5-2018

Optimizing Construction Estimation: A Case Study of the ETSU Football Stadium and the ETSU Fine Arts Center

John Paul Mitra

Optimizing Construction Estimation: A Case Study of the ETSU Football Stadium and the ETSU Fine Arts Center

by

JP Mitra

An Undergraduate Thesis Submitted in Partial Fulfillment
of the Requirements for the
University Honors Scholar Program
ETSU Honors College
East Tennessee State University

Mr. John Paul Mitra, Author	Date
Mr. Jeremy Ross, Thesis Mentor	Date
Dr. Joseph Shrestha, Reader	Date
Dr. Jinseok Hong, Reader	Date

TABLE OF CONTENTS

TABLE OF CONTENTS (CONT.)

ACKNOWLEDGEMENTS

Thank you to Mr. Jeremy Ross and to the ETSU Honors College for their patience and unending support of my research. I would have never been able to accomplish my goals and achievements in college without their help.

Thank you to my readers Dr. Joseph Shrestha and Dr. Jinseok Hong for their continued interest in my research and its future direction.

Thanks to the ETSU Facilities Management Office and to the many construction professionals who have supported me through their incredibly valuable input into the making of this thesis.

Special thanks to my family and friends for having my back at all times on my journey to graduation with my late nights working on this thesis, coffee breaks, and gummy bear revivals.

ABSTRACT

Considering the complexity of the construction industry, it is vital to predict costs accurately throughout the entire planning, design, and construction process of a project. Various factors such as overhead, delays, cost variation, and program and scope play significant roles in determining the viability and profitability of a project. Thus, it is important to learn about what makes construction estimates so variable even among expert estimators within the same company. This study will look at the estimation methods used by BurWil Construction Company and Denark Construction, Inc. for the ETSU Football Stadium and the ETSU Fine Arts Center, respectively, as case studies for both post- and in-development construction projects. The estimates used in different phases of the projects will be compared against the most current cost of the project; the final cost for the Football Stadium and the most up-to-date costs for the Fine Arts Center. Also, the different phases of design and construction and their corresponding estimates will be inspected thoroughly. As an ending discussion of the study, optimization efforts will be considered to assess how current planning and estimation methods can be improved to reduce cost and time for all parties involved in the project.

OPTIMIZING CONSTRUCTION ESTIMATION: A CASE STUDY OF THE ETSU FOOTBALL STADIUM AND FINE ARTS CENTER

1. INTRODUCTION

The newly built ETSU Football Stadium, William B. Greene Jr. Stadium, initially started construction on February 2016 and finished on September 2017, and its budgeted cost was 33.4 million dollars (“Football Stadium”, 2017). In the construction industry, it is important to maintain a budget and schedule because a variance of either or both will impact a project’s profitability. The ETSU Fine Arts Center (FAC) project is scheduled to be completed on December 2019 with a cost of approximately 52 million dollars. There is no doubt that a project with this size will need to be managed properly to remain profitable. Thus, proper and accurate methods of estimation are required when managing any construction project. This research will review the problems the construction industry is facing along with the difficulties of estimation, the correlation of proper estimation methods and efficiency, and the factors an estimator should consider during a project estimate.

1.1. Background

The construction industry is an incredibly competitive business with great risk of construction company bankruptcies due to profit inconsistencies and poor management (Riddell, 2016). As it stands today, it is one of the most technologically hindered industries as many contractors and managers fail to adopt new technologies to improve the trade (Riddell, 2016). Construction also has one of the smallest profit margins out of all industries in addition to its consumption of an extensive amount of natural resources (Riddell, 2016). According to Riddell (2016), “only 30% of firms currently deliver projects on budget and only 15% deliver on time,” which further implies the severe challenges project managers and estimators face during a construction project. One of the ways construction firms combat this problem is through careful planning and accurate estimation. Shiner (2013) states, “The goal of an accurate estimate is to determine your true costs and offer you the ability to accurately assess the progress and profitability of each job against a predetermined benchmark.” By preparing early during the planning and estimation phase of a construction project, firms are better able to identify areas where project managers can improve and when corrective action needs to take place (Shiner, 2013).

1.2 Literature Review

According to Shiner (2013), “It is important to remember that the mathematical difference between the budget and the bid is both overhead and profit.” When this difference becomes a negative value (i.e. when the budget exceeds the bid), a cost overrun has occurred (Al-Hazim et al., 2017). This could possibly be due to “unexpected excess cost[s], delays, and underestimation” (Al-Hazim et al., 2017). As far as the factors going into these excess costs and delays, a multiple set of parameters are to be considered. Some of the “main causes responsible for delays include: the lack of efficient project plans, contracts and implementation processes and procedures” as well as “financial aspects, coordination, and [problems] related to contractors and resources” (Al-Hazim et al., 2017). With this number of potential pitfalls for construction companies, it is no wonder many of them have difficulty staying in business.

Regarding the factors that are out of the control of managers and estimators, another list is needed to be accounted for. These include price instability of materials and constant change orders from the owner (Al-Hazim et al., 2017). A study by Al-Hazim et al. (2017) looked at the top twenty factors that hinder construction projects in Jordan, and they concluded the top three to be site conditions, weather, and the availability of labor. Riddell (2016) says that despite the constant growth of the construction industry, a shortage of labor is becoming an increasing trend as many professionals retire from the trade and the number of skilled laborers is diminishing.

Besides not accounting for the factors and parameters listed above, estimators have an even greater threat to worry about: poor estimation methods. Shiner (2013) says, "Too many contractors fail to calculate the true cost of a proposed project based upon three essential elements: overhead, risk and job costs." Many contractors only focus on job site costs and do not properly account for overhead costs (i.e. utilities, insurance, accounting, etc.), which is an essential aspect of running a construction company (Shiner, 2013). This negligence is a significant factor for any company going out of business. Next, any successful estimator has an essential necessity to have a gauge in risk regarding contingencies (Shiner, 2013). Construction companies are guilty of just padding costs all over an estimate instead of categorizing everything based on risk and adding contingencies accordingly. As a result, about 76% of projects are overestimated (Al-Hazim et al., 2017). According to Shiner (2013), "[T]he bidding process for contract jobs includes the most [risk]" for any construction company. Last, having no understanding of labor efficiencies, time estimation, and productivity can be devastating during the estimation of a project (Shiner, 2013). Without the knowledge of how fast specific jobs can be finished, an estimator is left guessing for these values increasing variability and the chances of steeply overestimating or underestimating a project (Shiner, 2013).

Along with poor estimation methods, having a competitive early estimate can be one of the most difficult aspects of a construction project. According to Swei et al. (2017), "The development of accurate and unbiased early cost estimates is an important component [of estimation]." Sometimes, estimators can be "overly optimistic" on their estimates simply because they want to attract potential clients with an incredibly low estimate (Swei et al., 2017). Considering final cost estimates, they vary so much that “the difference between actual cost and estimated cost of construction projects has an average of about 15%” (Al-Hazim et al., 2017). With early cost estimates, average cost overruns can go up as high as 30%, doubling the discrepancy of final cost estimates (Swei et al., 2017). Again, the main cause of this is the “strategic [and deliberate] misrepresentation” of project planners and promoters attempting to draw in clients (Swei et al., 2017).

There are many ways to mitigate these problems inherent with project estimation. With poor estimation practices, proper training and education will potentially help alleviate this problem. Shiner (2013) specifies that educating personnel is an investment, not a cost, because a knowledgeable estimator is an effective estimator. On another note, misleading clients about the cost of a project can lead to tensions and distrust among all parties involved in a project. Therefore, being transparent about potentially increasing costs needs to be established between the contractor and the client given a certain leniency and limit on these costs (Swei et al., 2017). In addition, spending time making sure an estimate is accurate and detailed will lead to profitable returns in the end (Shiner, 2013).

Finding the right estimation method or methods is dependent upon the type of project that is being estimated. With small or repeat projects (i.e. one-story dwelling, chain restaurants, etc.), estimation is simple and not as intensive because the variability of material costs is mostly eliminated, and the main problems become terrain and weather related (Al-Hazim et al., 2017). Usually, a bottom-up approach will suffice for this type of project. A bottom-up estimate is one where estimating is broken down to individual tasks and summed together (Corrie, 2016). On the other hand, large-scale and unique projects (i.e. football stadiums, high-rise buildings, etc.)

require using multiple methods and estimators to assess the project accurately. For these projects, a top-down approach, one where resources are allocated in various aspects of the project and budgeted accordingly, will better suit this type of project for early estimates (Corrie, 2016). As the name suggests, top-down is the complete opposite of the bottom-down approach (Corrie, 2016). However, a bottom-up approach is still useful and is usually more appropriate for doing the final cost estimate. In conjunction with both methods, the "Delphi technique" or expert judgement will be necessary to have an expert opinion on the estimate though these estimates tend to be highly subjective and dependent on the expertise of the advisors (Corrie, 2016).

More complicated methods can take up more time, but it can also lead to a better estimate. A comparative or analogous estimation uses similar projects from the past and references these similarities for the estimate (Corrie, 2016). Though strongly backed by projects already completed, material prices can dramatically change over time, and the assessment of project managers can be highly subjective regarding the similarity of the projects (Corrie, 2016). Possibly the most complicated of all methods, parametric estimating uses mathematical models to maximize objectivity in estimating as well as repeatability (Corrie, 2016). However, according to Swei et al. (2017), "In its current form, however, [parametric estimating is] susceptible to both systematic bias and heteroscedasticity (increased variability), both of which lead to incorrect assumptions about expected construction cost and uncertainty."

2. RESEARCH GOALS

The goals of this research are to optimize the time it takes to plan construction projects by reducing the number of budget revisions and time involved in the planning process, find the divisions or trades where estimates show the most variability, and potentially reduce the amount of excess contingency in a project. The methods applied to accomplish these goals are detailed in Section 5: Methodology.

3. ETSU FOOTBALL STADIUM

The ETSU Football Stadium, better known as the William B. Greene Stadium, started construction on February 2016 and finished on September 2017. Its final budgeted cost was $33,358,006. The stadium's architect was McCarty Holsaple McCarty, Inc. (MCM, Inc.) with estimating help from Vermeulens, a third-party pre-construction cost control consulting company. The stadium's construction manager and general contractor was Burwil Construction Company, Inc. The stadium's first phase of construction has been completed, and its second phase has yet to be scheduled as of April 2018. Proposed activities for the second phase include the addition of 3,400 seats to its northern end and a field house in its southern end. Figure 1 shows an overhead view of the stadium.

4. ETSU FINE ARTS CENTER (FAC)

The ETSU Fine Arts Center (FAC), has a budget of $52,338,250 with a construction schedule starting from August 2017 to December 2019. The architect is also MCM, Inc with estimating help from Vermeulens. The FAC's construction manager and general contractor is Denark Construction, Inc. This project is still under construction as of the writing of this thesis. One important detail from this project was the number of programmatic changes to the project due to an increased input from faculty and staff on the center's features (e.g. aerial arts studio, art gallery, bluegrass recording studio) and the state's limited approval of these features. Figure 2 shows an architectural drawing of the building.

Figure 1: The ETSU Football Stadium along with markers denoting the location of the future placement of future additions

Figure 2: The architectural design of the ETSU Fine Arts Center

5. METHODOLOGY

5.1 Problem

The problem addressed by this study is the apparent inaccuracy of cost estimation within the construction industry. This dilemma is incredibly troubling considering the competitiveness within the construction industry. Given state-funded projects with fixed budgets, staggered funding, and lump-sum contracts, specifically, it can prove to be difficult for these companies to find the fine line that separates a successful project from an unprofitable one.

5.2 Design

This research will be a quantitative study focusing on the architect's budgeting methods in conjunction with the estimation methods used by the two companies contracted by ETSU. By analyzing the accuracy of the budgets and estimates within each studied phase of the estimation process (e.g. schematic design, design development, and construction documents) through each division of construction (e.g. excavation, framing, finishes), this study will review the ways estimates may be adjusted, the role and efficiency of contingencies, and optimization of the budgeting process. A thorough review of the budgeting and estimation processes will explore the adequacy of current methods and opportunities for additional research.

