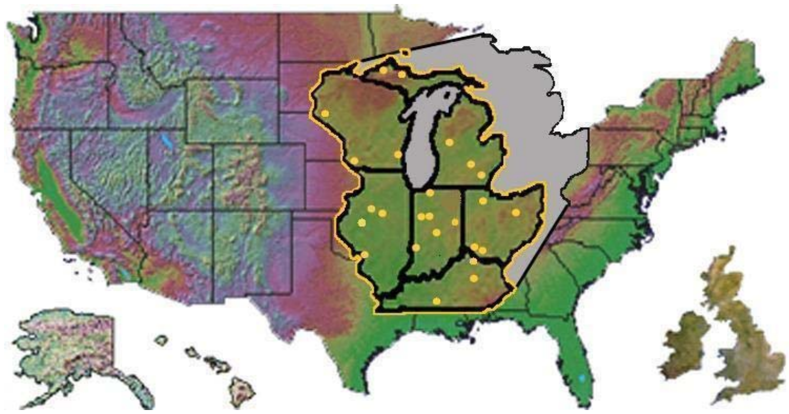

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Assessing Project Costs Associated with the General Conditions of the Contract

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This paper presents the method used in a course in Specifications to introduce and discuss project cost associated with the CSI *MasterFormat* category Division 0, General Conditions of the Contract. A primer developed by the author using the student edition of AIA 201, AIA's General Conditions of the Contract, is used in this approach. The primer places tenants in functional categories that help students and other end-users assess their meaning, use, and impact on project operations. This paper, however, discusses only the potential impact of those tenants with cost implications, and consideration(s) for their assessment(s). Although AIA 201 is the model of the General Conditions form used to discuss the concepts presented here, they are applicable to the overarching principles conveyed in General Conditions articles by the tenants found in any form of this document.

Keywords: Specifications, Estimating, CSI *MasterFormat*, Estimate Detail, Job Detail

Introduction

Project scope, estimate job details, and the schedule of activities associated with them, are developed and determined, primarily, from drawings and the "technical specifications" (CSI *MasterFormat* divisions 2 and above). Scope and job details associated with the material, labor, and methods necessary to achieve the project's intent encompass the vast majority of project funds, schedule activity, ancillary support requirements, and engineering (i.e., development of drawings and specifications). The costs associated with these items are often referred to as the project's "direct costs" (see Figure 1). Courses in specifications, estimating, and scheduling will generally focus on direct cost scope development, direct cost project activity identification, and the cost and schedule impacts of these items.

In a previous paper, the author discussed an approach for teaching Specifications that focused on linking construction drawings to CSI *MasterFormat* formatted specifications to develop scope and job details that incorporated a plan of execution (McFarland, 2009). The CSI *MasterFormat's* technical specifications were emphasized since they work in concert with drawings to convey the project's technical requirements. Undergraduate students, however, should also understand the impacts of the CSI *MasterFormat's* Division 0 (General Conditions of the Contract), Division 1 (General Requirement of the Contract), and supplements to these documents on a project's budget, its schedule, and on project profitability, and include these impacts in pre-construction planning activities (i.e., estimating, bidding, planning, and scheduling). These documents, the so called "non-technical specifications," should also be linked to drawings to assess scope requirements and impacts.

Figure 1 illustrates the connection between the construction documents and components that make up a project's total cost. Solid arrows connote primary connections between elements, while dashed arrows connote secondary connections between them. For example, tests required to assess the compressive strength of concrete on a project might be categorized as Overhead despite the fact that the requirement for the tests originated from a tenant found in a specification from Division 3 of CSI's *MasterFormat.*

Figure 1 shows the relationship between project documents, project costs components, and the range, as a

