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The New Science Building
Texas A&M International University
Laredo, TX

Technical Assignment #2

Analysis of Key Construction Features

28 October, 2004

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Executive Summary

This report discusses issues relating to the Texas A&M Science Building including an assemblies estimate of the structural system, the contractual relationships between entities on the construction side of the project, the staffing plan regarding the general contractor on site, design coordination of MEP systems, and a summary of the discussions about critical industry issues at the Pace Roundtable held on October 7, 2004. A detailed construction schedule was submitted separately.

An assemblies estimate was performed for the structural system of the science building to include CIP columns, CIP multi-span joist slabs, and a roof system of steel joists, beams, & deck on columns. After location and cost indexes were factored in, the total cost for the entire structural system was $933,007. For the detailed estimate in Technical Assignment #3, I plan to estimate the structure again, in order to obtain a more accurate price due to the uniqueness of some of the features of this building.

The contracts in this project are all lump sum awarded from public bids. The general contractor is required to carry various bonds and insurance, including performance and payment bonds, and builder's risk and owner's liability insurance. The subcontractors are required to carry standard insurance such as worker's compensation, and payment and performance bonds if they are contracted at over $25,000. This type of contractual relationship can be detrimental to the owner as well as the general contractor, because the quality of work is sacrificed for the cost.

The staffing plan of the general contractor on site includes a project manager, two project engineers, and two superintendents. The project manager oversees both engineers and both superintendents. One of the engineers is involved in the coordination of MEP work, while the other performs other standard project engineering work. Both superintendents share the work of the overall project.

MEP coordination is required per specifications via coordination drawings that are to adhere as much as possible to the design drawings issued by the architect. Areas of concern for coordination include laboratories where two mechanical, as well as two waste piping systems are required.

At the Pace Roundtable on October 7, 2004, I attended the sessions regarding globalization and technology, particularly 3D, 4D, and virtual reality modeling, in construction. Concerns about globalization included conducting meetings without all team members, and a solution was to implement video conferencing to include those members who were not local. Concerns about virtual reality modeling included the costs of such a system and the difficulty in measuring the value of it. More analysis of such systems could help to convince the industry of the benefits of this technology, which is why I am considering using this technology for my thesis for schedule analysis to determine constructability and sequencing issues.

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Assemblies Estimate

An assemblies estimate was performed for the structural system of the science building using Means Assemblies Cost Estimating Manual. This estimate includes the concrete columns, multi span joist slab, and roof structure. All costs include overhead and profit. The estimated value of this system is in CSI Uniformat II and is as follows:

B10 – Superstructure	
B1010 – Floor Construction	
B1010 203 - CIP Columns, Square Tied	$292,110
B1010 226 - CIP Multi-span Joist Slab	$1,174,500
B1020 – Roof Construction	
B1020 112 – Steel Joists, Beams, & Deck	$129,994
Total:	$1,596,604

Laredo, TX City Cost Index:	77.4
Laredo, TX Location Factor:	75.5

Total Cost= $1,596,604*0.774*0.755 = **$933,007**

This estimate does not include the cost of the structural steel for the planetarium. The special construction of this structure can not be accurately estimated using a standardized estimating method.

Assumptions:

1. The estimate for the roof system assumes that the system is connected to steel columns; however, this project uses concrete columns, which may slightly alter the cost of this system. The estimate also assumes a 25' x 25' bay size.

2. The columns in the science building are not all square, due some of the odd angles in the building. All columns are assumed square for this estimate.

3. The rib depth of the concrete joists in the science building is 25", which is greater than any of the values given for the estimate. Therefore the estimate was taken using a bay size larger than the actual 21'x26', and largest minimum column size rib depth for the given bay size. The CIP slab is assumed for a 4 bay x 4 bay building. My building is much larger than 4 bays, and is also not square or rectangular is shape. The odd shape of my building most likely adds cost to the estimated cost above.

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For the detailed estimate in technical assignment 4, I plan to perform a detailed estimate of the structural system, particularly the columns and floor system, because an estimate such as was performed here can not accurately account for a unique system. Also, considering that the values in the tables of this estimate do not seem to remotely relate to the design specifications for the science building, a structural redesign may be a viable value engineering consideration.

