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Using Conceptual Cost Estimating as a Constraint and Tool in Design Curriculum

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Abstract

Architectural firms use simple unit/area-based, pre-design budgeting to develop/confirm project scopes with clients. These budgets are created based on project history, plus the knowledge of local site attributes and contingencies associated with the specific project type to be designed. The typical budgeting models used lack specificity and do not address enough variables for a typical pre-design budget requirement. As an architectural and construction consultant, representing owners in the selection of professionals for project development, I developed a cost estimating tool that modeled risk assessment using factors such as: (1) the influence of location, (2) labor availability, (3) staging, (4) complexity, and (5) code enforcement. The tool was developed using a database of 60+ projects within the Long Island region and was used successfully in the capital planning of a major non-profit organization for 10+ years.

This conceptual cost method and spreadsheet has been adapted to teach design students to use this estimating approach to test: (1) size, (2) construction type, and (3) functional use, early in the design process. Using a spreadsheet and historical cost data provided by an authoritative national source, students can be trained to develop a budget for design, construction and project management costs. This budget can then be used to compare construction types, use groups and size quickly without extensive experience in conceptual design or field experience in construction. The factors from the assessment of site/location attributes, labor, staging, complexity and codes add a perspective that students without construction experience or professional networks in the design and construction sectors would normally apply.

This tool has been used in an upper-level design course for several years to examine the influence of size and construction types in preparing design responses. The data was used to describe ABET outcomes (SO 2) to demonstrate an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors, and (SO 6) to demonstrate an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.

Introduction

The design and construction sectors deliver services based on a profit model. Despite this, economic analysis in architectural design instruction is severely lacking. The standards that govern economic analysis in architectural design, professional, and instructional activities are ambiguous at best. This is reflected by the accreditation standards for professional programs overseen by the National Architectural Accreditation Board (NAAB) and for architectural engineering technology programs overseen by the Accreditation Board for Engineering Technology (ABET).

The design and construction sectors operate on a profit-driven model, yet the integration of economic analysis in architectural design education remains inadequate. The existing standards governing economic analysis in architectural design, both in professional practice and instructional activities, suffer from a lack of clarity. This discrepancy is evident in the accreditation standards set by NAAB for professional programs and ABET for architectural engineering technology programs.

NAAB requires that "SC.2 Professional Practice [1] – How the program ensures that students understand professional ethics, the regulatory requirements, the fundamental business processes relevant to architecture practice in the United States, and the forces influencing change in these subjects." ABET stipulates in Criterion 3 – Student Outcomes [2] that students learn to use and apply economic knowledge in outcomes 2 and 6. Outcome 2 states "an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors," while Outcome 6 states students shall demonstrate "an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions."

Despite these accreditation requirements, the inclusion of comprehensive economic analysis in architectural design education remains limited. Existing budgeting models used by architectural firms for pre-design purposes lack specificity and fail to address the multitude of variables that influence project costs. As an architectural and construction consultant representing project owners in the selection of professionals for project development, I recognized the need for a more robust cost estimating tool that incorporated risk assessment factors for location, labor availability, staging, complexity, and code enforcement.

The author of this paper led a program-management office that managed the project deliverables of architects as well as construction firms. Project cost projection was a focal point of contention during the design phase and at the acceptance of bids. Within the architectural profession, there is disagreement regarding the level of responsibility an architect assumes for the accuracy and specificity of a cost estimate. This raises issues of risk management in designing for budgets and how it applies to architects in this realm.

To address this gap, I developed a cost estimating tool that utilized historical data from over 60 projects in the Long Island region. This tool, which successfully facilitated capital planning for a major non-profit organization for over a decade, provided a conceptual cost method and spreadsheet that enabled design students to test the impact of size, construction type, and functional use during the early stages of the design process. By leveraging a spreadsheet and authoritative national cost data, students could acquire the skills to develop budgets encompassing design, construction, and project management costs.

This tool proves invaluable in enabling students to make quick comparisons between construction types, use groups, and sizes without requiring extensive experience in conceptual design or construction fieldwork. By employing this tool in an upper-level design course, we were able to examine the influence of size and construction types on design responses. The resulting data supported the fulfillment of ABET outcomes, specifically Outcome 2, which demonstrated the students' ability to apply engineering design principles to meet specified needs while considering various factors. Additionally, Outcome 6 was addressed through the students' capacity to conduct appropriate experimentation, analyze and interpret data, and exercise engineering judgment to draw meaningful conclusions.

By incorporating comprehensive economic analysis into architectural design education, we can bridge the gap between the profit-driven nature of the design and construction sectors and the development of well-rounded design professionals. This integration aligns with the accreditation standards established by NAAB and ABET, enabling students to acquire the necessary skills and knowledge to navigate the economic aspects of architectural design successfully.

Applicable Standards

The ambiguities created in these learning outcomes produce vague standards which make economic analysis subjective in teaching instruction. These are broad statements to ensure students are provided adequate instruction and experiences to learn the skills, techniques, and technical knowledge that will serve them to develop as design professionals. The "economic factors" and "economic knowledge" required are not measured specifically, consistently, or objectively from program to program. This subjective standard can produce design students who lack the proper training of real-world application of aligning scope and costs.

Students graduating from schools accredited by both programs (NAAB and ABET) can take the Architectural Registration Exam (ARE) offered by the National Council of Architectural Registration Board (NCARB). NCARB seems to provide a clearer standard.

NCARB has its own criteria to establish the minimum level of knowledge regarding economic analysis of architectural design. ARE Section 5, Project Planning and Design providing two clear objectives for exam candidates [3]:

(1) "Objective 5.1, Evaluate design alternatives based on the program", where "various factors that affect costs" are to be considered; and

(2) "Objective 5.2, Perform cost evaluation," where candidates must "Evaluate various methods of estimating project costs, including those based on program type, square footage, or systems/assemblies.

In addition to the two objectives stated by the NCARB on economic analysis, candidates must further develop basic estimation skills. In addition to alternatives and cost evaluations, candidates must also be able to create a preliminary cost estimate, adjust the estimate as the design develops, calculate the cost of design alternatives, and reconcile the estimate with the project budget;" and "Objective 5.3, Evaluate cost considerations during the design process," where the candidates "will need to determine if a project design must be modified based on cost evaluations and budgetary needs." The objective standards set forth by the NCARB directly relate to Design Professionals and that the goal to align scope development and design response with budgets.

The American Institute of Architects (AIA) Risk Management Trust published an article, "What is the architect's obligation to design to budget?" In this article, the AIA risk management staff cautioned practitioners to carefully review contractual obligation for cost projection and management. Their specific recommendations note:

> "In preparing estimates of the Cost of Work, the architect shall be permitted to include contingencies for design, bidding, and price escalation; to determine what materials, equipment, component systems, and types of construction are to be included in the Contract Documents; to recommend reasonable adjustments in the program and scope of the Project; and to include design alternates as may be necessary to adjust the estimated Cost of the Work to meet the Owner's budget" [4].