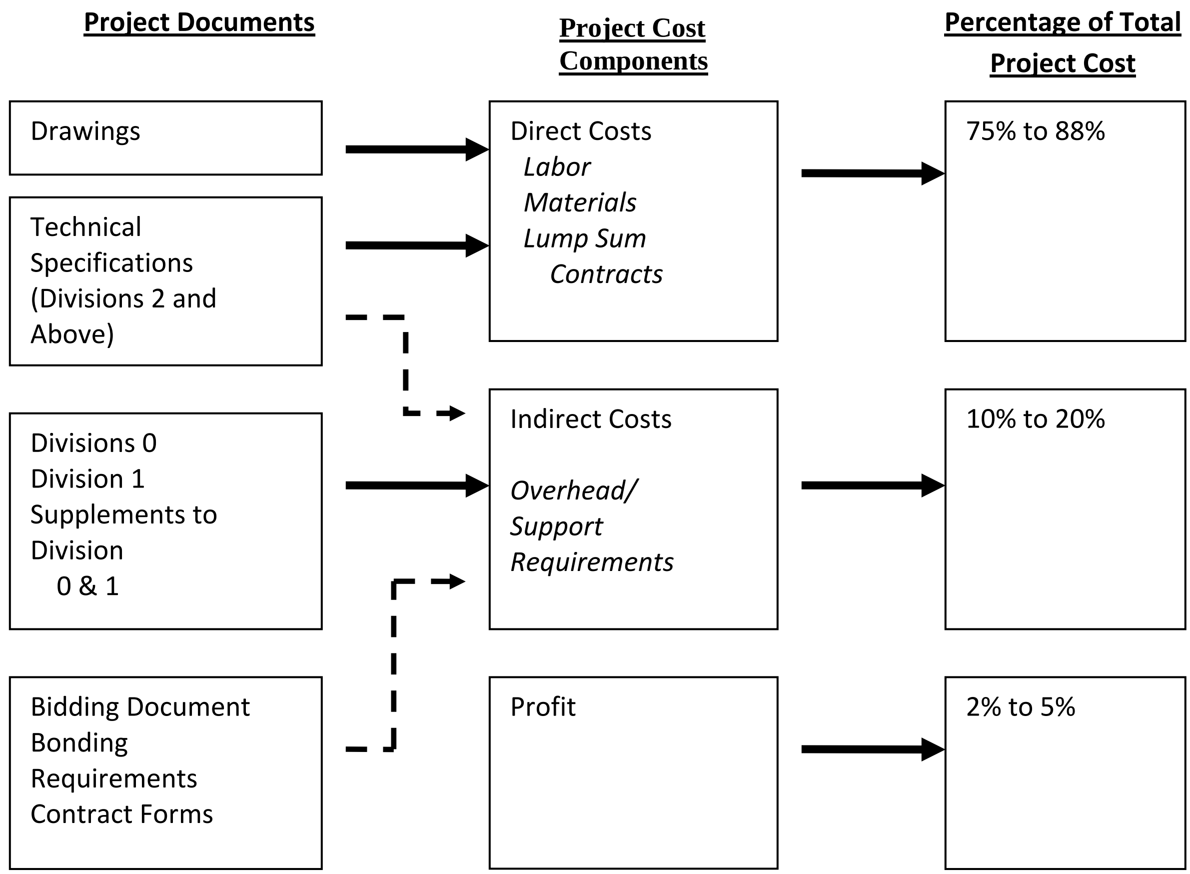

Figure 1: Project Documents Relationship to Project Cost Components

percentage of total project cost, attributable to each component (The Contractor's Business Digest, 2007) (ContractorCost.com, 2008) (Lorman Education Service, 2005). Note that, while indirect costs can comprise as little as 10 % of the total project budget, overruns in this component can cause negative impacts on profit. Overruns of 10%, for example, can reduce profits to 1% to 3% of total project cost (if direct costs are held within the range shown). Thus, all elements of indirect cost, as conveyed through the non-technical specifications and other project documents, must be properly accounted for and managed if the job is to achieve the profit desired. This paper presents a method used to introduce and discuss the cost, schedule, budget, and profitability implications associated with Division 0 in a Specifications class taught three times a year.

The intent of this method is not to quantify the costs associated with the tenants found in the Division 0; too many factors, many which hinge on the varied practices and philosophies used by different construction management firms, are involved to do this (especially within the limitations of the scope and time restraints imposed on an undergraduate class in Specifications). Instead, this author's purpose, when presenting this material, is to ensure that students are aware that tenants in the General Conditions of the Contract, when they are invoked, can have substantial cost and schedule implications, and should be evaluated to determine the impacts so that they can be included in project cost, schedule, and budget requirements.

The General Conditions of the Contract: AIA Document 201

AIA document 201, entitled “The General Conditions of the Contract,” is one of the model General Conditions documents commonly used for building construction projects. It is used here to present the concepts that follow.

Table 1: AIA 201 General Conditions of the Contract Articles

Article	Title	Article	Title
1	General Provisions	**9**	Payments and Completion
2	Owner	**10**	Protection of Persons and Property
3	Contractor	**11**	Insurance and Bonds
4	Architect	**12**	Uncovering and Correction of Work
5	Subcontractors	**13**	Miscellaneous Provisions
6	Construction by Owner or by Separate Contractors	**14**	Termination or Suspension of the Contract
7	Changes in the Work	**15**	Claims and Disputes
8	Time		

AIA 201 is organized using the article titles shown in Table 1. Note that other general conditions documents exist, and also, that the tenants in AIA 201 might be used fully, in part, or not at all. However, generally and regardless of the form, the tenants found in the AIA’s version of Division 0 outline the contract’s general and legal requirements, and specifies agreements between the Owner, his or her agent(s), the General Contractor, and any other party involved in the work.

As a “legal” document, tenants in AIA 201 are expressly written to establish the contractual terms of the agreement the parties are entering into. Thus, some tenants have no cost or schedule implications, and hence, no assessment of the cost or schedule impact of these items is required. Those tenants, however, do have ramifications associated with them; the severity depending, in part, on the nature of the tenant. Hence, the author has developed a primer for A201 that serves two purposed. First, it categorizes each tenant into one or more functional and/or project related groupings to help course participants understand its use and its impacts. This will be discussed in another paper. Second, it identifies tenants in A201 that have cost and schedule ramifications, categorizes them, and provides a qualitative means for assessing their impacts. This is discussed below.

Cost and Schedule Categorizations

Separate assessments for cost and schedule impacts were made for tenants in the AIA document that required them. As noted, the intent of these assessments is not to quantify the costs associated with each tenant. It’s to determine, if it is invoked, the impact of the tenant’s implementation on the project so that provisions for it can be included in the project’s scope, schedule, and budget requirements as necessary.

The following cost/schedule assessment categories are used: (I) High, (II) Moderate, (III) Assess, (IV) Normal Overhead, (V) Normal Contingency, (VI) Business Operations, (VII) Normal Overhead and Business Operations, (VIII) Business Operations and/or Normal Contingency, (IX) Assess With Other Tenant. They are discussed below. The primer includes commentary comments when necessary. A sample entry is shown in Table 2.

(I) High – Tenants with this categorization have a high probability that a separate evaluation will be required to determine their impact on the project because of the possibility that their implementation could necessitate the need for special project provisions that could impact or influence project expenses, budget and/or schedule. For example, tenant 3.4.1 of AIA 201, categorized as having a “high” cost and schedule potential, reads

Unless otherwise provided in the Contract Documents, the Contractor shall provide and pay for labor, materials, equipment, tools, construction equipment and machinery, water, heat, utilities, transportation, and other facilities *and services necessary for proper execution and completion of the Work, whether temporary or permanent and whether or not incorporated or to be incorporated in the Work.*

Under this tenant, items required for maintaining production, an Overhead sub-category, could also be the Contractor's responsibility. For example, a project for construction of a new hospital wing adjacent to its existing surgical wing required daily multiple monitoring of dust levels. Scope requirements for this provision included air monitoring equipment, increased filtering supplies, and personnel needed to check and record air monitor readings. Although the requirements are not direct costs for the new wing, assessment is necessary to determine the scope needed to "maintain production" since it is required (in this instance, its needed to maintain a sterile operating environment so that surgeries can be executed as scheduled). The costs of the requirements could be high enough to warrant a line item inclusion in the project's overhead assessment. The commentary comment for tenant 3.4.1,