5.3 Data Collection

Most of the data collected for this study was attained from ETSU Facilities Management. The data consisted of the different estimates for the two projects throughout their estimation phases, the budgeted cost progression by the architect, and multiple estimates from different subcontractors for specific divisions (i.e. framing, electrical, concrete, etc.). In addition, a comparison of the budget and subcontractor bids was available at specific points for both projects. BurWil Construction Co. and Denark Construction, Inc. were both contacted to collect data about their estimation methods for the ETSU Football Stadium and the ETSU FAC, respectively. However, only Denark's lead estimator was available for comment. The hurdles and challenges faced by the projects during construction were both noted. These are both separately listed in Section 7.1: Caveats and Section 7.2: Anecdotes.

5.4 Data Analysis

The analysis for this study will consist of finding the most variation within the divisions given in each project. Using the multiple subcontractor estimate data set, the method of analysis for this data set will be with the use of coefficient of variation (CV). With this method, a high CV corresponds with a large variation, and a low CV corresponds with a low variation. The equation for the coefficient of variation is given as the following:

$$Coefficient\ of\ Variation\ (CV) = \frac{Standard\ Deviation}{Mean} \times 100$$

To compare the allocation of the architect's budget with subcontractor bids for the Football Stadium data and Denark's estimate and the architect's estimate for the FAC data, the relative difference will be calculated for both data sets. A high relative difference corresponds to a low accuracy compared to a given value, and a low relative difference corresponds to a high accuracy compared to the same given value. The equation for the relative difference is given as the following:

$$Relative\ Difference = \frac{Estimated\ Value - Actual\ Value}{Actual\ Value} \times 100$$

To compare the most recent cost of the project and the different phases of estimation, the relative difference method will also be used. The different estimation phases reviewed include the schematic design, design development, and construction documents.

5.5 Football Stadium Data and Analysis

The data gathered for the Football Stadium analysis included a budget progression from August 8, 2013 to September 12, 2016 detailed on Appendix G: Football Stadium Raw Budget Data. For this set of data, relative difference analysis was used. Next, a separate set of data included multiple subcontractor estimates from May 9, 2016 detailed on Appendix J: Football Stadium Multiple Subcontractor Estimate Table. The coefficient of variation analysis was used for this data set. Last, a budget made by ETSU was compared to subcontractor bid estimates on April 22, 2016 detailed on Appendix B: Football Stadium Budget vs. Subcontractor Estimate. Again, the relative difference method was used for the analysis of this data set.

5.6 Fine Arts Center Data and Analysis

The data gathered for the FAC analysis included a pre-construction budget progression from February 11, 2015 to April 21, 2017 detailed on Appendix H: Fine Arts Center Raw Pre-Construction Budget Data. Compared to the Football Stadium Data, the FAC Data also included different estimates over time for the project ranging from a schematic design estimate on February 19, 2016 and a design development estimate on April 14, 2017, which was taken as the correct value for this data set. Again, relative difference analysis was used on the data set detailed on Appendix I: Fine Arts Center Raw Estimate Data. Next, the multiple subcontractor estimates data sets included one from February 17, 2016 and another on November 10, 2016 detailed on Appendix K: Fine Arts Center Multiple Subcontractor Estimate Table (18 Months) and Appendix L: Fine Arts Center Multiple Subcontractor Estimate Table (9 Months), respectively. The coefficient of variation analysis was used for these data sets. Last, an estimate made by Denark Construction, Inc. was compared to the architect's estimate on December 5, 2016 detailed on Appendix E: Fine Arts Center Denark Estimate vs. Vermeulens Estimate. The relative difference method was also used for the analysis of this data set.

6. RESULTS

6.1 Football Stadium Analysis

6.1.1 Budget Progression

Following an increase in budget, an increase in the stadium's cost is apparent as shown in Figure 3, which shows the projected cost of the building, the maximum allowable construction cost for the project (MACC), the project's overall grand total, and the progression of the allocated funding for the project. Key notes for this graph include the following. On August 28, 2013, the project was already under budget, so efforts were made to reduce its cost. With additional funding, however, the project's program and estimated cost increased and allocated to different parts of the project. In addition, on July 14, 2015, an estimate prepared by Burwil Construction was compared to the architect's budget, and once more, the project was under budget again. This was immediately followed by program reductions, design changes, and value engineering efforts, which decreased the project's cost substantially. Having construction contingencies already added to the grand total line, the difference between this line and the budget is a state requirement for contingency planning to accommodate for unexpected circumstances. The data points used to make this graph are listed on Appendix G: Football Stadium Raw Budget Data.

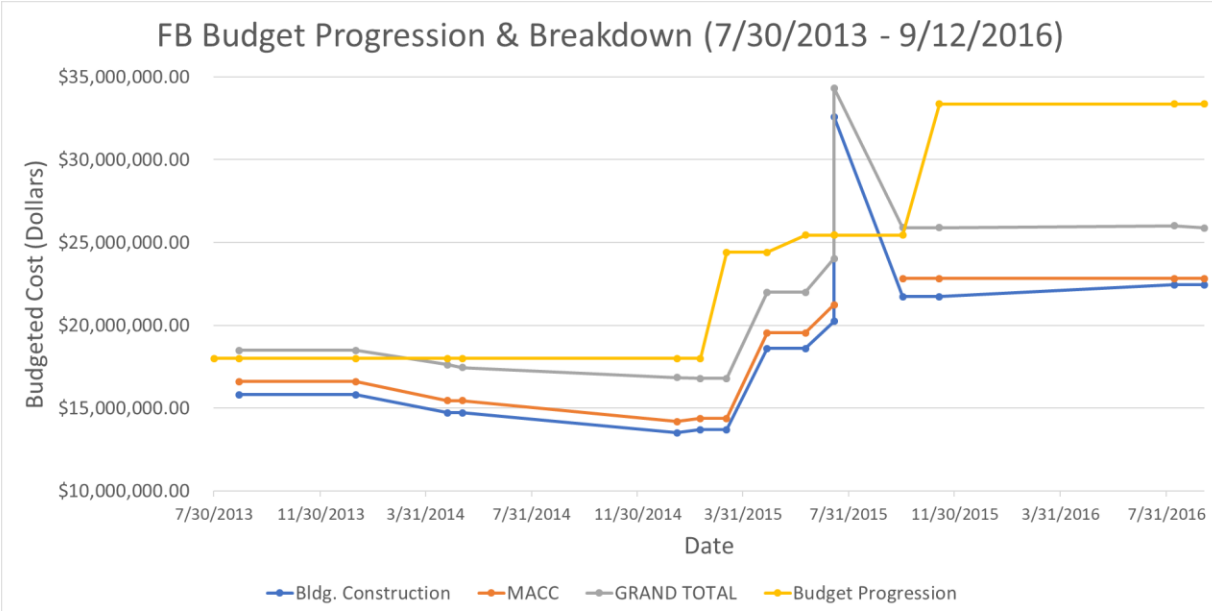

Figure 3: At the beginning of the stadium's funding, it was already under budget, so efforts were made to reduce its cost. With more funding, however, the project's estimated cost also rose, and the extra funding received was allocated to different parts of the project.

6.1.2 Coefficient of Variation (CV)

Using the CV to analyze the multiple subcontractor estimate data, Table 1 shows the 15 most variable trades according to their CV values for the subcontractor estimates from May 9, 2016. Given Electrical and Concrete appear on this list with the largest means and ranges, they are two specific trades that require the most attention with CV values of 28.30% and 12.28%, respectively, though Site Concrete also appears with a CV of 22.59%. This could be explained by the complex nature of electrical installation and the variability of concrete regarding its transportation and its labor. This could also be explained by the multiple changes in scope for the project with electrical and concrete being directly affected by these changes. The size of these trades compared to the others may also play a factor in the variability of their estimates.

Table 1: This table shows the 15 most variable trades according to their CV values. Having Electrical and Concrete appear on this list with the largest means and ranges, they are two specific trades that require the most attention. The entire list of trades for this data set is detailed on Appendix A: Football Stadium Coefficient of Variation Table.

TOP 15 MOST VARIABLE TRADES					
Date (5/9/2016)	Count	Range	Mean	S. Dev.	Coeff. of Var.
Spray Insulation	3	$ 33,710.00	$ 47,601.33	$ 16,904	35.51%
Caulking	2	$ 17,480.00	$ 36,260.00	$ 12,360	34.09%
Sprinkler	4	$ 123,884.00	$ 180,697.25	$ 56,733	31.40%
Stained Concrete	3	$ 5,735.00	$ 9,421.67	$ 2,911	30.90%
Electrical	3	$ 1,128,452.00	$ 2,194,484.00	$ 620,982	28.30%
Fluid Applied Flooring	4	$ 21,987.00	$ 37,952.25	$ 9,384	24.73%
Site concrete	4	$ 452,786.00	$ 1,009,901.50	$ 228,182	22.59%
Landscaping	4	$ 147,516.00	$ 307,121.75	$ 68,851	22.42%
Aluminum Plank Seating	2	$ 37,050.00	$ 131,425.00	$ 26,198	19.93%
Exterior Lighting	2	$ 21,555.00	$ 106,954.50	$ 15,242	14.25%
Concrete	3	$ 722,598.00	$ 3,046,474.67	$ 374,154	12.28%
Roofing	4	$ 40,016.00	$ 164,900.75	$ 19,267	11.68%
Acoustical Ceiling Tiles	3	$ 23,485.00	$ 105,192.67	$ 12,236	11.63%
Flag Poles	2	$ 953.00	$ 6,553.50	$ 674	10.28%
Toilet Accessories	3	$ 5,492.00	$ 27,116.00	$ 2,753	10.15%

On the other hand, the rest of the trades that show up on this list follow the trades that are involved later in the construction process (e.g. Caulking, Sprinkler, Landscaping) suggesting the effect of waiting time on the variability of these trades. The entire list of trades for this data set is detailed on Appendix A: Football Stadium Coefficient of Variation Table.

6.1.3 Project Budget vs. Subcontractor Estimates

An evaluation of the project's budget was made by comparing the architect's budget to the subcontractor estimates. Out of the 29 trades listed on Appendix B: Football Stadium Budget vs. Subcontractor Estimate, 16 were underbudgeted with 7 being underbudgeted by more than -40%. Table 2 details the top 10 underbudgeted trades from Appendix B. Again, many of the trades in this list are involved in the finishes of a construction project except for Metal Wall System, Thermal & Moisture, and Electrical. Specifically, Electrical has the highest difference at

$720,182 indicating the programmatic changes made in the project and confirming the difficulty involved in estimating it.

Table 2: This table details the top 10 underbudgeted trades from Appendix B: Football Stadium Budget vs. Subcontractor Estimate. Again, many of the trades in this list are involved in the finishes of a construction project except for Metal Wall System, Thermal

TOP 10 UNDERBUDGETED TRADES				
OVERALL TOTAL	$ 18,077,357.00	$ 16,349,908.00	$ (1,727,449.00)	-9.56%
Date (4/22/2016)	Bid Estimate	Budget	Difference	Rel. Diff.
Window Shades	$ 83,320.00	$ 7,702.00	$ (75,618.00)	-90.76%
Fencing	$ 206,973.00	$ 22,806.00	$ (184,167.00)	-88.98%
Metal Wall System	$ 189,598.00	$ 61,617.00	$ (127,981.00)	-67.50%
Landscaping	$ 259,800.00	$ 104,122.00	$ (155,678.00)	-59.92%
ACT	$ 105,711.00	$ 58,203.00	$ (47,508.00)	-44.94%
Retaining Wall	$ 55,719.00	$ 31,278.00	$ (24,441.00)	-43.86%
Millwork & Casework	$ 315,557.00	$ 183,976.00	$ (131,581.00)	-41.70%
Roofing	$ 148,099.00	$ 91,691.00	$ (56,408.00)	-38.09%
Thermal & Moisture	$ 171,956.00	$ 107,980.00	$ (63,976.00)	-37.20%
Electrical	$ 1,976,477.00	$ 1,256,295.00	$ (720,182.00)	-36.44%

On the other hand, Table 3 shows the top 10 overbudgeted trades in this data set. The relative differences for this list are substantially lower suggesting that it is much easier to underbudget than it is to overbudget a trade. Surprisingly, Mechanical/HVAC has one of the highest budgets and estimates on this list being close to $1.8 million, but its difference is only 3.11% of its bid estimate. This may be explained by the straightforwardness of the trade regarding material cost and labor with fluctuating prices not being an issue in this case. In addition, Sitework & Utilities, Concrete Work, and Masonry were incredibly close to having a 0% relative difference as shown in Appendix B. Since this data was collected 2 months into construction, it follows suitably that the divisions early in the construction process are already estimated with more detail and accuracy.