The Owner-Architect Agreement (AIA Form B101), Section 6.3 [4] governs the architect's responsibility for this specific fiduciary responsibility. The article recommends that architects carefully examine the contractual obligations for projection and estimating of project costs, lest they have to redesign the project to bring it back within the budget approved by the client.

For the Design Professional, this means that Owners may keep the Architect liable for project costs and controls in their contractual agreements. This is a major liability on large scale projects, where most Architects may be under the impression that they are only at fault for defects in their design. Furthermore, the extra risk for economic analyses for a project can create a massive increase in Design Professional malpractice insurance. Due to the standards, the AIA's position on an Architects responsibility for the creation of budget and estimates, and potential legal exposure and insurance increases to practitioners, we need objective standards taught to students to try and alleviate the current ambiguity in design course planning to prepare students for future design and fiduciary responsibilities as design professionals.

Estimates and Design Management

The accepted form of estimates provided by architects prior to clients bidding their work is a square-foot cost based upon historical data for the design program type. The AIA contract documents [4] noted in the article refer to historical unit cost as a professional standard. Dysert [5] describes this type of estimate as an analogous estimate; "an analogous estimate is typically prepared by selecting a completed project as a base case, and then adjusting the historical costs for the technical, performance, complexity, physical, and other differences between the new project and the base case." When preparing this estimate, we generally end up with a single point, which is usually the cost.

The single point (cost) is evaluated by generating a cost per unit (normally area), where the total project costs is divided by the total gross area of the building. Such evaluation is made without reference to: (1) specific conditions about site condition, (2) site limitations for implementation, (3) labor availability, and (4) complexity of construction or management. The exception to this would apply if the architect has all of those data sets available and has experience that would provide the client with appropriate data to manage financial risk vs. anticipated design/scope.

Data needed to create analogous estimates are available from several different sources. Common places to find data are from sources such as: (1) commercially created cost database (such as R.S Means/Gordian and Design Cost Data), (2) project data maintained by architectural firms using their portfolio of completed projects, in conjunction with consultation and current market conditions provided to them from local contractors that they have a long-term business relationship with. With this information, the architect makes analogous estimating the default standard. The AIA Risk Management articles noted that management of the specific fiduciary and economic tasks for project cost projection and control are often obscured [4]; "Most architects don't fully appreciate the impact of Section 6.3 or don't invoke it, tending to defer to other forces at work during the design process." The lack of controls in the cost analysis segment of design is a major risk management issue for architects which is not acknowledged during the training of architects.

An architect relying on a contractor's data for an analogous estimate are opening themselves to liability. The risk of using historical cost data without acknowledging or recognizing how a contractor uses their means and methods to factor and filter for risk may provide the architect or designer with a false range of costs in determining a budget by square foot analysis based on project type alone during the design of the project. Moreover, as Building Information Modeling (BIM) is adapted for designing both large and small projections, the integration of graphic, technical, and operational data will require that inexperienced designers be trained to recognize that historic cost data manipulated on a unit area basis will not satisfy the evolving expectations of clients to provide a real-time model to incorporate the impact of design and construction management criteria. The utilization of BIM in conjunction with the integrated project delivery method will reinforce the designer's need to have more accurate cost projections.

As BIM and integrated project delivery (IPD) become more widely accepted, the adaption of cost estimating throughout the entire design process which targets and manages all direct and indirect costs discretely will displace traditional design-bid-build strategies for project design, procurement, and cost management [6]. D.Do noted in this process, architects/designers, construction managers, clients, and other strategic stakeholders are working together from the initial design concept to the procurement phase, prior to construction, to monitor how the design and constr-uction work with the budget targets. This process is called "targeted value design".

The concept of "targeted value design" as presented by P. Orihuela, J. Orihuela and Pacheco [7] as an adaptation of lean construction project delivery establishes a target for "a cost structure following the same sequence as that of the design process, which allows economic valuations at any stage of process development." The observations of their study, paired with the use of the cost projection workbook presented in this paper would provide a suitable framework to develop a formal integration of targeted design value into architectural design studios. Moreover, the addition of these cost methods and projections can help the student become more prepared for the ARE, as well as meeting and exceeding NCARB standards.

These targets are established based on a robust evaluation of all direct and indirect cost data and the impact of factors external to the control of all stakehold-ers. Integrating cost projections throughout the phases of project development are critical for the construction team to achieve a completed project within the realm of the Owner's budget.

Integrating Cost Projection into Architectural Design Instruction

Design requires thought and skill, but the ability of designing within budgetary restraints is a strategic successful outcome for a design professional and should be taught to students accord-ingly. Lee [8] stated "Research finds that what one commonly sees in architecture schools is the separation of academic minds from the world around them." In her paper "Toward Teaching Cost Conscious Design in Architectural Design Education," she reviewed the various discussions within the professional community of architects teaching design about addressing the integration of budgetary constraints into the student design process as part of a larger goal. This goal was to encourage the profession to engage in projects that serve a more diverse and non-traditional

Table 2: When do you think is the most optimal time to discuss cost in architectural project?

Participants	Response
Construction Science Professor	Cost shall be considered at the conceptual stage of the design
NGOs in Housing	Even before any design is considered, budget should be the first thing discussed
Local Builder	From the beginning-it effects everything
Architectural Design Professor	While they are designing
Architects	Early on… very beginning, as early as possible

Figure 1. Lee, Table 2 [8]

Table 3: When do you think is the most optimal time to expose students to cost implication in architectural design?	
Participants	Response
Construction Science Professor	As early as possible, starting from the very first semester
NGOs in Housing	From the first year
Local Builder	From the beginning-it effects everything
Architectural Design Professor	When they start working on buildings fully – by the third year and even then it should be exploratory
Architects	Very early in the foundation years

Figure 2. Lee, Table 3 [8]

community. Using a survey of faculty, practicing architects, contractors, and clients (NGO as referenced), Lee summarizes the response to her inquiries with Tables 2 and 3 in her paper about the timing of developing project budgets and training students to recognize the importance of cost projection and management in the design process.

An additional question raised by Lee regarding the means and methods of providing students with "cost awareness" is inconclusive and reflects the diversity of the professionals surveyed. In summary, Lee states architectural design education is more focused on the ideology of design instead of socially responsible design, inferring that teaching students the relationship between design and costs is both appropriate for the development of students who will be practical emerging professionals.

Davis, Fuller and Petry discuss the importance of making their architectural engineering technology curriculum more integrative to reflect the actual practice of architecture that students emerging as professionals will encounter. [9] "Realistic issues are integrated into the design studios – real programs, real sites, cost estimating, and scheduling." Figure 2 presents a sample of their redesign of curriculum to achieve integration between design, technology and cost management that were implemented in their Design III, IV and V courses.