Table 2: Example Primer Entry Showing Cost and Schedule Categorizations and Commentary

ARTICLE 1 GENERAL PROVISIONS	Cost Potential	Schedule Potential	Comment
§ 3.8 ALLOWANCES			
§ 3.8.1 The Contractor shall include in the Contract Sum all allowances stated in the Contract Documents. Items covered by allowances shall be supplied for such amounts and by such persons or entities as the Owner may direct, but the Contractor shall not be required to employ persons or entities to whom the Contractor has reasonable objection.	Assess	Assess	(1) Cost and Schedule risk to the degree that that Work included in the Allowance impacts the Contractor's budget and schedule if should it not be completed within the allocations provided and/or the project's overall constraints. Hence, Contractor should review and understand all provisions associated with allowances. (2) Contractor should review all contract documents to assess allowances included in the work, and to ensure that adequate provisions/procedures are in place to manage changes from budgeted amount of allowances if deviations should occur as provided in 3.8.2.3

"Assessment of support requirements needed for project execution should be done and included in both project budget and schedule for execution,"

cites the need for assessment of this tenant for project support related scope requirements. Tenants with this categorization are shown in Table 3.

(II) Moderate – Tenants with this categorization have a moderate probability that a separate evaluation will be required to determine their impact on the project because of the possibility that their implementation could necessitate the need for special project provisions that could impact or influence project expenses, budget and/or schedule (see Table 3). Site safety, a responsibility of the Contractor under tenant 3.3.1 of AIA 201, might be an example of a scope item in Overhead that results from inclusion of this tenant. Scope requirements for site protection, an element of safety, might be simple (i.e., provide fencing) or more complex (i.e., barriers, guards, alarms, etc.). As with all tenants requiring assessment, this should be done using all project documents relevant to the tenant, with special attention given to requirements noted in the drawings and technical specifications.

(III) Assess – This category intimates that an evaluation of the item(s) required to implement the tenant be made using the Contractor's experience and knowledge of the particulars associated with the item(s) while considering the circumstances associated with its implementation (see Table 3). Items in this category can fall in any component of "indirect cost". For example, tenant 3.8.1 states that "*the Contractor shall include in the Contract Sum allowances stated in the Contract documents*" (see Table 2). The commentary for this tenant, in part, states that the Contractor should assess the risks associated with the allowance allocations for their impacts on cost and schedule. In other words, the Contractor should evaluate the allowance to see if it is sufficient to meet the intent of the element it provides for by examining the project documents, along with any other information provided and/or available, and determine if there are any cost and schedule risks associated with the allocation. Risks found should be quantified, categorized as a part of the indirect cost component "contingency," and included in the bid amount.

(IV) Normal Overhead – This category intimates that items invoked or implemented by tenants with this

Table 3: Cost Categories I, II, III, and IV Contract Tenants For Articles in AIA 201

AIA	**Category**			
201 Article	**(I) High**	**(II) Moderate**	**(III) Assess**	**(IV) Normal Overhead**
1				**1.6**
2				**2.1.2, 2.2.1**
3	3.4.1, 3.6, 3.7.1, 3.8.2.1, 3.8.2.2, 3.9.1, 3.17	3.3.1	3.8.1, 3.14.2, 3.15.1	3.1.1, **3.2.1**, **3.2.2, 3.3.2**, **3.3.3**, 3.5, 3.7.2, **3.7**.4, **3.8.3**, **3.10.2**, 3.11, **3.12.5**, **3.12.6**, **3.12.9**, **3.13**, **3.15.2**, 3.18.2
4				**4.2.5**
5				**5.3**
6				**6.1.1**, **6.1.3**, 6.2.1
7				7.1.2, 7.1.3, 7.3.2
8				
9			9.8.4, 9.9.1	9.2, 9.3.1, 9.6.2, 9.6.3, 9.6.4, 9.6.5, **9.7**, **9.8.2**, 9.10.2, 9.10.3
10	10.2.1, 10.2.1.1, 10.2.1.2, 10.2.1.3, 10.2.3, 10.2.4, 10.2.1.1, 10.2.1.2, 10.2.1.3			10.1, 10.2.2, 10.2.6, **10.2.7**, 10.2.8, 10.3.1, **10.3.5**, **10.3.6**
11	11.1.2, 11.4.1			11.1.3, 11.3.1.5, 11.4.2
12				
13	13.5.1			13.5.4
14				
15				

categorization are "readily charged to a specific project but not to a specific item of work on that project" (Dagostino, F. R., and Feigenbaum, L., 2003). Normal overhead expenses or components can include items ranging from salaries, temporary offices, temporary enclosures, temporary buildings, and cleanup, to sales taxes, insurance, permit fees, and expenses and depreciation of the portions of long life company assets (more than one year) chargeable to the project. It is sometimes assessed by listing and quantifying each item of overhead. It is also computed as a percentage of direct costs. Contractors using the percentage method usually base the percentage used for a project on some historical record of past jobs with criteria similar to the one under consideration. Construction documents should be checked to determine if normal overhead provisions provide enough budgetary funds to cover items invoked by tenants in this category.

Several tenants with this categorization have a low probability that a separate evaluation will be required to determine their impact on the project because of the possibility that their implementation could necessitate the need for special project provisions that could impact or influence project expenses, budget and/or schedule. They are connoted within their category with **BOLD** type in Table 3. They should be looked at carefully to ensure that normal overhead allocations will cover their implementation, especially when the allocation is determined using a percentage based on historical records of past projects.