Table 3: This table details the top 10 overbudgeted trades. Unlike Table 2, the relative differences on this table are substantially lower than with the underbudgeted trades. Surprisingly, Mechanical/HVAC was budgeted well.

TOP 10 OVERBUDGETED TRADES				
OVERALL TOTAL	$ 18,077,357.00	$ 16,349,908.00	$ (1,727,449.00)	-9.56%
Date (4/22/2016)	Bid Estimate	Budget	Difference	Rel. Diff.
Flooring	$ 183,578.00	$ 211,595.00	$ 28,017.00	15.26%
Doors, Frames, Hardware	$ 118,637.00	$ 136,049.00	$ 17,412.00	14.68%
Stadium Seating	$ 260,823.00	$ 295,460.00	$ 34,637.00	13.28%
Painting	$ 147,059.00	$ 164,907.00	$ 17,848.00	12.14%
Fire Suppression	$ 160,346.00	$ 175,847.00	$ 15,501.00	9.67%
Specialties	$ 157,831.00	$ 168,339.00	$ 10,508.00	6.66%
General Conditions	$ 411,843.00	$ 435,636.00	$ 23,793.00	5.78%
Storefront	$ 416,333.00	$ 432,786.00	$ 16,453.00	3.95%
Mechanical/HVAC	$ 1,789,164.00	$ 1,844,876.00	$ 55,712.00	3.11%
Metal Studs and Drywall	$ 353,460.00	$ 364,186.00	$ 10,726.00	3.03%

6.2 Fine Arts Center Analysis

6.2.1 Budget Progression

The data included in Figure 4 shows data points from February 11, 2015 all the way to December 12, 2017. Though incomplete due to missing data points, Figure 4 shows the progression of the FAC's budget compared to Denark's estimate, which was not available until February 19, 2016. This graph shows a large shift in the project's budget with an $8 million investment from the city of Johnson City as a contribution for program enhancement and increasing the number of auditorium seats from 635 to 1200 seats. In addition, as the steepness of the lines suggest, it is much easier to increase the budget of a project than it is to reduce the estimate through value engineering and design changes. By early 2017, the Estimated Cost was in sync with the Target Cost of the project. Figure 4 was made with data listed in Appendix H: Fine Arts Center Raw Pre-Construction Budget Data and Appendix I: Fine Arts Center Raw Estimate Data.

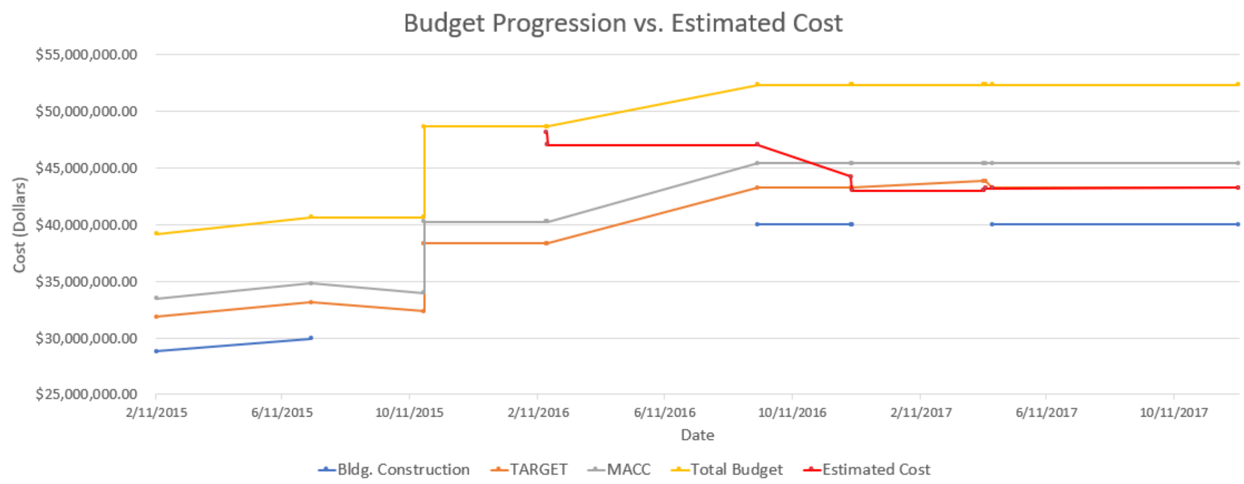

Figure 4: Comparing the ETSU budget to Denark's estimated cost, efforts were made to make the estimated cost consolidate with the line for the target cost of the project since it was severely underbudget when the one of the first estimates was made.

6.2.2 Coefficient of Variation (CV)

Having two sets of data from the FAC regarding multiple subcontractor estimates, it will be helpful to see the differences in CVs between two points during the estimation process. The first set of data, shown in Table 4, was taken on February 17, 2016, which was 18 months before construction began. As Table 4 shows, none of the trades exceeded a 23% CV with most being below 15% suggesting either a confirmation of transparency among subcontractors with an attempt to gain an initial relationship with the general contractor or a lack of need for competitive advantage.

Comparing the first to the second set of data, shown in Table 5 and taken on November 10, 2016, a major discrepancy regarding the CVs is seen. With an increase in CVs across the board, an increase in competitive bids may play a significant role in this phenomenon especially as the estimates get closer to the construction start date. Both sets of data are listed in more detail in Appendix C: Fine Arts Center Coefficient of Variation Table (18 Months) and Appendix D: Fine Arts Center Coefficient of Variation Table (9 Months).

Table 4: None of the trades during the February 17, 2016 subcontractor estimate exceeded a 23% CV suggesting either a confirmation of transparency among subcontractors with an attempt to gain an initial relationship with the general contractor or a lack of need for competitive advantage.

TOP 15 MOST VARIABLE TRADES (18 MONTHS BEFORE CONSTRUCTION)					
Date (2/17/2016)	Count	Range	Mean	S. Dev	Coeff. Of Var.
Roofing	3	$ 334,285.00	$ 842,157.00	$ 191,623	22.75%
Deep Foundations	3	$ 329,715.00	$ 1,141,295.00	$ 165,906	14.54%
Retaining Walls	2	$ 14,211.00	$ 76,873.50	$ 10,049	13.07%
Painting	3	$ 99,142.00	$ 447,525.33	$ 54,682	12.22%
Masonry & Stone	3	$ 910,308.00	$ 4,463,614.67	$ 517,971	11.60%
Paving	4	$ 21,644.00	$ 99,065.50	$ 9,773	9.87%
Plumbing & HVAC	3	$ 779,994.00	$ 6,623,777.67	$ 441,762	6.67%
Drywall & Acoustical	3	$ 467,484.00	$ 3,821,498.67	$ 243,883	6.38%
Sitework & Site Utilities	4	$ 241,160.00	$ 1,632,576.00	$ 103,320	6.33%
Flooring	3	$ 81,858.00	$ 877,408.67	$ 46,896	5.34%
Concrete	3	$ 321,204.00	$ 3,758,441.33	$ 184,133	4.90%
Elevators	2	$ 20,400.00	$ 314,031.00	$ 14,425	4.59%
Structural & Miscellaneous Steel	3	$ 292,327.00	$ 4,847,733.67	$ 168,074	3.47%
Polished Concrete	2	$ 635.00	$ 13,021.50	$ 449	3.45%
Aluminum Storefront & Glassing	3	$ 53,032.00	$ 1,124,429.33	$ 27,089	2.41%

Table 5: With an increase in CVs across the board, an increase in competitive bids may play a significant role in this phenomenon especially as the estimates get closer to the construction start date.

TOP 15 MOST VARIABLE TRADES (9 MONTHS BEFORE CONSTRUCTION)					
Date (11/10/2016)	Count	Range	Mean	S. Dev	Coeff. Of Var.
Painting	3	$ 295,770.00	$ 370,192.00	$ 147,944	39.96%
Waterproofing & Caulking	6	$ 337,628.00	$ 432,571.83	$ 138,092	31.92%
Landscaping and Irrigation	4	$ 78,271.00	$ 158,116.50	$ 33,693	21.31%
Auditorium Seating	4	$ 123,063.00	$ 327,979.75	$ 56,827	17.33%
Concrete	3	$ 968,214.00	$ 2,871,360.33	$ 484,235	16.86%
Polished Concrete	3	$ 31,929.00	$ 105,264.67	$ 16,194	15.38%
Metal Wall Panels	3	$ 79,406.00	$ 267,437.00	$ 40,005	14.96%
Deep Foundations	3	$ 305,725.00	$ 1,034,999.00	$ 154,599	14.94%
Electrical	4	$ 1,323,098.00	$ 4,486,927.25	$ 550,550	12.27%
Design Team Allowances	2	$ 552,908.74	$ 2,467,733.63	$ 390,966	15.84%
Flooring	4	$ 111,379.00	$ 553,542.00	$ 51,218	9.25%
Structural & Miscellaneous Steel	4	$ 886,796.00	$ 4,747,063.25	$ 371,903	7.83%
Sitework & Site Utilities	4	$ 367,803.00	$ 1,970,289.25	$ 168,938	8.57%
Masonry & Stone	4	$ 690,960.00	$ 4,566,848.75	$ 315,176	6.90%
Plumbing & HVAC	4	$ 774,646.00	$ 5,355,358.25	$ 343,435	6.41%

Table 6: This table shows the relative differences between Denark Construction, Inc.'s estimate vs. Vermeulens's estimate, which was taken as the correct value. In this table, most of the trades were within 5% of the actual value, and this is immediately expressed by the -0.69% relative difference of the total estimate for the entire project.

DENARK ESTIMATE VS. ARCHITECT ESTIMATE (8 MONTHS BEFORE CONSTRUCTION)				
TOTAL	$ 44,535,805.00	$ 44,227,288.00	$ (308,517.00)	-0.69%
Date (12/5/2016)	Architect	DCI	Difference	Rel. Diff.
Conveying Systems	$ 117,500.00	$ 144,405.00	$ 26,905.00	22.90%
Electrical	$ 4,215,711.00	$ 4,362,075.00	$ 146,364.00	3.47%
Contingencies	$ 2,735,955.00	$ 2,794,032.00	$ 58,077.00	2.12%
Masonry	$ 3,888,037.00	$ 3,909,613.00	$ 21,576.00	0.55%
Sitework	$ 3,001,391.00	$ 3,016,465.00	$ 15,074.00	0.50%
General Trades	$ 2,279,725.00	$ 2,283,693.00	$ 3,968.00	0.17%
Allowances	$ 3,141,340.00	$ 3,141,340.00	$ -	0.00%
Testing Allowance	$ 122,400.00	$ 122,400.00	$ -	0.00%
Mechanical	$ 5,993,168.00	$ 5,993,134.00	$ (34.00)	0.00%
Insurance, Profit, Bonds	$ 1,430,056.00	$ 1,429,663.00	$ (393.00)	-0.03%
Concrete	$ 3,330,608.00	$ 3,328,021.00	$ (2,587.00)	-0.08%
Permits & Overhead	$ 89,622.00	$ 88,793.00	$ (829.00)	-0.92%
Finishes	$ 5,294,119.00	$ 5,182,706.00	$ (111,413.00)	-2.10%
General Conditions	$ 1,314,065.00	$ 1,286,037.00	$ (28,028.00)	-2.13%
Doors/Windows	$ 830,808.00	$ 802,505.00	$ (28,303.00)	-3.41%
Metals	$ 4,984,522.00	$ 4,701,325.00	$ (283,197.00)	-5.68%
Thermal/Moisture Protection	$ 1,766,778.00	$ 1,641,081.00	$ (125,697.00)	-7.11%

6.2.3 Denark Estimate vs. Architect Estimate

The data set used for this section includes individual estimates from Denark Construction, Inc. and the architect, which was taken as the actual value, shown in Table 6. Since both companies specialize in construction estimation, it is apparent why the relative difference is much smaller than the Football Stadium Budget vs. Subcontractor Estimates. At -0.69% total estimate relative difference, the estimates made by Denark were done with more accuracy compared to the Football Stadium's 9.56% total estimate relative difference. The only massively overbudgeted trade from this data set was Conveying Systems at 22.90% relative difference, and for underbudgeted trades, Thermal/Moisture Protection appears at -7.11% relative difference. Remarkably, Mechanical shows up again at almost exactly 0.00% relative difference reaffirming the assumptions and hypotheses made in Section 6.1.3: Project Budget vs. Subcontractor Estimates.