Design IV: AET 352

Course Description: **An architectural design studio course with a focus on design of buildings, with an increased complexity and scale, in a contextual setting. A systematic site and environmental analysis and design of a preliminary master plan will be followed by an architectural project exploring the formal and informal fundamentals of design.**

Course Integrations:

Architectural Design	Site Planning
Architectural Drawing	Master Planning
Architectural History	Interior Design
Working Drawings	Estimating
Technical Writing and Communication	Structural Engineering
Abstract Composition	Mechanical Engineering
Model Making	Electrical Engineering
Sketching	Plumbing Engineering
Architectural Rendering	Civil Engineering
Psychology	

Figure 3. Davis, Fuller and Petry. Architectural Design IV course description [9]

The presentation by the authors is exceptional because economic analysis is incorporated as a fundamental activity for design instruction. Moreover, the identification of the relationship between economic analysis and design decisions helps students to deduce the necessity of the budget in their design to contribute to a successful design outcome, while exposing them at an early stage in their career on the problem-solving skills they must develop to get their design accepted by owners, who are measuring success partially through conformance to their self-identified budget(s). In addition, this opens an avenue for curriculums to expose students to lean construction methods, thereby embracing cost controls while reducing waste in construction. A shift into these educational models can provide tools for the students to achieving value for their clients while getting their designs built.

Cost Projection Tool Development to Facilitate Cost Projection for Design Students

Design students need to learn cost projection as part of the design process in order to help them prepare to adapt to the changing environment of project delivery systems. Current curriculums serving architecture and architectural engineering students present an opportunity to incorporate cost projection and evaluation by modeling processes. The process should use procedures or tools that are: (1) scalable; (2) adaptable for increasingly complex project scope; and (3) that can use a number of data sets to create a consistent ability to use the tool. The use of this process can help acclimate the students to the real-world encounters that they will incur as architectural professionals. The author of the paper has adapted a cost projection workbook spreadsheet developed to manage projects for a large non-profit institution that adapted a project management approach, similar to a targeted value design.

The development of this approach started with analogous estimates for approximately 60- 70 projects designed and constructed in our local market within a 5-year period. As Kanabar noted in his presentation regarding the adaption of the new estimating standards for the Project Management Institute [10], analogous estimating can be a useful departure point to develop high level budgets and estimates based upon identification of “Project Effort, Project Schedule, Project Cost, Project Resources, Project Documentation.”

The techniques used to develop the spreadsheet included review of 60-plus projects, using the schedule of values, change order scope and costs, relationship of general condition costs to the overall project costs and indirect costs for design and regulatory compliance.

Dell’Isola [11] summarized the application of this approach as accurately defining and aligning the scope of the project, expectations of the client, and budget management from the pre-design analysis to completion of construction. In his 2002 book, Architect’s Essentials of Cost Management, he further described many of the same strategies outlined by Do in his article on targeted value design. Both approaches embrace assembling data that models direct and indirect cost factors that enhance the use of the traditional analogous estimating approach traditionally used by architects.

This data produced by this spreadsheet was used on the owner-side of project development to organize budgets for design services with contingencies, construction costs with contingencies, regulatory costs with contingencies, and associated project management costs of the institution. Firms working with the author used this pre-design budgeting spreadsheet to develop/confirm project scope with clients based on project history, plus review of factors and contingencies identified by the institution's project management staff that significantly affected project costs. Using this tool to manage delivery of the project to clients, architectural professionals achieved a reduction or elimination of cost overruns previously experienced by institutional stakeholders over a 10-year period. Additionally, this spreadsheet has helped institutions make appropriate budgetary decisions on construction in an expedient and accurate manner.

The tool has been adapted by the author to engage students about the relationship between design projects and costs of projects. The approach used in the author's Architectural Design IV studio combines the activity of preparing an architectural program for the semester project to determine the size of the building proposal with the development of costs. The traditional method of applying square foot costs to a completed design is modified by introducing variables that incorporate factors used by construction firms and professionals to establish a context to assess construction related issues. The spreadsheet comes with several stipulations before using:

- The program preparation requires a design concept with defined functional elements and sizes.
- A proposed net square area of useable space and a gross square area to accommodate useable area, circulation, and structural space is determined.
- The construction type of the proposed building is proposed in accordance with the NFPA 220 Standard on Types of Building Construction [12].
- The students determine the use group of the proposed project using the Building Code of New York State, chapter 3 – Occupancy Classification and Use [13].
- The student will apply the net and/or gross area data to the cost projection tool and modify factors to develop a cost projection for the project that incorporates site factors, labor factors, and other direct/indirect cost factors.

The student can develop different scenarios based upon size, construction type, use group and modification of all site factors, labor factors, and other direct/indirect cost factors to examine options to establish a pre-design budget that will identify the target for the design/cost. Once the student has a design, the format for cost projection can be applied again to the proposed design to compare the program budget to the design budget. The student and the instructor can discuss design, resources required to construct the design, and the factors used to generate the cost projection to have an informed discussion on all issues affecting project development. Figure 3 presents the four worksheets of the workbook. Project identification and date of preparation is entered on Worksheet 1, and the data entry begins on Worksheet 4 and goes to Worksheet 3, then Worksheet 2 and Worksheet 1. As you can see from the worksheet, this is a learning tool that is more involved and advanced than a typical analogous estimate, with more variables to consider in decision making of design.