(V) Normal Contingency – An allocation for risks associated with items such as project unknowns, scope and/or job activities lacking clarity and/or detail, activities for which specific instructions are not given, and/or for which the Contractor is given wide berth for solution(s) and implementation (i.e., field routing of piping). This, too, is assessed by listing and quantifying each item of contingency and/or by computing it as a percentage of direct costs to provide a "normal" contingency allocation (Dagostino, F. R., and Feigenbaum, L., 2003). Contractors using the percentage method, quite often, will establish the percentage for a project using the historical record of contingency percentages from similar past projects performed by the company. Several tenants with this categorization, however, should still be assessed individually to ensure that the "normal" contingency allocation provision is sufficient to cover them. If not covered, their cost impacts should be determined and an allowance for their coverage

Table 4: Cost Categories V, VI, VII, VIII, and IX Contract Tenants For Articles in AIA 201

	Category				
AIA 201 Article	**(V) Normal Contingency**	**(VI) Business Operations**	**(VII) Normal Overhead and Business Operations**	**(VIII) Business Operations and/or Normal Contingency**	**(IX) Assess With Other Tenant (s)**
1					
2		2.4			
3	3.1.3	3.18.1			
4	4.2.11				4.2.6, 4.2.8, 4.2.9, 4.2.11
5	**5.2.3**	5.2.3			
6		6.2.3, 6.2.4			6.2.2, 6.2.5, 6.3
7	**7.3.1,** 7.4				
8					
9		9.5.1			9.3.2, 9.4.1, 9.4.2, 9.5.2, 9.6.1, 9.8.5
10			10.2.5		
11		11.3.1.2, 11.3.4			11.1.1, 11.1.4
12	**12.2.1**	12.1.1, 12.1.2		12.2.2.1,12.2.3, 12.2.4	
13				13.5.3	
14		14.2.2, 14.2.4, 14.4.1			14.4.2
15	15.3.3				

should be added to the normal contingency allocation. They are connoted within their category with **BOLD** type in Table 4. In any case, construction documents should always be checked to ensure that normal contingency allocations provide enough budgetary funds to cover items invoked by tenants in this category.

(VI) Business Operations (or Business Operating Expenses) – These are expenses associated with the cost of operating the business. They included expenses associated with equipment used for all business operations and services by personnel attributable to all operations within the business. Expenses in this category can be allocated to each company project on a prorated basis if desired (i.e., interest on borrowing, fees for credit lines, etc.), however, items like depreciation of office equipment or retainer fees for legal council are usually allocated to budgets equally when the business has multiple projects. Small businesses, however, should carefully evaluate the impact of allocating "all business operating expenses" to a single project since this could lead to a substantially higher bid.

(VII) Normal Overhead and Business Operations – Items invoked by tenants with this categorization have elements that can be charged to normal overhead and to business operations. Tenant 10.2.5 is the only tenant in AIA 201 with this categorization. It states, in part, that

“The Contractor shall promptly remedy damage and loss (other than damage or loss insured under property insurance required by the Contract Documents) to property referred to in Sections 10.2.1.2 and 10.2.1.3 caused in whole or in part by the Contractor, a Subcontractor, a Sub-subcontractor, or anyone directly or indirectly employed by any of them,…………”

Insurance coverage can pay for items invoked by this tenant, hence, the normal overhead designation. However, if insurance limits are exceeded and/or the loss is for an item is not covered by the Contractor’s insurance, the contractor must pay for the item by other means. The other means could involve funds from the Contractor’s operations and/or require the Contractor to use lines of credit to remedy the damage and loss as the Contractor is usually required to fund project operations and later receive pay from the Owner based on progress and payment schedules. Some companies categorize fees associated with lines of credit as general operating expense.

(VIII) Business Operations and/or Normal Contingency – Items under this category can be considered as either business operation expenses and/or contingency items depending on the strategy used by the Contractor. The tenants with this categorization are contained in section 12.2, a section that details requirements for “Correction of Work.” Tenants in section 12.2.2 involve correction of work after substantial completion of it and involve timeframes up to and including one year after substantial completion has occurred. The author’s comment for 12.2.2.1 reads

”Cost for work, management and administrative personnel, and for other requirements needed to ensure compliance of this contract tenant, if it occurs, should be considered under Normal Project Contingences. An assessment for normal project contingency should be made based on the Project Documents. Contractor should ensure that appropriate financial safeguards are in place to cover all cost, schedule, and all other requirements associated with this tenant should it occur.”

Since project closeout can occur prior to completion of the time period warranted by this tenant, the Contractor should ensure funds are available to execute any items invoked by it. Depending on the Contractor’s bidding and/or execution strategies, and on the risks assessed after review of the project documents, allocations for items potentially associated with this tenant might be included with project contingency funds and/or funded after project closeout through credit-lines the Contractor uses for business operations.

(IX) Assess With Other Tenant(s) – This means that other tenants, in addition to the one that invoked the item, impact it. All of the tenants should be reviewed when making an assessment of the item.

Summary of Categorizations

Table 5 shows the articles in A201 that categorized tenants are found in. Note that nearly all of the articles contain tenants that can impact project cost and schedule. This illustrates the need for students to be aware of the potential implications associated with the General Conditions of the Contract and all non-technical specifications. Table 3 and table 4 show the categorization of AIA 201 tenants with cost and schedule implications. Over 100 tenants were found to have provisions that could impact cost.

Student Assessment

Complete assessment of all elements within each component of project cost is necessary to provide reasonable assurance of project success. Student assessment of the concepts presented here is evaluated in the course using exercises, assignments, and/or class projects which require course participants to assess overhead, and/or develop other indirect cost scope and/or activities. These include activities such as (1) developing lists of required equipment whose cost are spread over the project (cranes, etc.), (2) developing execution strategy write-ups for projects that include staffing, equipment, and other overhead needs, and (3) test questions which assess student understanding of the connection between the cost components and the category of specifications that impact them.

Summary

The approach for using AIA 201discussed here helps students understand Division 0, the General Conditions of the Contract, by (1) showing that AIA 201 and other General Conditions of the Contract tenants have cost implications which can impact overhead and direct cost, (2) showing the impact of indirect costs on job and company profitability, and (3) providing guidance for assessing the tenant's impact on project profitability.