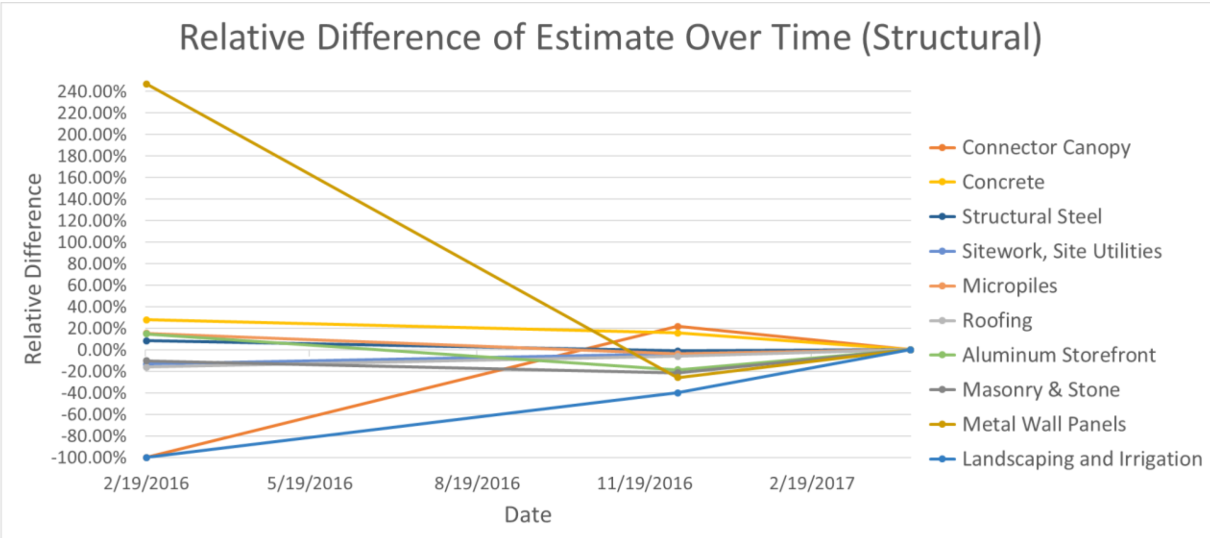

Figure 5: This graph shows the relative difference of the different trades over time with respect to structural trades.

6.2.4 Estimate Progression

The following section includes three sets of data including Denark's estimates for different trades during varying times in the estimation process. The first is a schematic design estimate made on February 19, 2016, second is another schematic design estimate with revisions from recommendations made by the architect made on December 7, 2016, and the third is a design development estimate made on April 14, 2017 and taken as the actual value for this relative difference analysis since the most recent estimate data is not available. The following graphs were separated into three divisions: structural, utilities, and interiors & miscellaneous given by Figures 5, 6, and 7, which were made by using data points from Appendix F: Fine Arts Center Change of Estimate Over Time derived from Appendix I: Fine Arts Center Raw Estimate Data. Given the progression of the trades' subtotal, the relative difference for the subtotal was 11.74% first, -0.55% second, and 0.00% third. The accuracy of the estimate improves substantially through the 10 months of corrections and revisions, but it will take another 4 months to correctly estimate the project, assumedly.

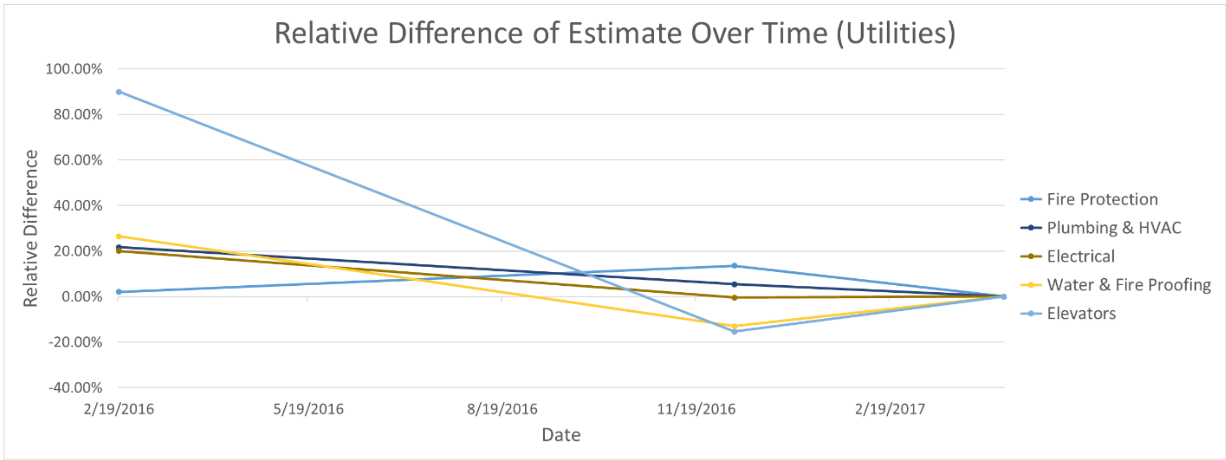

Figure 6: This graph shows the relative difference of the different trades over time with respect to trades involved with utilities.

Looking at all three figures, there is an apparent trendline of trades with relative differences not exceeding ±20% and specific ones that deviate from this trendline. In the structural division, specifically, Metal Wall Panels, Connector Canopy, and Landscaping and Irrigation were the poorest during the first schematic design estimate with 244.91%, -100.00%, and -100.00% relative differences, respectively. In the utilities division, Elevators led the rest with an 89.92% relative difference. Last, in the interiors & miscellaneous division, Flooring and General Trades start off with around 60% relative difference, but they already reach close to the zero line by the second schematic design estimate. Polished Concrete also appears with a -84.80% relative difference, but it does not correct itself as much with a -61.00% relative difference during the second schematic design estimate.

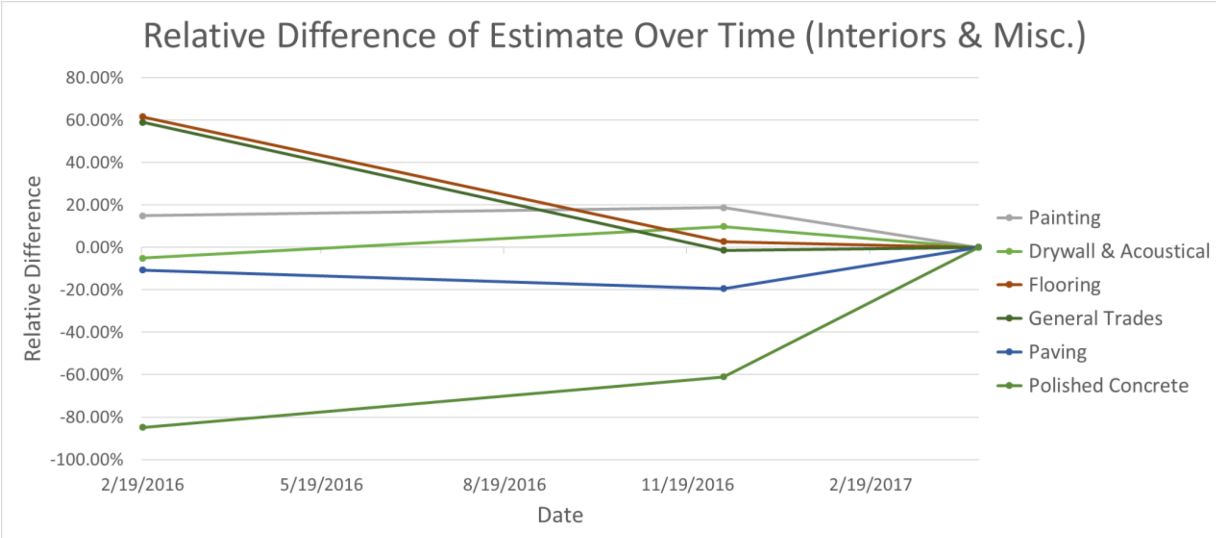

Figure 7: This graph shows the relative difference of the different trades over time with respect to interiors and miscellaneous trades.

7. DISCUSSION

7.1 Caveats

Given the scope of this research there are some caveats that are inherent to the budgeting and estimation process of construction projects. Efforts were made to accommodate for the multiple program changes, design options, change orders, design changes, and contingencies in both projects. Having these throughout both projects suggests the effect of a change in design does not immediately reflect as an improvement or retrogression in the accuracy of the estimate. In addition, the Football Stadium's program and scope included more than just the stadium itself (e.g. recycling center relocation, Basler Challenge Course relocation, east end roundabout), which were budgeted outside of the project's budget. On the other hand, faculty and staff involvement in choosing the FAC's program and scope brought many difficulties during planning, which could reflect as an increased cost through architect and engineering fees and an unfactored cost of delay. Most importantly, differences in the Football Stadium's and FAC's

Data were present as expected due to the method of data collection for this research (i.e. format, unit costs, detail, missing data). This was also due to the two construction companies' varying methods for estimating and cost tracking. As previously stated in Section 5.3: Data Collection, there was no contact with Burwil Construction Co. Their perspective would have been a valuable resource as a point of reference to better analyze the Football Stadium's data and ask them for their inputs on construction estimation optimization. A notable caveat from both projects is the uniqueness of state projects considering the amount of time it takes for a project's approval from the state as well as the state's funding process. In addition, having multiple levels of checks and balances in the state's approval process creates transparency among all parties involved but, in effect, also creates delays during the planning of projects, which reduces efficiency and potentially creates more delay costs through the period of time when a building could be built at a cheaper price regarding economic conditions.

7.2 Anecdotes

Referencing different people involved in the project, this section includes a few anecdotes from them to give more insight as to the challenges both projects faced as well as suggestions to improve construction estimation. To start, labor prices may already be severely inflated due to the construction industry's current labor shortage. Specifically, the round of hurricanes during Fall 2017 gave the FAC subcontractors more difficulty in finding labor because many laborers fled the east Tennessee region to help rebuild states in the southeastern coast of the U.S. Also, both projects experienced unique soil conditions with the Football Stadium accounting for massive boulders during excavation and the FAC dealing with contaminated soil. In addition, both projects were delivered with lump-sum contracts, which means that any cost savings that the companies make toward the project will be given back to the state. Given a fixed price for both projects' construction managers, they encounter the most risk in these projects if a cost overrun was to occur. Most notably, talking directly to Denark's lead estimator, he said more straightforward communication from architects will help speed the planning and estimation process for construction projects in general. Since the architect represents owner in these projects, owner communication, in and of itself, could present as the main issue regarding decreasing estimation time. The economic conditions for the FAC was also more favorable during 2016 when cheaper material costs were available, which suggests delays in planning might increase the overall cost of the project significantly.

