challenges when attempting to schedule and coordinate site logistics, parking, deliveries, storage, and material handling. The lack of available site space and the fact that the Owner needed a sales trailer also meant that the project team was unable to procure an office trailer and instead was forced to move their office several times throughout the project, depending on available areas inside of the

building. The extremely congested site not only hindered efficiency and productivity levels, but negatively affected worker safety and delayed several crucial activities.

Public Safety

Maintaining site productivity while catering to the public safety was challenging on the VIDA Fitness project. Transitions between public or occupied spaces and construction zones proved to be problematic, as much of the general public was more interested in seeing the ongoing construction than obeying the posted "Do Not Enter" signs. To ensure public safety, dust and noise pollution also had to be considered when erecting barriers that separated these two types of areas.

A Water-Tight Enclosure

The 100+ year old roof on the existing building was not water-tight, a fact that created several problems when rain revealed leaks in several locations. To heighten the magnitude of this problem, finishes on the interior of the building were commencing while construction was still in its beginning stages on the roof. Due to the moisture problems, several areas needed to be repainted and there were also a few locations where the athletic or bamboo flooring needed to be replaced.

HVAC System Start-Up and Commissioning

The process of getting the HVAC and mechanical system functional to allow the gym to open in the hot summer months also proved to be a problem on the VIDA project. Long lead times on mechanical equipment complicated this, as did the commissioning of an incredibly unique Variable Air Volume (VAV) system that conditioned air in 18 Air Handling Units (AHUs) located throughout the building. Challenges in balancing also caused the largest of the three chillers to often trip and shut off; this usually occurred at night, meaning the gym would open with a hot, muggy atmosphere until the re-set chiller could air condition the spaces. Even when the three chillers were properly balanced and were fully operational, the fourth floor and penthouse were significantly warmer than the first three floors, causing discomfort and complaints from VIDA employees and members.

Decreased Productivity Levels Due to Worker "Burn-Out"

The crew productivity levels of trades working six-day work weeks of 12-hour days began to drastically decrease towards the end of the summer. The general opinion was that of frustration, exhaustion, and burn-out from working such long hours on the same project. It became difficult to motivate workers and keep them on schedule late in the project.

Sustainability and LEED Certification

It is the common assumption that incorporating sustainable techniques or practices is not cost effective when implemented with smaller commercial projects. This is a fallacy, as sustainability practices, at a minimum, can lower energy consumption, decrease utility bills, elevate inhabitant productivity levels, and create healthier indoor environments. Though LEED certification was not attempted on this project, there are and were many areas where materials or practices could have been adjusted to earn LEED points without significantly changing the project schedule or cost.

Communication between the Designers and Forrester Construction

Because the interiors architect, SvS Architects, is located in Charlottesville, VA, the architect assigned to the project only visited the sight approximately once a month. This made it difficult to ask questions or discuss any areas of confusion, as the architect was not always current with ongoing construction and arising issues.

Decreased Productivity Resulting from Rework

Frustration often surfaced in subcontractors when rework was required due to finish changes, omissions in the design documents, or damaged work. Finishes and equipment locations were changed on multiple occasions due to Owner preference or general logistics. Exclusions in the project documents were also often discovered, causing change orders and rework in several situations. An example of this was a drain for a refrigerator on the first floor found to be missing from the plumbing drawings; part of the SOG had already been replaced before this was discovered, meaning part of the slab had to be demolished for the drain line installation. Lastly, materials or installed work had to be replaced that was damaged from either roof leaks or other trades. All of these instances generated change orders and annoyed workers that had to demolish or alter work they had just completed. This attitude usually tended to hinder productivity levels where rework was taking place.

TECHNICAL ANALYSIS OPTIONS:

Sustainability Integration for a Decrease in Utility Consumption

No specific sustainable practices or technologies were incorporated into the VIDA Project, due mainly to the fact that it was not a priority of the Owner. However, with the large consumption of water and electricity from the building, great potential exists to incorporate sustainability to decrease monthly utility bills. There are various ways in which green practices can be integrated into a project this size, many of which would not only decrease utility usages but could also aid in promoting a positive public image of the fitness center as an environmentally friendly building.

A myriad of technologies and methods are available that could be implemented into the existing building design. One of these includes integrated framing, a curtain wall system used as the façade of a building that contains photovoltaic glass windows. This is a unique alternative to a traditional photovoltaic panel system that would cover a significant amount of the valuable accessible roof real estate. Another potential idea is the ReRev energy harvesting system that captures kinetic energy produced in the form of DC power that is generated from cardio equipment. Solar hot water systems could also be analyzed to decrease costs associated with heating water for laundry, showers, or the two endless pools. Geothermal heating is another sustainable option that could be explored for potential energy savings.

Most of these systems have high initial equipment and installation costs, a fact that must be considered when researching the validity of these ideas. A life-cycle cost analysis and payback period must be researched for each of these concepts, along with how best to incorporate each system with this particular type of building. An electrical breadth would also likely need to be evaluated if any of these systems were considered for use.

Worker Morale and the Effects on Task Productivity

Several of the subcontractors resorted to working six, 12-hour days a week with the same crew in order to meet the tight project schedule. This strenuous work schedule not only frustrated workers, but also led to exhaustion and burn-out. Morale is often key to a project's success, which is why this negative attitude towards the project could have adversely affected productivity levels. Restricting the amount of over-time hours worked by subcontractors could potentially improve the general feeling towards the project and, potentially, the productivity levels of work.

Along these same lines, rework caused by a large number of change orders also decreased the morale of workers. Finish changes, omissions in the design documents, and damaged work were all contributing factors requiring material or system rework in some fashion. The excessive rework increased worker frustrations and nurtured negative attitudes toward the project. This additional negative effect on worker morale could also potentially influence productivity and quality levels.

These issues would both be extremely difficult to research, as it would be challenging to gauge worker satisfaction and morale and also how it is linked to productivity or quality levels on a project. Several construction workers on the VIDA Project from differing trades would have to be

consulted on their attitude changes towards the project and whether or not this affected their work ethics when work hours were increased from 40 to 60 hours a week or when they were forced to redo work they had already completed. Other research conducted could include how employee satisfaction and attitudes affect job performance, studies of which are often performed in large businesses; these ideas and statistics could then be applied to the AEC industry and, more specifically, the VIDA Fitness Project.

Quality Improvement and Cost Reduction through Material Handling

Not only could site congestion be improved through better material handling, but enhanced project quality, material cost reductions, and overall increased value to the Owner could also be potential benefits. Implementing lean construction could, theoretically, not only minimize waste and individual task time but also increase the overall project value. Job Order Contracting (JOC) could also be considered as a possible way to increase material costs and reduce delivery times.

To research this, advantages and disadvantages to both methods should be considered, along with the challenges and barriers associated with their employment on this project. Costs analyses should also be run for each, including initial costs versus savings over the project duration. Though quality is more difficult to measure, the implementation effects each method has on quality of finishes should also be researched and considered.

Chilled Beam Integration with the Mechanical System

Because of the many difficulties involved with all aspects of the mechanical system on the VIDA Project, a further examination of its efficiencies and loads could be used to vary its design. Introducing chilled beams over the VAV system could provide potential energy savings while still maintaining the high ceiling heights. This system utilizes water piping instead of a forced air system and is known for its higher efficiency. The chilled beam piping could also eliminate ductwork that caused low ceiling heights in certain areas of the fitness center. A cost analysis would have to be performed on this system, analyzing whether or not the higher initial system expenditures would prove to be cost effective over the life of the system.