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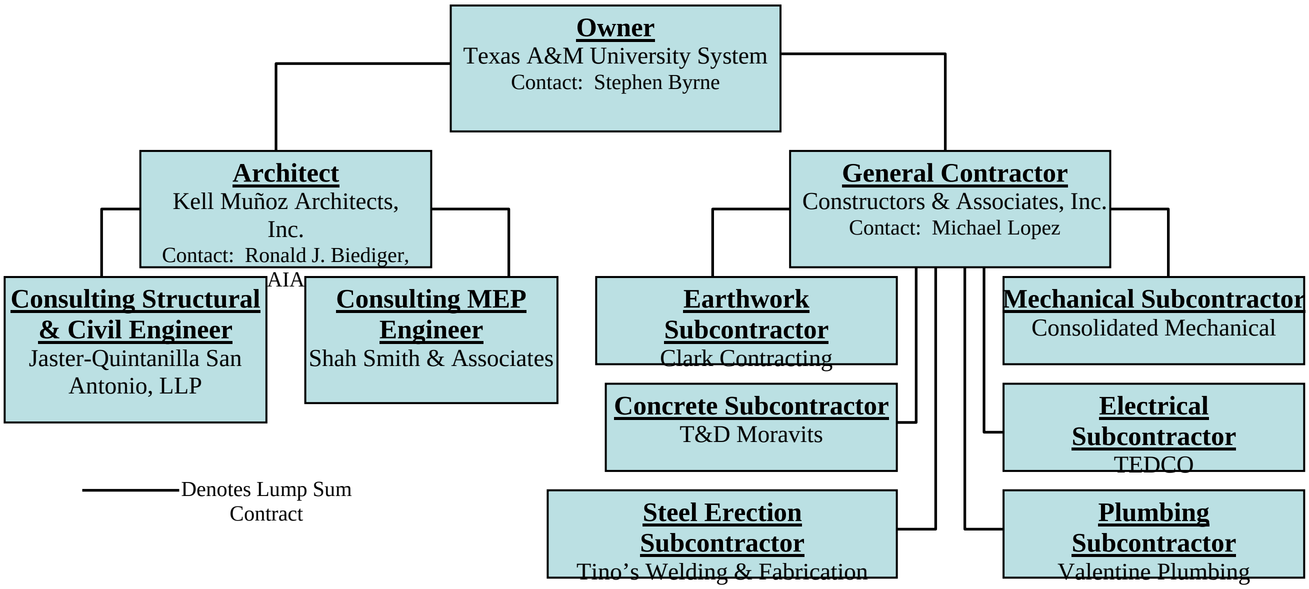
Contracts



All of the contracts for the project are lump sum contracts. The owner and architect put the project out to bid on March 6, 2003. The bid submittals consisted of 5 parts: (1) The competitive sealed proposal with base bid, alternates, and bid bond or cashier's check, (2) project qualifications, (3) financial qualifications, (4) historically underutilized business subcontracting plan and (5) subcontractor qualifications and cost reduction considerations.

Constructors and Associates won the bid and received a lump sum contract of $18,000,000. 540 days from notice to proceed were allotted by the owner for completion. If force majeure occurs, or inclement weather delays the project for more than the given weather delay days, the contractor may be allotted additional time for completion. After the bid was won, payment and performance bonds were required. The contractor was also required to have public liability and property damage insurance with an umbrella policy for $1,000,000, as well as employer's liability, comprehensive general liability, comprehensive automobile liability, owner's protective liability, and builder's risk insurance.

Constructors and Associates hired subcontractors based on their bids, qualifications, and historically underrepresented business (HUB) status. Each subcontractor was awarded a lump sum contract. Based on the size of the subcontractor's work, payment and performance bonds may have been required. If the amount of the subcontractor's contract was greater than $25,000, particularly site work, structural, and MEP contractors, the bonds would be required. Each subcontractor was also required to carry his own standard insurance on the project, such as worker's compensation.