7.3 Future Direction

Suggestions for the future direction of this research are given in this section. Since the FAC is still under construction, a follow-up cost analysis of this project will be beneficial to see the accuracy of its current budget and estimates. In contrast, to better accommodate for design changes and change orders, classifying them both into separate divisions and trades will show which ones see the most change and hopefully determine which ones require the most attention early in the planning process. Adding a scheduling component to this research may also give insight as to the specific cost of delays and time constraints during both planning and construction phases. Finally, equating a numerical cost associated with planning delays may increase understanding as to the effect and severity of these delays to project cost.

7.4 Conclusion

As ETSU is planning for new construction projects for the next few years, it is important to analyze where optimization efforts can be made during the planning, budgeting, and estimating of these future projects. From this research, some of the following conclusions can be made. A few notable trades that require the most attention include Electrical, Concrete, and Metal Wall Panel/System because these trades can be complex and volatile regarding the program and scope of their estimation. In addition, the variation for the trades involved in the FAC increased over time across most of the trades. This could be explained by the competitive risk of an estimate with subcontractors trying to attract attention with the lowest bid estimate. Also, many of the underbudgeted trades in the Football Stadium data follow the trades late in the construction process (i.e. Finishes, Landscaping) because there are more uncertainties involved with them. Surprisingly, Mechanical/HVAC was estimated incredibly well potentially due to its straightforward and uniform nature. Programmatic and scope changes might have also caused substantial changes in the estimates because these cannot be seen directly through the estimate itself. Several factors played key roles in the overall costs of these projects including planning and estimation delays, economic conditions, and the uniqueness of state projects. One definitive way to increase the efficiency of planning in the programmatic phase is to increase clarity and communication among all parties, specially the owner. Having the best interest of tax-payers in mind, the state must be able to use these funds optimally and efficiently, and the construction projects across the state’s universities are one of the most efficient ways to bring tremendous value to their communities.

REFERENCES

Al-Hazim, N., Salem, Z., & Ahmad, H. (2017). Delay and Cost Overrun in Infrastructure Projects in Jordan. *Procedia Engineering, 182*, 18-24. http://dx.doi.org/10.1016/j.proeng.2017.03.105

Campus Master Plan Update 2014. (2014). *etsu.edu*. Retrieved 4 October 2017, from http://www.etsu.edu/facilities/documents/mp2014.pdf

Corrie, J. (2016). *Project Estimation Methods*. *precursive.com*. Retrieved 3 October 2017, from https://precursive.com/blog/project-estimation-methods/

ETSU Facilities. (2018). *ETSU.edu.* Retrieved 14 February 2018, from https://www.etsu.edu/facilities/default.php

Football Stadium. (2017). *etsu.edu*. Retrieved 4 October 2017, from http://www.etsu.edu/facilities/football_stadium.php

Riddell, T. (2016). *Top 5 Issues Facing the Construction Industry in 2017*. *esub.com*. Retrieved 4 October 2017, from https://esub.com/top-issues-facing-the-construction-industry-2017/

Shiner, L. (2013). *10 Steps to Building a More Profitable Construction Business*. *sage.com*. Retrieved 3 October 2017, from https://www.sage.com/na/~/media/DF6D71246E5847189C86D69C4C29DF53.pdf

Swei, O., Gregory, J., & Kirchain, R. (2017). Construction cost estimation: A parametric approach for better estimates of expected cost and variation. *Transportation Research Part B: Methodological*, *101*, 295-305. http://dx.doi.org/10.1016/j.trb.2017.04.013

Appendix A: Football Stadium Coefficient of Variation Table

FB COEFFICIENT OF VARIATION (3 MONTHS INTO CONSTRUCTION)					
TOTAL			$ 17,550,247.83		
Date (5/9/2016)	Count	Range	Mean	S. Dev.	Coeff. of Var.
Turf Protector	1	$ -	$ 5,015.00	$ -	$ -
Canopies	1	$ -	$ 6,800.00	$ -	$ -
Fireproofing	1	$ -	$ 32,175.00	$ -	$ -
Wall Padding	1	$ -	$ 52,648.00	$ -	$ -
Painting	1	$ -	$ 141,200.00	$ -	$ -
Elevator	1	$ -	$ 212,911.00	$ -	$ -
Steel Erection	1	$ -	$ 260,500.00	$ -	$ -
Spray Insulation	3	$ 33,710.00	$ 47,601.33	$ 16,904	35.51%
Caulking	2	$ 17,480.00	$ 36,260.00	$ 12,360	34.09%
Sprinkler	4	$ 123,884.00	$ 180,697.25	$ 56,733	31.40%
Stained Concrete	3	$ 5,735.00	$ 9,421.67	$ 2,911	30.90%
Electrical	3	$ 1,128,452.00	$ 2,194,484.00	$ 620,982	28.30%
Fluid Applied Flooring	4	$ 21,987.00	$ 37,952.25	$ 9,384	24.73%
Site concrete	4	$ 452,786.00	$ 1,009,901.50	$ 228,182	22.59%
Landscaping	4	$ 147,516.00	$ 307,121.75	$ 68,851	22.42%
Aluminum Plank Seating	2	$ 37,050.00	$ 131,425.00	$ 26,198	19.93%
Exterior Lighting	2	$ 21,555.00	$ 106,954.50	$ 15,242	14.25%
Concrete	3	$ 722,598.00	$ 3,046,474.67	$ 374,154	12.28%
Roofing	4	$ 40,016.00	$ 164,900.75	$ 19,267	11.68%
Acoustical Ceiling Tiles	3	$ 23,485.00	$ 105,192.67	$ 12,236	11.63%
Flag Poles	2	$ 953.00	$ 6,553.50	$ 674	10.28%
Toilet Accessories	3	$ 5,492.00	$ 27,116.00	$ 2,753	10.15%
Waterproofing	2	$ 7,600.00	$ 53,800.00	$ 5,374	9.99%
Signage	2	$ 2,720.00	$ 20,510.00	$ 1,923	9.38%
Overhead Door	2	$ 8,506.00	$ 64,740.00	$ 6,015	9.29%
Masonry	3	$ 168,085.00	$ 977,601.33	$ 90,735	9.28%
Fixed Seating	3	$ 25,686.00	$ 150,247.33	$ 12,845	8.55%
Milwork	3	$ 36,169.00	$ 285,343.33	$ 20,160	7.07%
Metal Studs & Drywall	4	$ 77,736.00	$ 515,564.50	$ 34,002	6.60%
Mechanical/HVAC	4	$ 217,454.00	$ 1,825,734.25	$ 95,797	5.25%
Synthetic Turf	3	$ 75,570.00	$ 875,090.00	$ 40,845	4.67%
Doors, Frames, Hardware	2	$ 4,217.00	$ 103,375.50	$ 2,982	2.88%
Fire Extinguishers	2	$ 99.00	$ 2,436.50	$ 70	2.87%
Fluid Applied Weather Barrier	2	$ 2,361.00	$ 58,594.50	$ 1,669	2.85%
Retaining Wall	3	$ 2,501.00	$ 54,942.00	$ 1,294	2.35%
Fencing	3	$ 7,573.00	$ 201,542.33	$ 4,143	2.06%
Toilet Compartments	5	$ 3,053.00	$ 61,757.75	$ 1,269	2.06%
Sitework	2	$ 60,256.00	$ 2,306,768.00	$ 42,607	1.85%
Storefront	2	$ 8,913.00	$ 404,202.50	$ 6,302	1.56%
Asphalt Paving	3	$ 11,542.00	$ 460,811.67	$ 5,853	1.27%
Tile & Resilient Floor	2	$ 2,679.00	$ 149,527.50	$ 1,894	1.27%
Steel	2	$ 10,840.00	$ 854,353.00	$ 7,665	0.90%

Appendix B: Football Stadium Budget vs. Subcontractor Estimate

FB BUDGET VS. SUBCONTRACTOR ESTIMATES (2 MONTHS INTO CONSTRUCTION				
TOTAL	$ 18,077,357.00	$ 16,349,908.00	$ (1,727,449.00)	-9.56%
Date (4/22/2016)	Bid Estimate	Budget	Difference	Rel. Diff.
Window Shades	$ 83,320.00	$ 7,702.00	$ (75,618.00)	-90.76%
Fencing	$ 206,973.00	$ 22,806.00	$ (184,167.00)	-88.98%
Metal Wall System	$ 189,598.00	$ 61,617.00	$ (127,981.00)	-67.50%
Landscaping	$ 259,800.00	$ 104,122.00	$ (155,678.00)	-59.92%
ACT	$ 105,711.00	$ 58,203.00	$ (47,508.00)	-44.94%
Retaining Wall	$ 55,719.00	$ 31,278.00	$ (24,441.00)	-43.86%
Millwork & Casework	$ 315,557.00	$ 183,976.00	$ (131,581.00)	-41.70%
Roofing	$ 148,099.00	$ 91,691.00	$ (56,408.00)	-38.09%
Thermal & Moisture	$ 171,956.00	$ 107,980.00	$ (63,976.00)	-37.20%
Electrical	$ 1,976,477.00	$ 1,256,295.00	$ (720,182.00)	-36.44%
Asphalt Paving	$ 473,356.00	$ 386,435.00	$ (86,921.00)	-18.36%
Field Turf & Equipment	$ 1,011,068.00	$ 854,268.00	$ (156,800.00)	-15.51%
Steel	$ 1,217,550.00	$ 1,125,618.00	$ (91,932.00)	-7.55%
Overhead Doors	$ 63,000.00	$ 59,748.00	$ (3,252.00)	-5.16%
Sitework & Utilities	$ 2,115,352.00	$ 2,086,996.00	$ (28,356.00)	-1.34%
Concrete Work	$ 4,039,785.00	$ 4,014,953.00	$ (24,832.00)	-0.61%
Masonry	$ 912,395.00	$ 918,220.00	$ 5,825.00	0.64%
Allowance	$ 510,821.00	$ 520,610.00	$ 9,789.00	1.92%
Elevator	$ 221,746.00	$ 227,709.00	$ 5,963.00	2.69%
Metal Studs and Drywall	$ 353,460.00	$ 364,186.00	$ 10,726.00	3.03%
Mechanical	$ 1,789,164.00	$ 1,844,876.00	$ 55,712.00	3.11%
Storefront	$ 416,333.00	$ 432,786.00	$ 16,453.00	3.95%
General Conditions	$ 411,843.00	$ 435,636.00	$ 23,793.00	5.78%
Specialties	$ 157,831.00	$ 168,339.00	$ 10,508.00	6.66%
Fire Suppression	$ 160,346.00	$ 175,847.00	$ 15,501.00	9.67%
Painting	$ 147,059.00	$ 164,907.00	$ 17,848.00	12.14%
Stadium Seating	$ 260,823.00	$ 295,460.00	$ 34,637.00	13.28%
D/F/H	$ 118,637.00	$ 136,049.00	$ 17,412.00	14.68%
Flooring	$ 183,578.00	$ 211,595.00	$ 28,017.00	15.26%

Appendix C: Fine Arts Center Coefficient of Variation Table (18 Months)