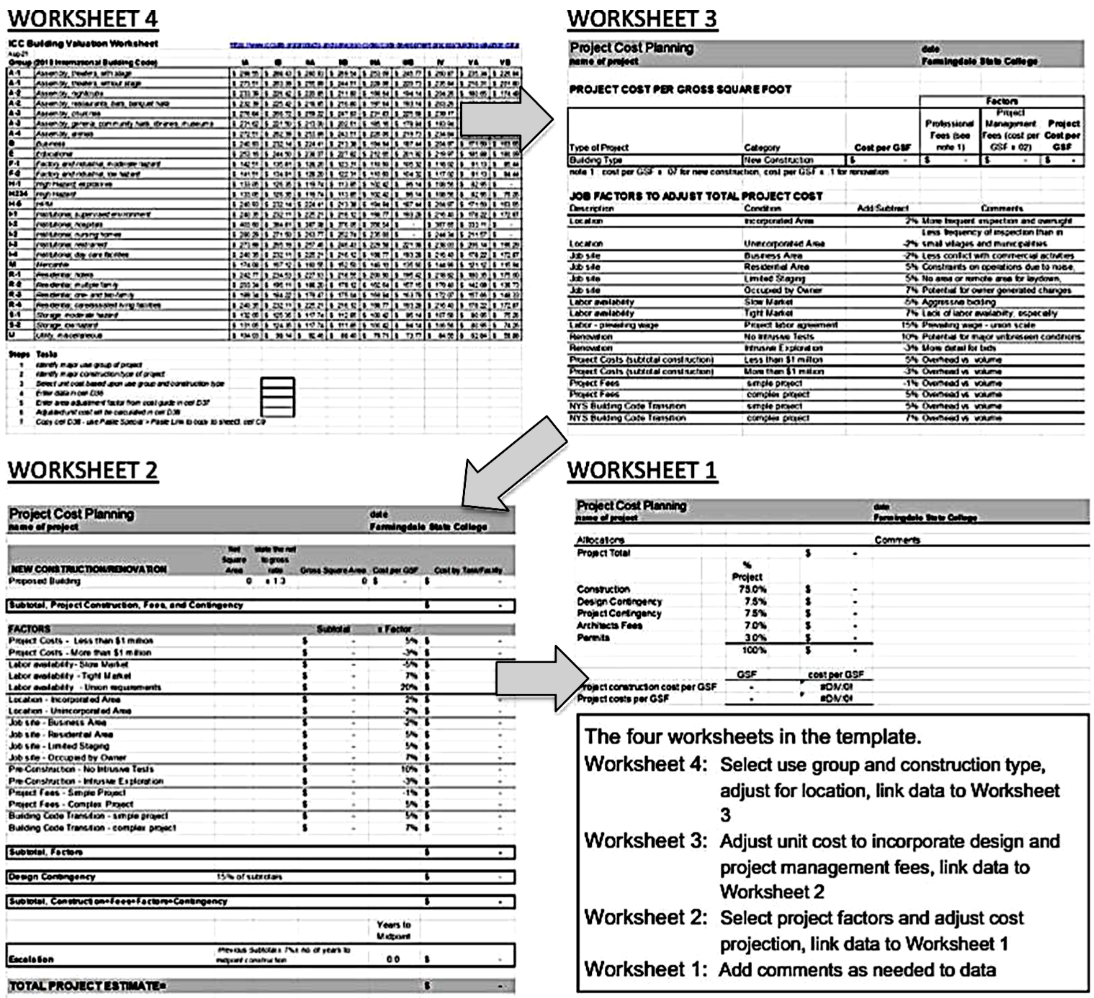

Figure 3. Overview of Cost Projection Workbook template

ICC Building Valuation Worksheet https://www.iccsafe.org/products-and-services/i-codes/code-development-process/building-valuation- data/

Aug-21

Group (2018 International Building Code)		IA	IB	IIA	IIB	IIIA	IIIB	IV	VA	VB
A-1	Assembly, theaters, with stage	$ 298.55	$ 288.43	$ 280.93	$ 269.54	$ 253.09	$ 245.77	$ 260.87	$ 235.34	$ 226.84
A-1	Assembly, theaters, without stage	$ 273.51	$ 263.39	$ 255.89	$ 244.51	$ 228.06	$ 220.73	$ 235.84	$ 210.31	$ 201.80
A-2	Assembly, nightclubs	$ 233.39	$ 226.42	$ 220.85	$ 211.80	$ 199.64	$ 194.14	$ 204.26	$ 180.65	$ 174.48
A-2	Assembly, restaurants, bars, banquet halls	$ 232.39	$ 225.42	$ 218.85	$ 210.80	$ 197.64	$ 193.14	$ 203.26	$ 178.65	$ 173.48
A-3	Assembly, churches	$ 276.84	$ 266.72	$ 259.22	$ 247.83	$ 231.83	$ 225.68	$ 239.17	$ 214.08	$ 205.57
A-3	Assembly, general, community halls, libraries, museums	$ 231.62	$ 221.50	$ 213.00	$ 202.61	$ 185.16	$ 178.84	$ 193.94	$ 167.42	$ 159.91
A-4	Assembly, arenas	$ 272.51	$ 262.39	$ 253.89	$ 243.51	$ 226.06	$ 219.73	$ 234.84	$ 208.31	$ 200.80
B	Business	$ 240.93	$ 232.14	$ 224.41	$ 213.38	$ 194.94	$ 187.44	$ 204.97	$ 171.50	$ 163.65
E	Educational	$ 253.16	$ 244.50	$ 238.07	$ 227.82	$ 212.65	$ 201.92	$ 219.97	$ 185.88	$ 180.09
F-1	Factory and industrial, moderate hazard	$ 142.51	$ 135.81	$ 128.20	$ 123.31	$ 110.60	$ 105.32	$ 118.02	$ 91.13	$ 85.44
F-2	Factory and industrial, low hazard	$ 141.51	$ 134.81	$ 128.20	$ 122.31	$ 110.60	$ 104.32	$ 117.02	$ 91.13	$ 84.44
H-1	High Hazard, explosives	$ 133.05	$ 126.35	$ 119.74	$ 113.85	$ 102.42	$ 96.14	$ 108.56	$ 82.95	$ -
H234	High Hazard	$ 133.05	$ 126.35	$ 119.74	$ 113.85	$ 102.42	$ 96.14	$ 108.56	$ 82.95	$ 76.26
H-5	HPM	$ 240.93	$ 232.14	$ 224.41	$ 213.38	$ 194.94	$ 187.44	$ 204.97	$ 171.50	$ 163.65
I-1	Institutional, supervised environment	$ 240.35	$ 232.11	$ 225.21	$ 216.12	$ 198.77	$ 193.28	$ 216.40	$ 178.22	$ 172.87
I-2	Institutional, hospitals	$ 403.60	$ 394.81	$ 387.08	$ 376.05	$ 356.54	$ -	$ 367.65	$ 333.11	$ -
I-2	Institutional, nursing homes	$ 280.29	$ 271.50	$ 263.77	$ 252.74	$ 235.00	$ -	$ 244.34	$ 211.57	$ -
I-3	Institutional, restrained	$ 273.98	$ 265.19	$ 257.46	$ 246.43	$ 229.58	$ 221.08	$ 238.03	$ 206.14	$ 196.29
I-4	Institutional, day care facilities	$ 240.35	$ 232.11	$ 225.21	$ 216.12	$ 198.77	$ 193.28	$ 216.40	$ 178.22	$ 172.87
M	Mercantile	$ 174.08	$ 167.12	$ 160.55	$ 152.50	$ 140.10	$ 135.60	$ 144.96	$ 121.12	$ 115.94
R-1	Residential, hotels	$ 242.77	$ 234.53	$ 227.63	$ 218.55	$ 200.90	$ 195.42	$ 218.82	$ 180.35	$ 175.00
R-2	Residential, multiple family	$ 203.34	$ 195.11	$ 188.20	$ 179.12	$ 162.64	$ 157.15	$ 179.40	$ 142.08	$ 136.73
R-3	Residential, one- and two-family	$ 189.34	$ 184.22	$ 179.47	$ 175.04	$ 169.94	$ 163.79	$ 172.07	$ 157.66	$ 148.33
R-4	Residential, care/assisted living facilities	$ 240.35	$ 232.11	$ 225.21	$ 216.12	$ 198.77	$ 193.28	$ 216.40	$ 178.22	$ 172.87
S-1	Storage, moderate hazard	$ 132.05	$ 125.35	$ 117.74	$ 112.85	$ 100.42	$ 95.14	$ 107.56	$ 80.95	$ 75.26
S-2	Storage, low hazard	$ 131.05	$ 124.35	$ 117.74	$ 111.85	$ 100.42	$ 94.14	$ 106.56	$ 80.95	$ 74.26
U	Utility, miscellaneous	$ 104.03	$ 98.14	$ 92.46	$ 88.40	$ 79.71	$ 73.77	$ 84.55	$ 62.84	$ 59.88