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The lump sum contracts awarded are typical for public projects. The owner is looking for the best price, because his budget is limited. However, the lowest bidder does not usually put out the best product. Because the general contractor had to bid for the project, the subcontractors also had to bid, so that the general contractor could get the best price. The general contractor also had to take into account the HUB contractors, which also affected the selection process.

Because of Constructors' limited control of subcontractor selection, numerous subcontractors were not able to handle the size of this project, and removed themselves from the project. This required Constructors to re-bid these scopes, which took time and money, and subsequently delayed the project. This type of contract might seem to be optimal for a public owner; however, the consequences of bid-build projects with lump sum contracts can far outweigh the advantages.

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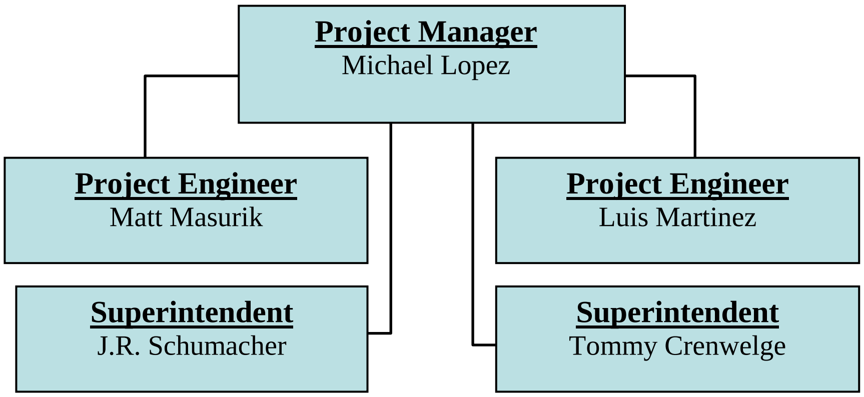
Staffing Plan



The field construction staff consists of the project manager, Michael, two project engineers, Matt and Luis, and two superintendents, J.R. and Tommy. Michael oversees both project engineers and both superintendents.

Matt joined the team to help with the coordination of the MEP contractors. He was involved in the acquisition of these trades, and helped find a new plumber after the original plumber went out of business and left the project. Luis handles most of the regular project engineering work. J.R. and Tommy work jointly on the project because of its size, and J.R. is also overseeing the work on the central plant.

Constructors and Associates' office is located in San Antonio, about three hours from San Antonio, so this team is made up of people who were both capable of completing the job successfully and willing to relocate for the duration of the project.

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Design Coordination

The scope of the Mechanical/Electrical/Plumbing required includes the entire building. MEP systems run through all floors and many walls. This is because there are numerous laboratories throughout the building. There are also two mechanical systems, including VAV ductwork and chilled and hot water piping to the laboratories. The waste piping includes both standard black iron, as well as anti-corrosive glass piping which runs from the laboratory sinks to the acid neutralization basin.

According to the specifications, **section 01040 – Coordination**, mechanical and electrical work must be coordinated with the work of other trades so that various components of systems are installed at the proper time, fit available space, and allow proper service access to all systems that require maintenance. Project space and sequence of installation of MEP work should be coordinated as indicated on the drawings. Routings shown on the drawings for pipes, ducts, and conduits should be followed as closely as possible. Coordination drawings must be prepared to define the relationships between sleeves, piping, ductwork, conduit, ceiling grid, lighting, fire sprinkler, HVAC equipment, and other MEP equipment with other building components such as beams, columns, ceilings, and walls.

The areas that would require the most coordination are the areas around the laboratories, due to the supplementary systems that are included. Also, mechanical and electrical rooms and the areas around them would require close coordination due to the large amount of system components located in those areas. The planetarium would also pose coordination issues, because it does not have any walls in which system components could be run through. All systems have to be located under the first floor, in the crawl space.

MEP coordination began with a coordination meeting including the mechanical, electrical, plumbing, and fire protection contractors. Any major areas of concern were brought to light at that meeting. Then the mechanical contractor started the process to create the coordination drawings, by inserting his scope of work in the drawings provided by the architect. The coordination drawing needed to follow the design plan as much as possible, according to the specifications. Following was the plumbing contractor, next the fire protection contractor, and lastly the electrical contractor. After the coordination drawings were complete, another meeting was held to discuss the results and any subsequent problems that occurred or were discovered during the process.