FA COEFFICIENT OF VARIATION (18 MONTHS BEFORE CONSTRUCTION)					
TOTAL			$ 43,114,629.50		
Date (2/17/2016)	Count	Range	Mean	S. Dev	Coeff. Of Var.
Auditorium Seating	0	$ -	$ -	$ -	$ -
Connector Canopy	0	$ -	$ -	$ -	$ -
Landscaping and Irrigation	0	$ -	$ -	$ -	$ -
Design Team Allowances	1	$ -	$ 2,709,199.00	$ -	$ -
TBR Testing Allowance	1	$ -	$ 122,400.00	$ -	$ -
Electrical	3	$ 46,682.00	$ 5,193,168.67	$ 23,564	0.45%
Fire Protection	2	$ 6,758.00	$ 391,361.00	$ 4,779	1.22%
General Trades	2	$ 83,718.00	$ 3,115,814.00	$ 59,198	1.90%
Waterproofing & Caulking	2	$ 23,356.00	$ 716,148.00	$ 16,515	2.31%
Metal Wall Panels	4	$ 40,875.00	$ 783,090.00	$ 18,476	2.36%
Aluminum Storefront & Glassing	3	$ 53,032.00	$ 1,124,429.33	$ 27,089	2.41%
Polished Concrete	2	$ 635.00	$ 13,021.50	$ 449	3.45%
Structural & Miscellaneous Steel	3	$ 292,327.00	$ 4,847,733.67	$ 168,074	3.47%
Elevators	2	$ 20,400.00	$ 314,031.00	$ 14,425	4.59%
Concrete	3	$ 321,204.00	$ 3,758,441.33	$ 184,133	4.90%
Flooring	3	$ 81,858.00	$ 877,408.67	$ 46,896	5.34%
Sitework & Site Utilities	4	$ 241,160.00	$ 1,632,576.00	$ 103,320	6.33%
Drywall & Acoustical	3	$ 467,484.00	$ 3,821,498.67	$ 243,883	6.38%
Plumbing & HVAC	3	$ 779,994.00	$ 6,623,777.67	$ 441,762	6.67%
Paving	4	$ 21,644.00	$ 99,065.50	$ 9,773	9.87%
Masonry & Stone	3	$ 910,308.00	$ 4,463,614.67	$ 517,971	11.60%
Painting	3	$ 99,142.00	$ 447,525.33	$ 54,682	12.22%
Retaining Walls	2	$ 14,211.00	$ 76,873.50	$ 10,049	13.07%
Deep Foundations	3	$ 329,715.00	$ 1,141,295.00	$ 165,906	14.54%
Roofing	3	$ 334,285.00	$ 842,157.00	$ 191,623	22.75%

Appendix D: Fine Arts Center Coefficient of Variation Table (9 Months)

FA COEFFICIENT OF VARIATION (9 MONTHS BEFORE CONSTRUCTION)					
TOTAL			$ 36,796,222.13		
Date (11/10/2016)	Count	Range	Mean	S. Dev	Coeff. Of Var.
Fire Protection	1	$ -	$ 379,892.00	$ -	$ -
Retaining Walls	0	$ -	$ -	$ -	$ -
TBR Testing Allowance	1	$ -	$ 153,000.00	$ -	$ -
Painting	3	$ 295,770.00	$ 370,192.00	$ 147,944	39.96%
Waterproofing & Caulking	6	$ 337,628.00	$ 432,571.83	$ 138,092	31.92%
Landscaping and Irrigation	4	$ 78,271.00	$ 158,116.50	$ 33,693	21.31%
Auditorium Seating	4	$ 123,063.00	$ 327,979.75	$ 56,827	17.33%
Concrete	3	$ 968,214.00	$ 2,871,360.33	$ 484,235	16.86%
Design Team Allowances	2	$ 552,908.74	$ 2,467,733.63	$ 390,966	15.84%
Polished Concrete	3	$ 31,929.00	$ 105,264.67	$ 16,194	15.38%
Metal Wall Panels	3	$ 79,406.00	$ 267,437.00	$ 40,005	14.96%
Deep Foundations	3	$ 305,725.00	$ 1,034,999.00	$ 154,599	14.94%
Electrical	4	$ 1,323,098.00	$ 4,486,927.25	$ 550,550	12.27%
Flooring	4	$ 111,379.00	$ 553,542.00	$ 51,218	9.25%
Sitework & Site Utilities	4	$ 367,803.00	$ 1,970,289.25	$ 168,938	8.57%
Structural & Miscellaneous Steel	4	$ 886,796.00	$ 4,747,063.25	$ 371,903	7.83%
Masonry & Stone	4	$ 690,960.00	$ 4,566,848.75	$ 315,176	6.90%
Plumbing & HVAC	4	$ 774,646.00	$ 5,355,358.25	$ 343,435	6.41%
Drywall & Acoustical	3	$ 323,976.00	$ 3,634,525.67	$ 168,190	4.63%
Roofing	4	$ 93,193.00	$ 866,473.00	$ 38,395	4.43%
General Trades	2	$ 109,803.00	$ 1,930,209.50	$ 77,642	4.02%
Elevators	2	$ 9,690.00	$ 175,566.00	$ 6,852	3.90%
Aluminum Storefront & Glassing	2	$ 48,814.00	$ 960,742.00	$ 34,517	3.59%
Connector Canopy	2	$ 4,111.00	$ 121,942.50	$ 2,907	2.38%
Paving	2	$ 576.00	$ 108,188.00	$ 407	0.38%

Appendix E: Fine Arts Center Denark Estimate vs. Vermeulens Estimate

DENARK ESTIMATE VS. VERMEULENS ESTIMATE (8 MONTHS BEFORE CONSTRUCTION)				
TOTAL	$ 44,535,805.00	$ 44,227,288.00	$ (308,517.00)	-0.69%
Date (12/5/2016)	Vermeulens	DCI	Difference	Rel. Diff.
Conveying Systems	$ 117,500.00	$ 144,405.00	$ 26,905.00	22.90%
Electrical	$ 4,215,711.00	$ 4,362,075.00	$ 146,364.00	3.47%
Contingencies	$ 2,735,955.00	$ 2,794,032.00	$ 58,077.00	2.12%
Masonry	$ 3,888,037.00	$ 3,909,613.00	$ 21,576.00	0.55%
Sitework	$ 3,001,391.00	$ 3,016,465.00	$ 15,074.00	0.50%
General Trades	$ 2,279,725.00	$ 2,283,693.00	$ 3,968.00	0.17%
Allowances	$ 3,141,340.00	$ 3,141,340.00	$ -	0.00%
Testing Allowance	$ 122,400.00	$ 122,400.00	$ -	0.00%
Mechanical	$ 5,993,168.00	$ 5,993,134.00	$ (34.00)	0.00%
Insurance, Profit, Bonds	$ 1,430,056.00	$ 1,429,663.00	$ (393.00)	-0.03%
Concrete	$ 3,330,608.00	$ 3,328,021.00	$ (2,587.00)	-0.08%
Permits & Overhead	$ 89,622.00	$ 88,793.00	$ (829.00)	-0.92%
Finishes	$ 5,294,119.00	$ 5,182,706.00	$ (111,413.00)	-2.10%
General Conditions	$ 1,314,065.00	$ 1,286,037.00	$ (28,028.00)	-2.13%
Doors/Windows	$ 830,808.00	$ 802,505.00	$ (28,303.00)	-3.41%
Metals	$ 4,984,522.00	$ 4,701,325.00	$ (283,197.00)	-5.68%
Thermal/Moisture Protection	$ 1,766,778.00	$ 1,641,081.00	$ (125,697.00)	-7.11%

Appendix F: Fine Arts Center Change of Estimate Over Time

CHANGE OF ESTIMATE OVER TIME (RELATIVE DIFFERENCE)			
	DENARK SD	REVISED SD (VE)	DESIGN DEV.
Date	2/19/2016	12/7/2016	4/14/2017
Design Team Allowances	23.64%	26.28%	0.00%
Connector Canopy	-100.00%	21.73%	0.00%
Painting	14.87%	18.78%	0.00%
Concrete	27.84%	15.75%	0.00%
Fire Protection	2.13%	13.61%	0.00%
Drywall & Acoustical	-5.09%	9.80%	0.00%
Plumbing & HVAC	21.69%	5.44%	0.00%
Flooring	61.60%	2.71%	0.00%
General Conditions	-13.26%	-0.23%	0.00%
Electrical	20.05%	-0.38%	0.00%
Structural Steel	8.57%	-1.10%	0.00%
General Trades	58.99%	-1.36%	0.00%
Sitework, Site Utilities	-13.13%	-3.59%	0.00%
Micropiles	15.32%	-3.90%	0.00%
Roofing	-16.05%	-6.04%	0.00%
Water & Fire Proofing	26.50%	-12.94%	0.00%
Elevators	89.92%	-15.41%	0.00%
Aluminum Storefront	14.79%	-18.54%	0.00%
Paving	-10.73%	-19.42%	0.00%
TBR Testing Allowance	-20.00%	-20.00%	0.00%
Masonry & Stone	-10.20%	-21.42%	0.00%
Metal Wall Panels	246.91%	-25.81%	0.00%
Landscaping and Irrigation	-100.00%	-40.02%	0.00%
Polished Concrete	-84.80%	-61.00%	0.00%
TRADES SUBTOTAL	11.74%	-0.55%	0.00%

Appendix G: Football Stadium Raw Budget Data

	Scenario 2			Option 5 - Revised	Phase 1	Option 5
Date	8/28/2013	4/25/2014	5/12/2014	1/14/2015	2/10/2015	2/10/2015
Seats	6,400	6,400	6,400	6,400	6,400	6,400
Site Development Construction Cost	$ 5,500,000.00	$ 6,768,231.00	$ 6,768,231.00	$ 6,768,231.00	$ 7,000,000.00	$ 7,000,000.00
Football Field Construction Cost	$ 100,000.00	$ 898,134.00	$ 898,134.00	$ 898,134.00	$ 898,100.00	$ 898,100.00
Skybox Suites & Press Level						
Temporary Press Structure		$ 250,000.00	$ 250,000.00	$ 250,000.00	$ 215,000.00	$ 215,000.00
Seating Bowl, Toilets, Concessions, Field Lighting				$ 4,971,900.00	$ 4,971,900.00	$ 4,971,900.00
Hospitality Venue & Prep Kitchen				$ 615,000.00	$ 615,000.00	$ 615,000.00
Stadium and Related Facilities	$ 9,300,000.00	$ 6,791,900.00	$ 6,791,900.00			
Expand Suites Level by 4 Corporate Suites						
New East Roundabout						
Existing Buildings Relocations, Basler Challenge Course						
Subtotal	$ 15,800,000.00	$ 14,708,265.00	$ 14,708,265.00	$ 13,503,265.00	$ 13,700,000.00	$ 13,700,000.00
Owner's Construction Contingency	$ 800,000.00	$ 735,413.00	$ 735,413.00	$ 675,163.00	$ 685,000.00	$ 685,000.00
Maximum Allowable Construction Cost (MACC) (Projected)	$ 16,600,000.00	$ 15,443,678.00	$ 15,443,678.00	$ 14,178,428.00	$ 14,385,000.00	$ 14,385,000.00
A/E Fees: Per State Fee Formula	$ 986,311.00	$ 957,149.00	$ 957,149.00	$ 826,886.00	$ 901,500.00	$ 901,500.00
SUBTOTAL	$ 17,586,311.00	$ 16,400,827.00	$ 16,400,827.00	$ 15,005,314.00	$ 15,286,500.00	$ 15,286,500.00
Donated Brick		$ (67,220.00)	$ (67,220.00)	$ (161,600.00)	$ (161,600.00)	$ (161,600.00)
Additional Services (Allowance)	$ 100,000.00	$ 90,019.00				
Additional Design Fees				$ 566,555.00	$ 235,398.00	$ 273,467.00
DD/CD Fees for Skybox Suites and Field House				$ 240,000.00		
FF&E (Furniture, Fixtures, and Equipment) (Allowance)	$ 150,000.00	$ 75,000.00	$ 95,000.00	$ 50,000.00	$ 95,000.00	$ 95,000.00
Food Service Equipment		$ 300,000.00	$ 200,000.00	$ 300,000.00	$ 360,000.00	$ 360,000.00
Scoreboard (Allowance - No Video Board)		$ 185,000.00	$ 185,000.00	$ 185,000.00	$ 185,000.00	$ 185,000.00
Audio/Video Equipment						
Reimbursables - Design Phases (Pre-Con Surveying, Geotech Explor)	$ 19,980.00					
Construction Testing (Allowance)	$ 225,000.00	$ 225,000.00	$ 225,000.00	$ 200,000.00	$ 200,000.00	$ 200,000.00
Commissioning (Allowance/Projection)	$ 60,000.00	$ 60,000.00	$ 60,000.00	$ 60,000.00	$ 30,000.00	$ 30,000.00
Administration & Miscellaneous (Allowance/Projection)	$ 353,689.00	$ 353,689.00	$ 353,689.00	$ 400,000.00	$ 527,810.00	$ 527,810.00
GRAND TOTAL	$ 18,494,980.00	$ 17,622,315.00	$ 17,452,296.00	$ 16,845,269.00	$ 16,758,108.00	$ 16,796,177.00