STEP 1
Identify use group
STEP 2
Identify construction type
STEP 3
Select unit cost based on use group & type
STEP 4
Enter data in cell
STEP 5
Enter area location factor From FIGURE 5
STEP 6
Adjusted unit cost will be calculated and is linked to worksheet 3

Figure 4. Worksheet 4 – Cost per gross square foot by use group and construction type [14].

METRO AREA MULTIPLIERS		
State	Metropolitan Area	Multiplier
NY	ALBANY	1.09
	AMSTERDAM	1.18
	BINGHAMTON	1.06
	BUFFALO	1.04
	DUTCHESS COUNTY	1.40
	ELMIRA	1.07
	GLENS FALLS	1.08
	ITHACA	1.18
	JAMESTOWN	1.05
	KINGSTON	1.18
	LOCKPORT	1.18
	LONG ISLAND	1.18
	MALONE	1.18
	NASSAU	1.44
	NEW YORK CITY	1.50
	NEWBURGH	1.40
	NIAGARA FALLS	1.16
	ROCHESTER	1.07
	ROME	1.07
	SCHENECTADY	1.09
	SUFFOLK	1.44
	SYRACUSE	1.06
	TROY	1.09
	UTICA	1.07
	WATERTOWN	1.18
	WHITE PLAINS	1.18

Figure 5. Area Multiplier Table, DCD Guide [15]

The Building Valuation Data is created by the International Code Council to assist building departments to calculate the cost of permit fee from permit sets submitted for review. The introduction notes [14] "The BVD table provides the "average" construction costs per "square foot"; this data is collected nationally and reflects the average cost of construction for each use group and construction type.

These costs are updated every 6 months, and will not reflect changes to cost based upon escalation, supply chain disruption, or other market volatility.

Area location must be used to adjust the cost per square foot by multiplying the unit cost by the percent above or below the national average cost.

Worksheet 3 brings the adjusted cost per square foot from Worksheet 4 and modifies the cost to account for design and project management fees. The instructor can discuss professional fees as a topic in class to make students aware of how and why professional services are calculated for compensation. The table is a guide to the next series of cost adjustments that will be made to the overall costs. Location based on political jurisdiction is assessed and selected to model risk assessment contractors might apply in job pricing. The adjacencies and/or conditions of project sites are reviewed to exposure to risks beyond the control of the project stakeholders for project operations at the site. Labor availability is assessed to determine if the solicitation of trades will cost less or more for that period. Project cost risks are assessed to determine if the cost of the project will result in a lower percentage of cost supporting company overhead. A similar assessment is applied to project fees. Finally, every 3 to 5 years, building code adaption affects the oversight of the project by the authority having jurisdiction; plan review and field activities are affected by the learning curve for revised or new code amendments and often lead to less flexible interpretations of the code. This data was compiled from the 60+ projects reviewed by the author for the development of the institutional cost projection worksheet.

Enter the net and gross area to calculate an analogous total cost. The total cost is modified by direct and indirect project cost factors. An allocation for design contingency is calculated, and escalation based on an estimated midpoint of construction cost is calculated. The instructor guides students into general discussions about these factors and the duration of direct costs, indirect costs, and the general duration of project pre-construction and construction activities. This review provides pragmatic depth to assist the students in acquiring the knowledge that both NAAB and ABET standard stipulate about ensuring students understand the factors affecting

PROJECT COST PER GROSS SQUARE FOOT			Factors		
Type of Project	Category	**Cost per GSF**	Professional Fees (see note 1)	Project Mgmt. Fees (cost per GSF x.02)	**Project Cost per GSF**
Building Type	New Construction	$ -	$ -	$ -	**$ -**
note 1: cost per GSF x .07 for new construction, cost per GSF x .1 for renovation					

JOB FACTORS TO ADJUST TOTAL PROJECT COST			
Description	Condition	Add/ Subtract	Comments
Location	Incorporated Area	2%	More frequent inspection and oversight
Location	Unincorporated Area	-2%	Less frequency of inspection than in small villages and municipalities
Job site	Business Area	-2%	Less conflict with commercial activities
Job site	Residential Area	5%	Constraints on operations due to noise,
Job site	Limited Staging	5%	No area or remote area for laydown,
Job site	Occupied by Owner	7%	Potential for owner generated changes
Labor availability	Slow Market	-5%	Aggressive bidding
Labor availability	Tight Market	7%	Lack of labor availability, especially
Labor - prevailing wage	Project labor agreement	15%	Prevailing wage - union scale
Renovation	No Intrusive Tests	10%	Potential for major unforeseen conditions
Renovation	Intrusive Exploration	-3%	More detail for bids
Project Costs (subtotal construction)	Less than $1 million	5%	Overhead vs. volume
Project Costs (subtotal construction)	More than $1 million	-3%	Overhead vs. volume
Project Fees	simple project	-1%	Overhead vs. volume
Project Fees	complex project	5%	Overhead vs. volume
NYS Building Code Transition	simple project	5%	Overhead vs. volume
NYS Building Code Transition	complex project	7%	Overhead vs. volume

Figure 5. Worksheet 3 – Adjust costs from Worksheet 4 for design and project management fees

NEW CONSTRUCTION/RENOVATION	Net Square Area	state the net to gross ratio	Gross Square Area	Cost per GSF	Cost by Task/Facility
Proposed Building	0	x 1.3	0	$ -	$ -
Subtotal, Project Construction, Fees, and Contingency					**$ -**
FACTORS			Subtotal	x Factor	
Project Costs - Less than $1 million			$ -	5%	$ -
Project Costs - More than $1 million			$ -	-3%	$ -
Labor availability- Slow Market			$ -	-5%	$ -
Labor availability - Tight Market			$ -	7%	$ -
Labor availability - Union requirements			$ -	20%	$ -
Location - Incorporated Area			$ -	2%	$ -
Location - Unincorporated Area			$ -	-2%	$ -
Job site - Business Area			$ -	-2%	$ -
Job site - Residential Area			$ -	5%	$ -
Job site - Limited Staging			$ -	5%	$ -
Job site - Occupied by Owner			$ -	7%	$ -
Pre-Construction - No Intrusive Tests			$ -	10%	$ -
Pre-Construction - Intrusive Exploration			$ -	-3%	$ -
Project Fees - Simple Project			$ -	-1%	$ -
Project Fees - Complex Project			$ -	5%	$ -
Building Code Transition - simple project			$ -	5%	$ -
Building Code Transition - complex project			$ -	7%	$ -
Subtotal, Factors					**$ -**
Design Contingency	15% of subtotals				$ -
Subtotal, Construction+Fees+Factors+Contingency					**$ -**
				Years to Midpoint	
Escalation	Previous Subtotal x 7%x no. of years to midpoint construction			0.0	$ -
TOTAL PROJECT ESTIMATE=					**$ -**