The approach discussed above focuses on the end-user of the document. The categories used were developed by the author's and are based on his assessment of the tenants in AIA 201. Most of the tenants impact the indirect cost component of project costs. However, its impact on the project might be severe if proper assessment of the tenant is not made.

Table 5: General Conditions Articles Containing Tenants With Potential Cost Implications

AIA 201	**Cost Category**								
Article	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**
1				x					
2				x		x			
3	x	x	x	x	x	x			
4				x	x				x
5				x	x	x			
6				x		x			x
7				x	x				
8									
9			x	x		x			x
10	x			x			x		
11	x			x		x			x
12					x	x		x	
13	x			x				x	
14						x			x
15					x				

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Greening Gradually: Growing Faculty Competence and Curricular Approaches in Sustainable Construction Through an Independent Study Course

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The call for "green" and sustainable topics to be integrated into construction management curricula has been sounded from many organizations. Just as industry has been slow to adopt these practices, construction management programs at many universities have been struggling with how to integrate green and sustainable practices at the topical, course, and program levels, as well as how to prepare faculty to teach these subjects. This paper examines the approach that one university program took, which utilized an independent study course format. This format offered a collaborative structure for students and faculty alike, familiarizing them with the material, pooling their resources, preparing them for certification, and generating interest for future courses. The advantages and disadvantages of this approach are examined, as well as other situations where this approach might be appropriate.

Key Words: Green construction, collaborative learning, independent study

Introduction

Sustainable, or "green," construction practices have grown from relative obscurity to frequent usage nationwide, with owners, designers, and constructors changing the ways that buildings are designed and constructed. As industry has grown to accept green construction, the expectation that students matriculating from university-level construction management programs will be prepared for this new way of building has also grown.

However, there are several challenges facing construction management programs who are trying to incorporate green and sustainable topics, with a variety of methods being adopted. This paper examines an approach that one Midwestern university adopted: the use of an independent study course. This framework allowed faculty to work towards becoming accredited on a personal level at the same time as students, as well as offered insights on the learning process. The advantages and disadvantages of this approach, as well as the results, are provided for faculty at other institutions in similar situations.

Need

Interest in sustainable construction, commonly referred to as "green" construction, has grown exponentially over the last several years. Organizations as disparate and diverse as the United States Green Building Council (USGBC) and the United Nations have called for more awareness and involvement in green and sustainable building practices. The USGBC claims its membership has grown to more than 20,000 since its inception 15 years ago, and that 114, 291 individuals had become Leadership in Energy and Environmental Design Accredited Professionals (LEED-APs) as of June 2009 (USGBC, 2009).

As Mead (2001) stated: "To meet this [green building education] need, construction educators will have to develop new curricula and techniques" (p. 175). Higher education has taken notice and several programs have already established separate courses or integrated green topics into existing courses. Green and/or Sustainable construction has been a topic that has been specifically requested for papers and publications by many organizations, including the National Association of Industrial Technology (2008, 2009).

However, just as the construction industry has been somewhat slow and reluctant to adopt sustainable building practices, many construction management programs have struggled to integrate them into their curricula. Chen and Jones (2008) described several challenges facing programs integrating green construction. A basic challenge cited is finding enough time. They state:

> Most construction curricula already have many other competing topics that are deserving of course time. With most programs already constrained by accreditation and other requirements, the decision to add material on green construction likely would result in something else having to be eliminated or a reduction in the number of electives as well as limiting student choice. (34)

Chen and Jones go on to state that this is often exacerbated from the faculty perspective, since "its relative newness often means that current faculty do not have experience, expertise, or credentialing in green/sustainable construction, and new faculty are in short supply" (2008, p. 34). The combined difficulties of finding time in an existing curriculum and faculty qualified to teach the subject matter have slowed the adoption of green construction into construction management programs.

The program described in this paper found itself facing both of these issues, as well as others. The program had been admitted for candidacy for accreditation through the American Council for Construction Education, and had been insuring that all of the required topical content had been included throughout their courses. None of their full-time or adjunct faculty were LEED-APs, nor had any worked professionally on a LEED-certified project. Although there was student interest, the faculty were undecided which curricular approach to utilize. Curricular options considered included : a standalone course devoted to the topic, integration of the material into existing courses, or a combination of the two. Additionally, anticipated faculty loading would not allow a new course to be offered immediately (Spring semester of 2009), delaying the process further.

Independent Study Course Approach

In response to these challenges, the faculty decided to offer an independent study course in sustainable construction to select students. At this institution, independent study courses could be offered with variable credit in any semester and did not count against faculty "load." These courses were therefore offered as unpaid overload courses by any faculty member volunteering to do administer them. The course described in this paper was officially administered by a single faculty member, who also had the responsibility of assigning grades, but a total of three interested faculty members participated.

Two students, who had previously expressed interest in the topic, elected to sign up for the course. One student took the course for three credits; one signed up for two credits to avoid incurring an overload fee on tuition.

The participants set up regular, weekly meetings, but did so with consideration to the schedules of all faculty members. At the first meeting, goals and expectations were established. The group decided to focus on preparing participants for the LEED-AP exam, with secondary foci on preferred teaching/learning techniques and resources, and the implementation of sustainable practices in the construction industry. Resources were also pooled and reviewed at the initial meeting. The two students had been provided training and/or materials during their internships at construction companies, and the faculty shared their personal materials and textbooks. A schedule and deliverables were developed, as well as expectations.

Sections from the LEED Reference Guide were assigned and scheduled for each meeting, as well as relevant supplemental materials from the participants' personal collections. Practice LEED-AP examinations were assigned throughout the semester, with the emphasis being on improvement over the term of the course. Students also prepared short presentations on the applicable section or sections of the reference guide for each session, with the emphasis on how the requirements were best being met in current sustainable practice, as well as how these approaches contrasted with typical industry practice, and these were then discussed by the group. Students also logged their individual learning progress and how they believed that translated to their progress on the practice examinations (e.g. the use of flash cards resulting in more improvement than simply rereading the materials several times). The expectations included full participation in the course and discussions, professional presentations, obtaining a passing score on practice examinations, and offering relevant feedback regarding their own individual learning styles and preferences as they related to the material.