Appendix G (cont.): Football Stadium Raw Budget Data

	Phase 1	Phase 1	Phase 1 - CM	Phase 1	Phase 1	Phase 1
Date	4/28/2015	7/14/2015	7/14/2015	10/1/2015	8/9/2016	9/12/2016
Seats	6,400	6,400	6,400	7,009	7,009	7,009
Site Development Construction Cost	$ 7,000,000.00	$ 7,000,000.00	$ 11,091,815.00	$ 7,217,000.00		
Football Field Construction Cost	$ 898,100.00	$ 898,100.00	$ 1,137,757.00	$ 999,000.00		
Skybox Suites & Press Level	$ 4,665,862.00	$ 4,665,862.00	$ 6,371,260.00			
Temporary Press Structure						
Seating Bowl, Toilets, Concessions, Field Lighting	$ 4,971,900.00	$ 4,971,900.00	$ 10,543,655.00			
Hospitality Venue & Prep Kitchen	$ 615,000.00	$ 615,000.00	$ 1,599,719.00			
Stadium and Related Facilities						
Expand Suites Level by 4 Corporate Suites	$ 456,000.00	$ 456,000.00	$ 517,666.00			
New East Roundabout		$ 630,000.00				
Existing Buildings Relocations, Basler Challenge Course		$ 1,000,000.00	$ 1,332,660.00			
Subtotal	$ 18,606,862.00	$ 20,236,862.00	$ 32,594,532.00	$ 21,736,000.00	$ 22,442,440.00	$ 22,442,440.00
Owner's Construction Contingency	$ 930,343.00	$ 1,011,843.00		$ 1,086,800.00	$ 112,212.00	$ 224,424.00
Maximum Allowable Construction Cost (MACC) (Projected)	$ 19,537,205.00	$ 21,248,705.00		$ 22,822,800.00		
A/E Fees: Per State Fee Formula	$ 1,113,528.00	$ 1,203,936.00		$ 1,491,765.00	$ 1,291,138.00	$ 1,291,138.00
SUBTOTAL	$ 20,650,733.00	$ 22,452,631.00	$ 32,594,532.00	$ 24,314,565.00	$ 22,554,653.00	$ 22,666,865.00
Donated Brick	$ (161,600.00)	$ (161,600.00)				
Additional Services (Allowance)						
Additional Design Fees						
DD/CD Fees for Skybox Suites and Field House						
FF&E (Furniture, Fixtures, and Equipment) (Allowance)	$ 230,000.00	$ 230,000.00	$ 230,000.00	$ 290,000.00	$ 239,000.00	$ 239,000.00
Food Service Equipment	$ 160,000.00	$ 380,000.00	$ 380,000.00	$ 260,000.00	$ 489,000.00	$ 281,270.00
Scoreboard (Allowance - No Video Board)	$ 185,000.00	$ 185,000.00	$ 185,000.00		$ 294,000.00	$ 294,000.00
Audio/Video Equipment					$ 648,000.00	
Reimbursables - Design Phases (Pre-Con Surveying, Geotech Explor)						
Construction Testing (Allowance)	$ 275,000.00	$ 275,000.00	$ 275,000.00	$ 300,000.00		
Commissioning (Allowance/Projection)	$ 70,000.00	$ 70,000.00	$ 70,000.00	$ 30,000.00	$ 50,000.00	$ 50,000.00
Administration & Miscellaneous (Allowance/Projection)	$ 590,000.00	$ 590,000.00	$ 590,000.00	$ 708,735.00	$ 440,294.00	$ 440,294.00
GRAND TOTAL	$ 21,999,133.00	$ 24,021,031.00	$ 34,324,532.00	$ 25,903,300.00	$ 26,006,085.00	$ 25,885,567.00

Appendix H: Fine Arts Center Raw Pre-Construction Budget Data

			750-SEAT THEATRE	1200-SEAT THEATRE
Date	2/11/2015	7/9/2015	10/25/2015	10/25/2015
Bldg. Construction	$ 28,790,000.00	$ 29,940,000.00		
Site & Utilities	$ 1,280,000.00	$ 1,330,000.00		
Built-in Equip.	$ 1,810,000.00	$ 1,880,000.00		
TARGET	$ 31,880,000.00	$ 33,150,000.00	$ 32,340,636.00	**$ 38,341,380.00**
Contingency/Ctgy	$ 1,594,000.00	$ 1,660,000.00	$ 1,617,032.00	**$ 1,917,069.00**
MACC	$ 33,474,000.00	$ 34,810,000.00	$ 33,957,668.00	$ 40,258,449.00
Design Fee	$ 1,837,872.00	$ 1,906,142.00	$ 1,906,142.00	$ 2,182,813.00
Moveable Equip	$ 2,702,124.00	$ 2,702,124.00	$ 3,640,000.00	$ 4,540,000.00
Other (Preconstruction Services)	$ 250,000.00	$ 100,000.00	$ 75,000.00	$ 90,000.00
Commission & Schedule	$ 330,000.00	$ 230,000.00	$ 230,000.00	$ 266,000.00
C&I Fees				
Admin & Misc	$ 606,004.00	$ 901,734.00	$ 841,190.00	$ 1,312,738.00
LOCAL PO & Work Orders				
Total Budget	**$ 39,200,000.00**	**$ 40,650,000.00**	**$ 40,650,000.00**	**$ 48,650,000.00**

Date	9/8/2016	12/6/2016	4/12/2017	4/20/2017
Bldg. Construction	$ 40,030,280.00	$ 40,030,280.00		$ 40,030,280.00
Site & Utilities	$ 1,330,000.00	$ 1,330,000.00		$ 1,330,000.00
Built-in Equip.	$ 1,880,000.00	$ 1,880,000.00		$ 1,880,000.00
TARGET	$ 43,240,280.00	$ 43,240,280.00	$ 43,873,297.00	$ 43,240,280.00
Contingency/Ctgy	$ 2,162,015.00	$ 2,162,015.00	$ 2,162,015.00	$ 2,162,015.00
MACC	$ 45,402,295.00	$ 45,402,295.00	$ 45,402,295.00	$ 45,402,295.00
Design Fee	$ 2,440,096.00	$ 2,440,096.00	$ 2,440,096.00	$ 2,440,096.00
Moveable Equip	$ 2,853,124.00	$ 2,853,124.00	$ 2,853,124.00	$ 2,853,124.00
Other (Preconstruction Services)	$ 135,000.00	$ 135,000.00	$ 135,000.00	$ 490,000.00
Commission & Schedule	$ 355,000.00	$ 355,000.00	$ 355,000.00	
C&I Fees				
Admin & Misc	$ 1,152,735.00	$ 1,152,735.00	$ 1,152,735.00	$ 1,152,735.00
LOCAL PO & Work Orders				
Total Budget	**$ 52,338,250.00**	**$ 52,338,250.00**	**$ 52,338,250.00**	**$ 52,338,250.00**

Appendix I: Fine Arts Center Raw Estimate Data

	DENARK SD	SUB	SCHEMATIC DESIGN
Main Building, TOTAL SF		101,577	89,920
Date	2/19/2016	2/19/2016	12/5/2016
Self Performed Totals			
General Conditions	$ 1,118,000.00	$ 1,118,000.00	$ 1,286,037.00
Sitework, Site Utilities	$ 1,674,126.00	$ 1,487,786.00	$ 1,857,828.00
Micropiles	$ 1,162,800.00	$ 965,685.00	$ 969,000.00
Paving	$ 96,832.00	$ 91,747.00	$ 87,414.00
Retaining Walls	$ 69,768.00	$ 69,768.00	
Landscaping and Irrigation			$ 102,163.00
Concrete	$ 3,654,442.00	$ 3,649,839.00	$ 3,328,021.00
Masonry & Stone	$ 4,178,124.00	$ 4,151,206.00	$ 3,909,613.00
Structural Steel	$ 5,041,804.00	$ 4,749,477.00	$ 4,701,325.00
Waterproofing & Fireproofing	$ 727,826.00	$ 704,470.00	$ 600,868.00
Metal Wall Panels	$ 780,193.00	$ 758,179.00	$ 218,756.00
Roofing	$ 733,942.00	$ 729,122.00	$ 821,457.00
Aluminum Storefront	$ 1,130,830.00	$ 1,094,713.00	$ 802,505.00
Drywall & Acoustical	$ 3,627,937.00	$ 3,627,937.00	$ 4,172,431.00
Flooring	$ 850,976.00	$ 849,696.00	$ 540,861.00
Wood Floor			
Polished Concrete	$ 13,339.00	$ 12,704.00	$ 34,219.00
Painting	$ 420,872.00	$ 411,281.00	$ 435,195.00
Audience Seating - See Design Team Allowance			$ -
Elevators	$ 324,231.00	$ 303,831.00	$ 144,405.00
Fire Protection	$ 387,982.00	$ 387,982.00	$ 431,584.00
Plumbing & HVAC	$ 6,384,179.00	$ 6,353,580.00	$ 5,561,550.00
Electrical	$ 5,214,644.00	$ 5,167,962.00	$ 4,362,075.00
Design Team Allowances	$ 2,709,199.00	$ 2,709,199.00	$ 3,141,340.00
TBR Testing Allowance	$ 122,400.00	$ 122,400.00	$ 122,400.00
General Trades	$ 3,157,673.00	$ 3,073,955.00	$ 2,088,670.00
Connector Canopy			$ 195,023.00
Subtotal	$ 43,582,119.00	$ 42,590,519.00	$ 39,914,740.00
CROSS CHECK SUBTOTAL	$ 43,582,119.00	$ 42,590,519.00	$ 39,914,741.00
SUBTOTAL	$ 43,582,119.00	$ 42,590,519.00	$ 39,914,741.00
Design & Cost Escalation Contingency	$ 1,743,285.00	$ 1,703,621.00	$ 1,596,590.00
DCI Contingency	$ 1,307,464.00	$ 1,277,716.00	$ 1,197,442.00
SUBTOTAL	$ 46,632,868.00	$ 45,571,856.00	$ 42,708,773.00
Bldg. Permit	$ 96,788.00	$ 94,600.00	$ 88,793.00
SUBTOTAL	$ 46,729,656.00	$ 45,666,456.00	$ 42,797,566.00
Contractor Provided Insurance	$ 112,854.00	$ 109,453.00	$ 176,204.00
DCI Profit	$ 983,693.00	$ 961,294.00	$ 902,449.00
P & P Bonds	$ 334,783.00	$ 327,160.00	$ 351,010.00
SUBTOTAL	$ 48,160,986.00	$ 47,064,363.00	$ 44,227,229.00
TOTAL	$ 48,160,986.00	$ 47,064,363.00	$ 44,227,229.00