Figure 6. Worksheet 2– Adjust costs from Worksheet 3 with allocations to incorporate factors based on project complexity, labor availability, job site context, pre- construction review, project fee and code transition fee adjustment.

economic analysis of projects and integrating it within an applied design process. Additionally, with the availability of the multivariable factors given in the worksheet, instructors have the flexibility of stressing factors they feel are more relevant in their jurisdiction, while exposing students to the details and considerations needed in overall cost projections.

Finally, the adjusted total cost is imported into Worksheet 1 and is allocated 75% constr-uction and 25% fees/contingencies. The construction costs and the project costs totals are divided by the gross square area to establish a unit cost per square feet. These costs can be compared with established construction costs databases or guides to review the similarities or differences and have a review of additional issues with the students to identified additional factors that may affect specific building types, construction types, or site-specific issues.

Allocations					Comments
Project Total				$ -	
		% Project			
Construction		75.0%		$ -	
Design Contingency		7.5%		$ -	
Project Contingency		7.5%		$ -	
Architects Fees		7.0%		$ -	
Permits		3.0%		$ -	
		100%		$ -	
		GSF		cost per GSF	
Project construction cost per GSF		-		#DIV/0!	
Project costs per GSF		-		#DIV/0!	

Figure 7. Worksheet 1– Import overall projected project costs from Worksheet 2 and allocate to direct and indirect costs. Determine project construction cost per gross square foot, and overall project cost per gross square foot.

Sample project calculation

Figures 8 through 11 present a sample calculation for a simple building. To prepare a cost projection, the following information describes a pre-design scenario.

- The project is a community meeting hall, net area of 5,250 SF and gross area of 7,500 square feet on a site in a medium density business district (lot size is 25,000 SF). The use group of the building is A -3, general, community halls, libraries, museums.
- The construction system is a Type 1B fire resistive system (pre-engineering steel frame, spray fire-proofing, 1-hour wall assemblies with punched windows and double doors
- Parking is available for 50 automobiles (allocate 350 SF per car) = 17,500 square feet.
- The site is in an unincorporated area, and the township is the authority having jurisdiction (AHJ) for building codes and ordinances. The location of the project site has one access point from a heavily trafficked street from 6:00 AM to 7:00 PM. The AHJ has imposed restrictions on delivery during this period.

METRO AREA MULTIPLIERS

State	Metropolitan Area	Multiplier
NY	ALBANY	1.09
	AMSTERDAM	1.18
	BINGHAMTON	1.06
	BUFFALO	1.04
	DUTCHESS COUNTY	1.40
	ELMIRA	1.07
	GLENS FALLS	1.08
	ITHACA	1.18
	JAMESTOWN	1.05
	KINGSTON	1.18
	LOCKPORT	1.18
	LONG ISLAND	1.18
	MALONE	1.18
	NASSAU	1.44
	NEW YORK CITY	1.50
	NEWBURGH	1.40
	NIAGARA FALLS	1.16
	ROCHESTER	1.07
	ROME	1.07
	SCHENECTADY	1.09
	SUFFOLK	1.44
	SYRACUSE	1.06
	TROY	1.09
	UTICA	1.07
	WATERTOWN	1.18
	WHITE PLAINS	1.18

Figure 8. Area Location Table [15] pg.9

ICC Building Valuation Worksheet https://www.iccsafe.org/products-and-services/i-codes/code-development-process/building-valuation-data/

Aug-21

Group (2018 International Building Code)		IA	IB	IIA	IIB	IIIA	IIIB	IV	VA	VB
A-1	*Assembly, theaters, with stage*	$ 298.55	$ 288.43	$ 280.93	$ 269.54	$ 253.09	$ 245.77	$ 260.87	$ 235.34	$ 226.84
A-1	*Assembly, theaters, without stage*	$ 273.51	$ 263.39	$ 255.89	$ 244.51	$ 228.06	$ 220.73	$ 235.84	$ 210.31	$ 201.80
A-2	*Assembly, nightclubs*	$ 233.39	$ 226.42	$ 220.85	$ 211.80	$ 199.64	$ 194.14	$ 204.26	$ 180.65	$ 174.48
A-2	*Assembly, restaurants, bars, banquet halls*	$ 232.39	$ 225.42	$ 218.85	$ 210.80	$ 197.64	$ 193.14	$ 203.26	$ 178.65	$ 173.48
A-3	*Assembly, churches*	$ 276.84	$ 266.72	$ 259.22	$ 247.83	$ 231.83	$ 225.68	$ 239.17	$ 214.08	$ 205.57
A-3	*Assembly, general, community halls, libraries, museums*	$ 231.62	**$ 221.50**	$ 213.00	$ 202.61	$ 185.16	$ 178.84	$ 193.94	$ 167.42	$ 159.91
A-4	*Assembly, arenas*	$ 272.51	$ 262.39	$ 253.89	$ 243.51	$ 226.06	$ 219.73	$ 234.84	$ 208.31	$ 200.80
B	*Business*	$ 240.93	$ 232.14	$ 224.41	$ 213.38	$ 194.94	$ 187.44	$ 204.97	$ 171.50	$ 163.65
E	*Educational*	$ 253.16	$ 244.50	$ 238.07	$ 227.82	$ 212.65	$ 201.92	$ 219.97	$ 185.88	$ 180.09
F-1	*Factory and industrial, moderate hazard*	$ 142.51	$ 135.81	$ 128.20	$ 123.31	$ 110.60	$ 105.32	$ 118.02	$ 91.13	$ 85.44
F-2	*Factory and industrial, low hazard*	$ 141.51	$ 134.81	$ 128.20	$ 122.31	$ 110.60	$ 104.32	$ 117.02	$ 91.13	$ 84.44
H-1	*High Hazard, explosives*	$ 133.05	$ 126.35	$ 119.74	$ 113.85	$ 102.42	$ 96.14	$ 108.56	$ 82.95	$ -
H234	*High Hazard*	$ 133.05	$ 126.35	$ 119.74	$ 113.85	$ 102.42	$ 96.14	$ 108.56	$ 82.95	$ 76.26
H-5	*HPM*	$ 240.93	$ 232.14	$ 224.41	$ 213.38	$ 194.94	$ 187.44	$ 204.97	$ 171.50	$ 163.65
I-1	*Institutional, supervised environment*	$ 240.35	$ 232.11	$ 225.21	$ 216.12	$ 198.77	$ 193.28	$ 216.40	$ 178.22	$ 172.87
I-2	*Institutional, hospitals*	$ 403.60	$ 394.81	$ 387.08	$ 376.05	$ 356.54	$ -	$ 367.65	$ 333.11	$ -
I-2	*Institutional, nursing homes*	$ 280.29	$ 271.50	$ 263.77	$ 252.74	$ 235.00	$ -	$ 244.34	$ 211.57	$ -
I-3	*Institutional, restrained*	$ 273.98	$ 265.19	$ 257.46	$ 246.43	$ 229.58	$ 221.08	$ 238.03	$ 206.14	$ 196.29
I-4	*Institutional, day care facilities*	$ 240.35	$ 232.11	$ 225.21	$ 216.12	$ 198.77	$ 193.28	$ 216.40	$ 178.22	$ 172.87
M	*Mercantile*	$ 174.08	$ 167.12	$ 160.55	$ 152.50	$ 140.10	$ 135.60	$ 144.96	$ 121.12	$ 115.94
R-1	*Residential, hotels*	$ 242.77	$ 234.53	$ 227.63	$ 218.55	$ 200.90	$ 195.42	$ 218.82	$ 180.35	$ 175.00
R-2	*Residential, multiple family*	$ 203.34	$ 195.11	$ 188.20	$ 179.12	$ 162.64	$ 157.15	$ 179.40	$ 142.08	$ 136.73
R-3	*Residential, one- and two-family*	$ 189.34	$ 184.22	$ 179.47	$ 175.04	$ 169.94	$ 163.79	$ 172.07	$ 157.66	$ 148.33
R-4	*Residential, care/assisted living facilities*	$ 240.35	$ 232.11	$ 225.21	$ 216.12	$ 198.77	$ 193.28	$ 216.40	$ 178.22	$ 172.87
S-1	*Storage, moderate hazard*	$ 132.05	$ 125.35	$ 117.74	$ 112.85	$ 100.42	$ 95.14	$ 107.56	$ 80.95	$ 75.26
S-2	*Storage, low hazard*	$ 131.05	$ 124.35	$ 117.74	$ 111.85	$ 100.42	$ 94.14	$ 106.56	$ 80.95	$ 74.26
U	*Utility, miscellaneous*	$ 104.03	$ 98.14	$ 92.46	$ 88.40	$ 79.71	$ 73.77	$ 84.55	$ 62.84	$ 59.88