Advantages for Faculty

The independent study course approach offered several advantages for the faculty and administration. First, it offers faculty the opportunity to familiarize themselves with green and sustainable construction topics in a collaborative, supportive environment. Since participation was voluntary, only those who were truly interested elected to attend. This helped to bond the faculty team together and eliminated problems associated with mandatory workshops or other required participation. It offered structure, as opposed to an ad hoc group, particularly since students were involved.

Additionally, faculty benefitted from the resources of the other participants. Everyone in the group had some resources to contribute, including the following:

- Documents and standards
- Case studies
- Study guides
- Study flashcards
- Notes from previous test-takers
- Textbooks (including sample copies)

This allowed faculty to examine other resources at no cost to see if they might be valuable for them personally, or as materials for a future sustainable construction course.

Additionally, the experience of the group proved to be invaluable, particularly that of the students. None of the faculty members had participated on a LEED-certified project, so the experience of the students during their internships provided a "real world" perspective regarding how the practices were actually implemented. Beyond this, the frank discussions throughout the course of what study techniques were preferred and which appeared to be most effective (as measured through practice examinations) provided input on future course design. Two faculty members were also preparing for the LEED-AP examination as well, and similarities and differences in faculty-student views were interesting.

The course also succeeded in generating student interest beyond the two student participants. As word spread about the course through the student "grapevine," students began asking if there were plans to offer a regular course on the topic, creating a pool of potential students for a future course on sustainable construction.

Finally, it was a fun experience, with faculty and students in a shared learning environment. While this might not be easily replicated on a larger scale (class), it was still a distinct positive from the perspective of faculty participants and should not be overlooked as simply a nicety or byproduct.

From a faculty administration perspective, it did not carry any "load" and was therefore without cost from a salary perspective. There were also no administrative issues in offering the course, as it was a standard offering with variable credit (1-3 credit hours) every semester. Since independent study courses were considered "one off" offerings, there were also no concerns about having a minimum number of students sign up for the course (typically 10 students at this institution) or having it be listed as under-enrolled and potentially cancelled.

Disadvantages for Faculty

There were several disadvantages from the faculty perspective. The primary disadvantage was that of time. Faculty are typically busy; this group was no exception. Conflicts inevitably arose, and meeting times had to occasionally be shifted. This was particularly true for the faculty that were simultaneously participating in the course and also studying themselves for the LEED-AP exam.

While this particular format worked well in this case, some faculty might be uncomfortable in a situation where they are not “in control” and at times shift roles from teacher to student, or where students become overly familiar. This is a variable that clearly depends on the particular faculty/student mix of participants.

Faculty participation was also dependent on their own interest in gaining exposure to the subject. In other words, it could not be expected to have three faculty members participate voluntarily after they were already familiar with the topic (such as having already passed the LEED-AP examination). It is also clear that the student impact is extremely limited: two students in this case. This format is not expected to be easily transferrable to a more typical class size of twenty to forty students (or more).

While the lack of “load” was an advantage from an administrative position, the faculty were donating their time to the process in the hopes that the benefits would be justified.

Advantages for Students

Many of the advantages for students echo those for the faculty. They were able to gain access to resources and experiences that might not have been otherwise available to them. The structure was a distinct advantage from their perspective; it made it a “real class” that they were taking instead of just an extracurricular. The students also enjoyed the “bragging rights” associated with being in the first course focused on sustainable construction. The students were also able to see their instructors in a different view, as collaborators and learners. And, of course, having fun was a big advantage as well.

Disadvantages for Students

As noted for faculty, some students might not easily adapt to the independent study format. In particular, students who do not identify strongly as self-directed learners might struggle with this approach (Knowles, 1975). Time was also an issue from the student perspective; the students did more work than they could have if they had simply decided to study for the LEED-AP on their own. The additional requirements (papers, discussions, presentations) clearly impacted the time and effort required.

Results

While anecdotal, the results from the course were interesting. Both faculty members who participated with the intent of taking the LEED-AP examination, passed the examination on their first try. Both students had intended to take the LEED-AP examination, but only one actually did, and passed on the first try. One of the faculty members who took and passed the examination relocated to another university.

Based on student interest, coupled with a newly-accredited LEED professional faculty member, the institution offered a sustainable construction course the following semester, with an enrollment of 24 students. The course content was based on learning the LEED requirements (including examination preparation), as well as case studies, best practices, field trips, guest speakers and a team project. Preferred learning practices from student and faculty perspectives were integrated into the new, dedicated course.

Recommendations and Next Steps

While the use of an independent study course is not a panacea for every new construction-related topic, it has its place in a program’s course offerings. Here are some other specific tips:

- Having a faculty team can be enjoyable, but is not necessary. A single faculty member can work just as well (or better) in many situations.
- Set clear timetables and expectations – do not overlook aspects such as grading.
- Record your perspective as a student – note what learning tasks were easy, difficult, boring etcetera.
- Be flexible and willing to learn from everyone involved.
- Select students carefully for participation. Getting the right mix is important.

- Do not focus solely on a single deliverable, such as passing a certification or accreditation examination – integrate that learning into part of the larger course perspective.

For those programs that elect to convert the independent study class into a standalone course, here are some next steps to consider:

- Consider class size and makeup carefully – not all teaching approaches will transfer readily from an intimate independent study class to a standard class size. For example, it might not be possible to have every student present their findings at every class meeting.
- Course scheduling is always important with elective courses – make the course accessible to as much of your student population as possible.
- Use previous students and faculty to help generate interest and resulting enrollment.

There are many "hot topics" where the independent study course format can be used as a trial run where student and faculty member learn a great deal. Similar applications might include preparation for the Project Management Institute's Project Management Professional examination and the application of the principles covered or learning a new Building Information Modeling (BIM) software package.