As of yet, there have been no major problems between the structure and MEP work, other than problems occurring from trying to fit all of the work into tight spaces. These issues required re-coordination of the MEP work in those areas, to be able to make everything fit properly.

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Critical Industry Issues

At the Pace Roundtable on October 7, 2004, I attended the discussions “Integrated Design and Construction I – Integrating Distributed Teams” and “Integrated Design and Construction II – Role of Technology”.

In the first session we discussed the effects of construction professionals, particularly architects and engineers, who work in a location far from the projects that they are handling. This can pose a problem for numerous reasons. It is more difficult to explain problems that arise over the phone or using pictures than to have the architect or engineer visit the site. If a question needs to be answered, the architect or engineer is much less likely to respond as quickly because they do not necessarily feel the accountability that they normally would, because they do not have face-to-face contact with the rest of the construction team. There may also be a severe time difference between the architect and the construction team, which leads to problems for being able to carry on a live conversation. A non-local architect or engineer may not be familiar with local construction practices and codes of the project, and therefore he may design incorrectly for the area.

There were numerous solutions to these problems, including setting aside more money for the architect or engineer to travel to the project on a regular basis. However, I think that the most valuable option was to use video phones, so that regular meetings can be held to include all of the project team members. They can converse face-to-face, which eliminates the lack of accountability typically associated with distance. The problems that arise with this technology, however, are that video phones are not as convenient as might be expected. There can be long delays in receiving messages from the other end, depending on distance. Also, these systems are still quite expensive, which brings up the question, “Who will pay”?

The second session discussed the use of 3D, 4D, and virtual reality modeling. The purpose of this technology would be to model a project before it is built, so that the architect and owner can see what they are getting before construction begins. This could reduce the number of change orders occurring during construction, because the owner might be able to catch what he doesn’t like, and have it changed at the beginning. The models could also help the construction team to analyze the construction process and discover any critical errors in the schedule that might cause delay, and any constructability issues that need to be discussed with the engineer. If all of these issues could be resolved at the beginning of the project, then it is possible that a significant amount of money, as well as stress, could be saved by the owner as well as the construction team.

Some of the concerns that arise due to this technology primarily revolve around money. The biggest concern of the general contractors seemed to be, “Who will pay”? The cost of these programs, primarily virtual reality modeling, which will also add the most value to a project, is significant. However, if one large error is found in the schedule on one project, or a large change order is eliminated, the cost of the program might be paid for. From then on, the

value that the program adds to the company would be pure profit. But as one of the general contractors said, construction companies keep their overhead as low as possible, so buying such a program and keeping it as an overhead cost isn't feasible. If the owner would allow the program to be entered as a line item for the project, that would be different. But the value of these programs are hard to measure, so how much a general contractor can charge the owner for its use on his project is another concern. This technology can be an extremely useful tool for construction; however, the value of the program is hard to measure, which is difficult to accept due to the high initial cost.

One of the biggest things that surprised me about the discussions was how reluctant the industry is to accept new methods, ideas, and technology. If the goal can not be accomplished with what is already immediately available to the company, without extra cost, than the company would rather not try to fix it. This is a rather bold statement, but the fact is that construction has been well behind the curve regarding technology, and the industry members did not seem too concerned. They came up with many more cons to the use of these technologies than pros.

For my thesis project, I want to create a 4D model, and possibly a virtual reality model, to analyze the schedule, and look for any sequencing constructability issues that may occur. By looking at the results of this model, and the issues that surfaced during actual construction, I hope to be able to illustrate the value that this technology could bring to a project. I think that the more examples of success of these programs that there are, the more likely that the construction industry will be able to embrace it.

A few of the contacts that I would be able to discuss my thesis project with would be Bill Moyer with James G. Davis Construction Company and Anne Pernell with Turner Construction Company. Both of these contacts would be able to provide me with feedback about the progress and feasibility of my project from a general contractor's perspective, as well as provide general construction advice.