Steps	Tasks			
1	*Identify major use group of project*			Selected A-3 General
2	*Identify major construction type of project*			Selected 1-B, Fire Resistive
3	*Select unit cost based upon use group and construction type*			Use $ 221.50
4	*Enter data in cell D36*		$ 221.50	
5	*Enter area adjustment factor from cost guide in cell D37*		1.18	Use 18% over national average for Long Island, DCD Guide 2022 (pg.9)
6	*Adjusted unit cost will be calculated in cell D38*		$ 261.37	
7	*Copy cell D38 - use Paste Special > Paste Link to copy to sheet3, cell C9*			

Figure 9. Worksheet 4 – Sample calculation Select $ 221.50 x 1.18 = $ 261.37 per SF.

Project Cost Planning		1-Feb-22	
Sample Building - Assembly		**Farmingdale State College**	

PROJECT COST PER GROSS SQUARE FOOT

			Factors		
Type of Project	Category	**Cost per GSF**	Professional Fees (see note 1)	Project Management Fees (cost per GSF x.02)	**Project Cost per GSF**
Building Type	New Construction	$ 261.37	$ 18.30	$ 5.23	**$ 285**
Parking Lot	New Construction	$ 15.00	$ 1.05	$ 0.30	**$ 16**

note 1: cost per GSF x .07 for new construction, cost per GSF x .1 for renovation

The project is a community meeting hall, net area of 5,250 square feet and gross area of 7,500 square feet on a site in a medium density business district (lot size is 25,000 square feet). The site is in an unincorporated area, and the township is the authority having jurisdiction (AHJ) for zoning and building codes and ordinances. The location of the project site has one access point from a heavily trafficked street from 6:00 AM to 7:00 PM. The AHJ has restrictions on delivery during this period

* The **use group of the building is A -3**, *general, community halls, libraries, museums.*

* The construction system is a **Type 1B fire resistive system** (pre-engineering steel frame, spray fire-proofing, 1-hour wall assemblies with punched windows and double doors.

* **Parking is available for 50 automobiles** (allocate 350 square feet per car) = 17,500 square feet.

* The allocation for architectural fees is 7%, and CM fees are 2%.

JOB FACTORS TO ADJUST TOTAL PROJECT COST

Description	Condition	Add/Subtract	Comments
Location	Incorporated Area	2%	More frequent inspection and oversight
Location	Unincorporated Area	-2%	Less frequency of inspection than in small villages and municipalities
Job site	Business Area	-2%	Less conflict with commercial activities
Job site	Residential Area	5%	Constraints on operations due to noise,
Job site	Limited Staging	5%	No area or remote area for laydown,
Job site	Occupied by Owner	7%	Potential for owner generated changes
Labor availability	Slow Market	-5%	Aggressive bidding
Labor availability	Tight Market	7%	Lack of labor availability, especially
Labor - prevailing wage	Project labor agreement	15%	Prevailing wage - union scale
Renovation	No Intrusive Tests	10%	Potential for major unforeseen conditions
Renovation	Intrusive Exploration	-3%	More detail for bids
Project Costs (subtotal construction)	Less than $1 million	5%	Overhead vs. volume
Project Costs (subtotal construction)	More than $1 million	-3%	Overhead vs. volume
Project Fees	simple project	-1%	Overhead vs. volume
Project Fees	complex project	5%	Overhead vs. volume
NYS Building Code Transition	simple project	5%	Overhead vs. volume
NYS Building Code Transition	complex project	7%	Overhead vs. volume

Figure 10. Worksheet 3– Sample calculation.

Select the factors to adjust the analogous total cost: Location-Unincorporated Area; Job Site-Business Area, Limited Staging; Labor Availability-Tight Market; Renovation-Intrusive Exploration; Project Fees-simple project, NYS Building Code Transition- simple project. Prepare Worksheet 2 by adding a line below the proposed building for the parking lot. Then, enter the data in each of the factor cells to adjust the total costs. The design contingency will be automatically be calculated. Add a duration for the midpoint of construction (expressed in years). The total project 7. Worksheet cost will automatically be summarized and transmitted to Worksheet 1.