With prudent use, the independent study course format can be used as a trial or "proofing" run of courses to insure both their initial and continued success. It also can also offer a quicker "time to market" on new and emerging topics as opposed to standard course development, allowing programs to be more responsive and flexible in their course offerings.

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BIM across the Construction Curriculum

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To keep pace with the leading-edge building information modeling (BIM) technology commercially available in industry and to reinforce concepts throughout the construction curriculum, we are piloting the use of BIM across the construction curriculum. This paper discusses the challenges and opportunities of applying BIM in construction education and describes the steps to consider in the process of implementing BIM across the construction curriculum.

Keywords: Building information modeling, curriculum design

Introduction

Building information (BIM) technology has matured to the point that it being adopted by a large segment of the AEC industry. BIM is not solely a different tool for modeling facilities, and hence simply a different computer aided design software to teach. Building information modeling is also producing and facilitating new ways of delivering construction projects. This brings new attention to what and how we teach, and in particular, what role building information modeling plays in the constriction curriculum. To keep pace with the leading-edge building information modeling (BIM) technology commercially available in industry and to reinforce concepts throughout the construction curriculum, we are piloting the use of BIM across the construction curriculum. This paper discusses the challenges and opportunities of applying BIM in construction education and describes the steps to consider in the process of implementing BIM across the construction curriculum.

BIM defined

Several building information modeling technologies (e.g. 3D, 4D, energy modeling, and clash detection) represent separate, but synergistic ways in which computer technologies can aid firms over the lifecycle of construction projects and built facilities. Public exposure to, understanding of, and adoption of BIM technologies are evolving and expanding (GSA 2006). A consequence of this process is the use of various definitions for BIM. In this paper, we adopt the definition provided by the U.S. General Services Administration, a public owner that has actively supported the use of open standards and BIM across the US construction industry. GSA defines BIM as: “the development and use of a multi-faceted computer software data model to not only document a building design, but to simulate the construction and operation of a new capital facility or a recapitalized (modernized) facility. The resulting Building Information Model is a data-rich, object-based, intelligent and parametric digital representation of the facility, from which views appropriate to various users’ needs can be extracted and analyzed to generate feedback and improvement of the facility design.” In other words, BIM is a process (e.g. modeling) and a product (e.g. a model) used throughout the facility lifecycle.

Initial BIM implementation findings have been widely published. These publications describe successful cases and clearly demonstrate the advantages of using BIM for different purposes across the industry. Fisher et al. (2003) presented an extensive list of benefits to users of BIM models and illustrates these benefits with specific examples from actual uses on a variety of projects. Their article illustrates how current business practices and project delivery approaches allow or do not allow facility owners to reap these benefits. Each major perspective (e.g. owners, designers, general contractors, and subcontractors) has reported benefits from using 4D models to assist in understanding, analyzing and communicating a design and construction schedule. Owners have used 4D models to plan the construction of facilities that require significant phasing prior to contract award to verify the overall constructability of a proposed design given the project timeline and available space. General contractors have used 4D models for overall and for detailed construction planning, to communicate scope and schedule information effectively to subcontractors and other parties, and to test the constructability of the design (Korman and Tatum 2006) and the "executability" of the schedule prior to committing resources to the field.

According to Riley (2003), the use of 4D modeling for planning project logistics and evaluating project schedules is evolving rapidly. His research explores the 4D modeling of work spaces and material movement. Planning such spaces can be highly challenging when multiple sequence options and complex networks of prerequisite work exist (Akinci et al. 2002). BIM models can also support other aspects of production planning such as Lean Construction implementation. Recent articles published by the International Group of Lean Construction have described the potential synergies between BIM and LEAN. In 2009, Sacks et al. (2009 a) presented a very detailed study pointing out positive synergies between the building information model and Lean Construction. Sacks et al. (2009b) provides examples that illustrate the use of BIM to enable a "pull flow" mechanism to reduce variability within the construction process.

Even though recent implementations have demonstrated the positive impact BIM can have on project performance, many challenges still need to be overcome by the construction industry for a widespread use in the near future. Challenges such as lack of interoperability and standards, the rapid and constant changes in software, the need for specialized training to use the software, as well as the associated high costs to buy a BIM package (Denzer and Hedges 2008) are possible reasons why its use in the construction industry is not quite up to potential at this point. These are challenges for academic use of BIM as well.

Despite the challenges to full implementation, the depth of use of BIM technologies and the quality of the experience of using BIM technologies in the construction industry has motivated the discussion of how to introduce BIM in the classroom. Below we describe the benefits and challenges of applying BIM in the construction curriculum and project our vision for introducing BIM across the construction curriculum.

Benefits of BIM in Construction Education

The primary benefit of including BIM in construction education programs is that it is quickly becoming the state of practice and instrumental in project delivery approaches (e.g. Integrated Project Delivery) and objectives (e.g. sustainable construction). Students are using BIM in their internships and industry is starting to ask for BIM experience at job interviews (Rubenstone, 2007). Although there is noticeable resistance to using advanced computer technology such as BIM by constructors in the field, mindsets are changing. Contractors are starting to use BIM for 4D model based scheduling and 5D model based estimating (Post, 2008). Recent graduates with BIM education are bringing new ideas and understanding to the industry.

Using BIM can show students how the various parties involved in a construction project interact and at what point in the process. Students learn team collaboration and communication by using BIM and its many tools to develop class projects and collaborate on various aspects of the engineering and construction process (Hu and He, 2008). Use of BIM shows how communication can be streamlined and technical information can be transferred between parties. For example, students can see how construction costs can be updated as new materials and methods are incorporated into a building system. BIM provides new opportunities for collaboration among professionals and students in architecture, construction, and engineering, rather than segregating these disciplines. It also gives students the ability to see a higher level of complexity in building systems that has not been possible prior to the development of BIM software and integration (Mulva and Tisdel, 2007). BIM shows the coordination potential between multiple design disciplines throughout the building life cycle from design, construction to facility management. Data can be viewed in 3D or 2D and exchanged with other software programs for energy and structural analysis, estimating and project management (Goldberg, 2004). BIM software used as a teaching tool may be helpful in explaining course content or make it more interesting to students when shown in an "applied" environment (i.e. a beam pulled from a BIM model becomes more "real" than a beam drawn on a chalkboard, as students can see where it was in the structure and readily see its purpose).