Appendix I (cont.): Fine Arts Center Raw Estimate Data

	REVISED AFTER VE	DESIGN DEVELOPMENT	CONST. DOCUMENTS
Main Building, TOTAL SF	89,920	89,920	89,920
Date	12/7/2016	4/14/2017	12/12/2017
Self Performed Totals			$ 125,303.00
General Conditions	$ 1,286,037.00	$ 1,288,960.00	$ 640,832.00
Sitework, Site Utilities	$ 1,857,828.00	$ 1,927,096.00	$ 1,649,832.00
Micropiles	$ 969,001.00	$ 1,008,316.00	$ 894,500.00
Paving	$ 87,414.00	$ 108,476.00	$ 144,214.00
Retaining Walls			
Landscaping and Irrigation	$ 102,163.00	$ 170,341.00	$ 291,596.00
Concrete	$ 3,308,736.00	$ 2,858,523.00	$ 3,387,380.00
Masonry & Stone	$ 3,656,242.00	$ 4,652,777.00	$ 4,681,709.00
Structural Steel	$ 4,592,532.00	$ 4,643,791.00	$ 4,694,500.00
Waterproofing & Fireproofing	$ 500,868.00	$ 575,345.00	$ 449,927.00
Metal Wall Panels	$ 166,852.00	$ 224,900.00	
Roofing	$ 821,457.00	$ 874,221.00	$ 1,530,428.00
Aluminum Storefront	$ 802,505.00	$ 985,149.00	$ 1,063,730.00
Drywall & Acoustical	$ 4,197,181.00	$ 3,822,639.00	$ 4,049,993.00
Flooring	$ 540,861.00	$ 526,602.00	$ 414,241.00
Wood Floor			$ 325,295.00
Polished Concrete	$ 34,219.00	$ 87,731.00	
Painting	$ 435,195.00	$ 366,374.00	$ 435,002.00
Audience Seating - See Design Team Allowance		$ 292,682.00	
Elevators	$ 144,405.00	$ 170,721.00	
Fire Protection	$ 431,584.00	$ 379,892.00	$ 400,845.00
Plumbing & HVAC	$ 5,531,550.00	$ 5,246,188.00	$ 5,434,219.00
Electrical	$ 4,327,075.00	$ 4,343,757.00	$ 4,893,461.00
Design Team Allowances	$ 2,767,190.00	$ 2,191,279.00	
TBR Testing Allowance	$ 122,400.00	$ 153,000.00	$ 150,088.00
General Trades	$ 1,959,193.00	$ 1,986,111.00	$ 4,997,792.00
Connector Canopy	$ 145,940.00	$ 119,887.00	
Subtotal	$ 38,788,428.00	$ 39,004,758.00	$ 40,654,887.00
CROSS CHECK SUBTOTAL	$ 38,828,428.00	$ 39,004,758.00	$ 40,654,886.00
SUBTOTAL	$ 38,828,428.00	$ 39,004,758.00	$ 40,654,886.00
Design & Cost Escalation Contingency	$ 1,553,137.00	$ 1,560,190.00	
DCI Contingency	$ 1,164,853.00	$ 1,170,143.00	$ 1,223,662.00
SUBTOTAL	$ 41,546,418.00	$ 41,735,091.00	$ 41,878,548.00
Bldg. Permit	$ 86,390.00	$ 86,780.00	
SUBTOTAL	$ 41,632,808.00	$ 41,821,871.00	$ 41,878,548.00
Contractor Provided Insurance	$ 171,409.00	$ 172,187.00	$ 169,071.00
DCI Profit	$ 877,889.00	$ 881,875.00	$ 890,155.00
P & P Bonds	$ 341,457.00	$ 343,007.00	$ 301,160.00
SUBTOTAL	$ 43,023,563.00	$ 43,218,940.00	$ 43,238,934.00
TOTAL	$ 43,023,563.00	$ 43,218,940.00	$ 43,238,934.00

Appendix J: Football Stadium Multiple Subcontractor Estimate Table

Date (5/9/2016)	Estimates ->				
Sitework, Thomas Construction	$ 2,276,640.00	$ 2,336,896.00			
Site concrete, Summers-Taylor	$ 814,060.00	$ 821,300.00	$ 1,137,400.00	$ 1,266,846.00	
Asphalt Paving, Pave-Well	$ 454,477.00	$ 461,939.00	$ 466,019.00		
Fencing, Rio Grande	$ 198,727.00	$ 199,600.00	$ 206,300.00		
Retaining Wall, JJC	$ 53,500.00	$ 55,325.00	$ 56,001.00		
Synthetic Turf, Carolina Green	$ 828,350.00	$ 893,000.00	$ 903,920.00		
Landscaping, Planters & Designers	$ 247,484.00	$ 257,340.00	$ 328,663.00	$ 395,000.00	
Concrete, Procon	$ 2,741,313.00	$ 2,934,200.00	$ 3,463,911.00		
Masonry, Relyt	$ 913,305.00	$ 938,109.00	$ 1,081,390.00		
Steel, Fabricraft	$ 848,933.00	$ 859,773.00			
Steel Erection, ESI	$ 260,500.00				
Milwork, Preston	$ 262,115.00	$ 295,631.00	$ 298,284.00		
Waterproofing, ABG	$ 50,000.00	$ 57,600.00			
Spray Insulation, Mullins	$ 30,000.00	$ 49,094.00	$ 63,710.00		
Fluid Applied Weather Barrier, TF	$ 57,414.00	$ 59,775.00			
Caulking, C&W	$ 27,520.00	$ 45,000.00			
Roofing, Cornett	$ 142,192.00	$ 155,688.00	$ 179,515.00	$ 182,208.00	
Fireproofing, Firestop Technologies	$ 32,175.00				
Doors, Frames, Hardware, Trimble	$ 101,267.00	$ 105,484.00			
Overhead Door, Overhead Door of J	$ 60,487.00	$ 68,993.00			
Storefront, Keller	$ 399,746.00	$ 408,659.00			
Canopies, Interstate Awning	$ 6,800.00				
Metal Studs & Drywall, WFI	$ 487,259.00	$ 504,428.00	$ 505,576.00	$ 564,995.00	
Tile & Resilient Floor, Bonitz	$ 148,188.00	$ 150,867.00			
Acoustical CT Ceilings, Mullins (opt. 13)	$ 91,465.00	$ 109,163.00	$ 114,950.00		
Fluid Applied Flooring, Sure Step	$ 28,000.00	$ 33,900.00	$ 39,922.00	$ 49,987.00	
Stained Concrete, Sure Step	$ 6,265.00	$ 10,000.00	$ 12,000.00		
Painting, Woods Paint	$ 141,200.00				
Signage, Snyder	$ 19,150.00	$ 21,870.00			
Toilet Compartments, Southern	$ 60,269.00	$ 61,430.00	$ 62,010.00	$ 63,322.00	$ 69,697.00
Toilet Accessories, CLS	$ 24,254.00	$ 27,348.00	$ 29,746.00		
Fire Extinguishers, Southern	$ 2,387.00	$ 2,486.00			
Flag Poles, Southern	$ 6,077.00	$ 7,030.00			
Wall Padding, Sportsfield Specialties	$ 52,648.00				
Turf Protector, Southern Athletic	$ 5,015.00				
Aluminum Plank Seating, Southern	$ 112,900.00	$ 149,950.00			
Fixed Seating, Camatic	$ 137,531.00	$ 149,994.00	$ 163,217.00		
Elevator, Kone	$ 212,911.00				
Sprinkler, Simplex Grinnell	$ 140,765.00	$ 153,975.00	$ 163,400.00	$ 264,649.00	
Mechanical, HVAC	$ 1,717,881.00	$ 1,780,785.00	$ 1,868,936.00	$ 1,935,335.00	
Electrical, Kingsport Armature	$ 1,780,000.00	$ 1,895,000.00	$ 2,908,452.00		
Exterior Lighting, Lighting Trends	$ 96,177.00	$ 117,732.00			

Appendix K: Fine Arts Center Multiple Subcontractor Estimate Table (18 Months)

Date	2/17/2016			
	DCI			
Sitework & Site Utilities	$ 1,674,126.00	$ 1,728,946.00	$ 1,487,786.00	$ 1,639,446.00
Deep Foundations	$ 1,162,800.00	$ 1,295,400.00	$ 965,685.00	
Paving	$ 96,832.00	$ 91,747.00	$ 94,292.00	$ 113,391.00
Landscaping and Irrigation				
Retaining Walls	$ 69,768.00	$ 83,979.00		
Concrete	$ 3,654,442.00	$ 3,649,839.00	$ 3,971,043.00	
Masonry & Stone	$ 4,178,124.00	$ 4,151,206.00	$ 5,061,514.00	
Structural & Miscellaneous Steel	$ 5,041,804.00	$ 4,749,477.00	$ 4,751,920.00	
Waterproofing & Caulking	$ 727,826.00	$ 704,470.00		
Metal Wall Panels	$ 780,193.00	$ 794,934.00	$ 799,054.00	$ 758,179.00
Roofing	$ 733,942.00	$ 729,122.00	$ 1,063,407.00	
Aluminum Storefront & Glassing	$ 1,130,830.00	$ 1,094,713.00	$ 1,147,745.00	
Drywall & Acoustical	$ 3,627,937.00	$ 3,741,138.00	$ 4,095,421.00	
Flooring	$ 850,976.00	$ 849,696.00	$ 931,554.00	
Polished Concrete	$ 13,339.00	$ 12,704.00		
Painting	$ 420,872.00	$ 510,423.00	$ 411,281.00	
Elevators	$ 324,231.00	$ 303,831.00		
Fire Protection	$ 387,982.00	$ 394,740.00		
Plumbing & HVAC	$ 6,384,179.00	$ 6,353,580.00	$ 7,133,574.00	
Electrical	$ 5,214,644.00	$ 5,167,962.00	$ 5,196,900.00	
Design Team Allowances	$ 2,709,199.00			
TBR Testing Allowance	$ 122,400.00			
General Trades	$ 3,157,673.00	$ 3,073,955.00		
Connector Canopy				
Auditorium Seating				

Appendix L: Fine Arts Center Multiple Subcontractor Estimate Table (9 Months)

Date	11/10/2016					
	DCI					
Sitework & Site Utilities	$ 1,851,600.00	$ 2,219,403.00	$ 1,927,096.00	$ 1,883,058.00		
Deep Foundations	$ 1,008,316.00	$ 895,478.00	$ 1,201,203.00			
Paving	$ 107,900.00	$ 108,476.00				
Landscaping and Irrigation	$ 110,021.00	$ 170,341.00	$ 188,292.00	$ 163,812.00		
Retaining Walls						
Concrete	$ 2,858,523.00	$ 2,393,672.00	$ 3,361,886.00			
Masonry & Stone	$ 4,283,509.00	$ 4,652,777.00	$ 4,356,640.00	$ 4,974,469.00		
Structural & Miscellaneous Steel	$ 4,852,252.00	$ 4,643,791.00	$ 4,302,707.00	$ 5,189,503.00		
Waterproofing & Caulking	$ 580,696.00	$ 575,345.00	$ 491,903.00	$ 370,566.00	$ 243,068.00	$ 333,853.00
Metal Wall Panels	$ 273,105.00	$ 224,900.00	$ 304,306.00			
Roofing	$ 863,798.00	$ 910,533.00	$ 817,340.00	$ 874,221.00		
Aluminum Storefront & Glassing	$ 936,335.00	$ 985,149.00				
Drywall & Acoustical	$ 3,498,663.00	$ 3,822,639.00	$ 3,582,275.00			
Flooring	$ 607,414.00	$ 526,602.00	$ 584,117.00	$ 496,035.00		
Polished Concrete	$ 87,731.00	$ 119,660.00	$ 108,403.00			
Painting	$ 365,374.00	$ 224,716.00	$ 520,486.00			
Elevators	$ 180,411.00	$ 170,721.00				
Fire Protection	$ 379,892.00					
Plumbing & HVAC	$ 5,700,226.00	$ 5,245,180.00	$ 5,550,447.00	$ 4,925,580.00		
Electrical	$ 5,162,808.00	$ 4,601,434.00	$ 4,343,757.00	$ 3,839,710.00		
Design Team Allowances	$ 2,191,279.26	$ 2,744,188.00				
TBR Testing Allowance	$ 153,000.00					
General Trades	$ 1,875,308.00	$ 1,985,111.00				
Connector Canopy	$ 123,998.00	$ 119,887.00				
Auditorium Seating	$ 357,000.00	$ 292,582.00	$ 269,637.00	$ 392,700.00		