Project Cost Planning			1-Feb-22		
Sample Building - Assembly			**Farmingdale State College**		
NEW CONSTRUCTION/RENOVATION			Gross Square Area	Cost per GSF	Cost by Task/Facility
Proposed Building			7500	$ 285	$ 2,136,682.39
Parking Lot			17500	$ 16	$ 286,125.00
Subtotal, Project Construction, Fees, and Contingency					**$ 2,422,807.39**
FACTORS			Subtotal	x Factor	
Project Costs - Less than $1 million			$ -	5%	$ -
Project Costs - More than $1 million			$ 2,422,807.39	-3%	$ (72,684.22)
Labor availability- Slow Market			$ -	-5%	$ -
Labor availability - Tight Market			$ 2,422,807.39	7%	$ 169,596.52
Labor availability - Union requirements			$ -	20%	$ -
Location - Incorporated Area			$ -	2%	$ -
Location - Unincorporated Area			$ 2,422,807.39	-2%	$ (48,456.15)
Job site - Business Area			$ 2,422,807.39	-2%	$ (48,456.15)
Job site - Residential Area			$ -	5%	$ -
Job site - Limited Staging			$ 2,422,807.39	5%	$ 121,140.37
Job site - Occupied by Owner			$ -	7%	$ -
Pre-Construction - No Intrusive Tests			$ -	10%	$ -
Pre-Construction - Intrusive Exploration			$ 2,422,807.39	-3%	$ (72,684.22)
Project Fees - Simple Project			$ 2,422,807.39	-1%	$ (24,228.07)
Project Fees - Complex Project			$ -	5%	$ -
Building Code Transition - simple project			$ -	5%	$ -
Building Code Transition - complex project			$ 2,422,807.39	7%	$ 169,596.52
Subtotal, Factors					**$ 193,824.59**
Design Contingency	15% of subtotals				$ 392,494.80
Subtotal, Construction+Fees+Factors+Contingency					**$ 3,009,126.77**
				Years to Midpoint	
Escalation	Previous Subtotal x 7%x no. of years to midpoint construction			1.5	$ 315,958.31
TOTAL PROJECT ESTIMATE=					**$ 3,325,085.09**

Figure 11. Worksheet 2– Sample calculation.

Project Cost Planning					1-Feb-22
Sample Building - Assembly					**Farmingdale State College**
Allocations					Comments
Project Total				**$ 3,325,085**	Midpoint of construction is 1.5 years
		% Project			
Construction		75.0%		$ 2,493,814	Type 1B, Use Group A-3
Design Contingency		7.5%		$ 249,381	
Project Contingency		7.5%		$ 249,381	
Architects Fees		7.0%		$ 232,756	
Permits		3.0%		$ 99,753	Township is Authority Having Jurisdiction
		100%		**$ 3,325,085**	
		GSF		cost per GSF	
Project construction cost per GSF		**7,500**		**$ 333**	
Project costs per GSF		**7,500**		**$ 443**	

Figure 12. Worksheet 1– Sample calculation.

Worksheet 1 presented the 75%/25% split in total costs, and the cost per SF for direct construction and the total project.

Next Steps

A brief review of the curriculums in one NAAB and one ABET accredited program co-located in the metro New York area yield limited information on current practices to provide instruction on cost estimating to architectural students. The NAAB-accredited program had a professional practice class whose syllabus indicated instruction about analogous-style cost estimating based upon square foot cost was provided for 1 week of the semester. In the ABET-accredited program, no clear identification of estimating as a stand-alone program was possible. The institution where the author teaches requires architecture students to take a quantity surveying and costing class that uses traditional take-off of completed projects, which does not serve the purpose to use cost projection as a measurement of design intent and constraints.

The introduction of the cost projection workbook into the author's ARC476 design class as part of the development of architectural building programs provided a tool to bring together the identification of specific client or project program goals for size, space and construction type with preliminary design strategies and material/systems for project proposals. Contrast this with the traditional design course, which accepts the premise that architects design first and then applies historical cost data to determine the estimated cost of the project. The historical cost data maintained by professional firms does not model the project "means and methods" factors incorporated by the presented cost projection workbook. Traditional design pedagogy does not model more integrative project delivery models such as design-build or integrated project delivery, where design professionals collaborate with construction professionals to align the definition and response to client design deliverables by defining the project budget before the design definition and response process begins. With the integration of this cost projection worksheet, the author creates course objectives that transcends traditional design classes with their reliance on limited historical cost models and helps students understand economic resources and constraints as it relates to design and construction of buildings.

Test Preparation and Design

To evaluate how this tool can be utilized in similar course at other institutions with similar architectural programs, a program to measure its use with similar classes to the authors' Architectural Design IV class would be conducted as follows:

Step 1. Identification of Institutional Participants: The integration of the cost projection workbook could be conducted with courses in existing architectural and architectural engineering programs within the public university systems in our state.

Step 2. Pre-Test Training - Faculty: After a solicitation to participate in a study to measure the tool's performance, a module to teach the use of the workbook would be developed and demonstrated to participating program instructors.

Step 3. Pre-Test Training - Students: Both groups will receive training sessions specific to their assigned cost estimation approach to ensure they understand the principles and techniques involved.

Step 4. Design Assignment: Students in both groups will be given the same architectural design assignment and the target budget. They will work individually or in small teams to develop their design solutions.

Step 5. Cost Estimation: Students will estimate costs based on their assigned approach, considering the relevant factors provided to them.

Step 6. Design Submission: Both groups will submit their final design solutions along with their estimated cost breakdowns.

Step 7. Evaluation: Expert evaluators will assess the designs and compare the estimated costs against the actual costs to determine accuracy and adherence to the target budget.

Step 8. Data Analysis: The collected data will be analyzed using appropriate statistical methods to evaluate the performance of the two groups and compare the outcomes.

Step 9. Student Perception: A survey or interview will be conducted to gather feedback from students on their experiences and perceptions regarding the two approaches.

Step 10. Presentation of Findings: A paper describing the measurement of strengths, weaknesses, opportunities and threats (SWOT) incorporating the tool to student design outcomes would be presented.

The test will be conducted with full respect for ethical guidelines and participants' rights. Informed consent will be obtained from all participants, ensuring their voluntary participation and understanding of the purpose of the test. Confidentiality and anonymity will be maintained throughout the research process.

Conclusion

The cost projection worksheet can serve as an introduction to the concept of targeted value design for architectural design students. This conceptual cost method and spreadsheet can be adapted to teach design students to use this estimating approach to test: (1) size, (2) construction type, and (3) functional use, early in the design process. This approach provides students without extensive experience in conceptual design or field experience in construction to develop a viable and integral analysis that bring functional, aesthetic and economic assessment together to provide a more robust response to modeling client expectations for good design and resource management. The cost projection workbook provides flexibility in the way in which a project can be developed to respond to functional, aesthetic, and economic concerns. The evolution of design and construction delivery from compartmental design and construction relationships into integrative project delivery systems would make the cost projection workbook and its ease of use initiate a new alignment of design and economic analysis into architectural design instruction.

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