Challenges of BIM in Construction Education

Challenges with BIM include the rapid development and ever changing software environment. There are a variety of BIM software applications and all have advantages and disadvantages (Goldberg, 2005). The software is still evolving at a rapid pace and standards are still being implemented (Goldberg, 2006). Students naturally want to use the most up-to-date versions of BIM software. The software can be quite expensive, and can pose a significant time commitment by instructors to learn the software and keep up with changes (Denzer and Hedges, 2008). Students may not have or have forgotten basic IT skills necessary to fully utilize BIM software by the time they reach their senior year, the time when class projects are assigned and the benefits of BIM can be fully utilized (Casey, 2008). For some students who are not strong in IT abilities, the software can be intimidating and they may get less out of a course of study if they avoid having to confront the technology. The question of how BIM affects the learning and critical thinking processes of students needs to be addressed (Denzer and Hedges, 2008). In addition, consideration must be given as to how the use of BIM is to be incorporated in a course curriculum in view of accreditation standards and requirements (Livingston, 2008).

Pilot: **BIM across Curriculum**

To pilot the use of BIM across the curriculum, we are targeting three types of courses: an introduction to BIM technologies; a subset of construction specialty courses to apply BIM; and a course that integrates lessons learned from across the curriculum (including BIM). We have selected a set of junior- and senior-level classes for this effort. The course sequence begins with a computer applications course that introduces BIM applications, such as Vico and Revit. In this course, students are introduced to 3D, 4D, and 5D visualization, information exchange between modeling and estimating and scheduling software, and queries of building information (e.g. material type or material quantity). This class helps students develop computing skill sets that will grant them confidence in basic interactions with BIM technologies, an understanding of the benefits of working with information-rich parametric models, and the challenges of working with sometimes “bleeding edge” technology.

With a base of BIM skill sets, students are prepared to work with the technology in specialized applications. For example, in the structural systems class, students derive information from a model from a building information model to evaluate the structural system (e.g. for beam or formwork design). In the planning and scheduling class, students interact with a 4D model to evaluate the schedule of an example building. These classes focus on particular skills and particular needs of a building information model. Finally, in the capstone class, students use building information models in more of an integrative application to perform charrettes, quickly performing what-if scenarios with schedule, cost, and design. The use of charrettes in the capstone class helps demonstrate BIM as a process, and demonstrates the types of contractual environments most appropriate to BIM applications.

Skill sets targeted:
- Generation and exchange of information
- Oral and written communication, coordination, and collaboration
- Schedule and estimate analysis and trouble-shooting
- Balancing construction management needs and technology capabilities

Based upon our findings from this initial step, we will decide how to proceed with other courses within the curriculum. A series of rubrics embedded within BIM-related exercises and student interviews will help calibrate the use of BIM as both a tool and a subject of instruction. We envision that a broad-based coverage of BIM in the curriculum, particularly an approach that employs the same model from different perspectives (e.g. structural systems and scheduling), will allow students to integrate their lessons learned across courses much earlier than the senior capstone class. A preliminary vision plan for implementation of BIM across the curriculum is shown in Table 1.

Table 1: Preliminary Vision for Implementation

Educational Objectives	**Course**
Students will:	Where implemented:
1. Understand what BIM is and how it applies to the construction industry.	CNST 120 Introduction to Construction
2. Be able to see how to use BIM to determine construction materials and methods for a construction project.	CNST 210 Construction Materials and Methods
3. Understand how to use BIM to develop, coordinate, and investigate the mechanical systems in a facility prior to construction.	CNST 332 Mechanical Systems/HVAC
4. Understand how to use BIM in the design of facilities.	CNST 351 Analysis, Design and Construction of Structural Systems
5. Understand how to use BIM to develop construction documentation.	CNST 341 Plans and Specifications
6. Understand how to use BIM software and apply it to construction projects for basic designs, schedules, and estimates.	CNST 353 Computer Applications in Construction
7. Understand how to use BIM in the detailed planning and scheduling of construction projects.	CNST 403 Planning and Scheduling
8. Understand how to use BIM in the detailed quantity takeoff and development of estimates.	CNST 451 Estimating and Bidding
9. Develop expertise in BIM modeling and project controls.	CNST 442 Building Information Modeling
10. Understand how to use BIM in all aspects of construction management.	CNST 452 Construction Management

Conclusions and Next Steps

BIM has cut across several disciplines addressed in the construction curriculum beyond computing. We are piloting an approach to extend BIM across additional specialty classes to demonstrate the process of deriving information and performing analyses, and to an integrative capstone class, where students use BIM as a means of integrating the lessons learned from previous classes in charrette sessions. The pilot is comprised of roughly sequential, independent modules that incorporate BIM for particular classes. The next step is integrative—clearly defining the progression of skill sets using BIM throughout the curriculum, and possibly using the same model from different perspectives in several courses, as appropriate. Such an effort requires careful consideration of the abilities of the technologies available, necessary training for faculty members, effects on accreditation requirements, and the question of whether BIM is a tool or subject of instruction in each particular course. This effort offers the possibility that a BIM-integrated curriculum enhances students' abilities to collaborate and integrate their lessons learned across the curriculum, and graduate prepared to lead in an industry that is rapidly adopting BIM.

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The Integrated Design Process on Paper and In Practice: A Case Study

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The use of an integrated design process is encouraged or required by a number of green building certifications, but many design and construction professionals have very limited knowledge about how to practice integrated design. This paper compares the integrated design process as practiced on one design project in mid-sized urban center in the Midwestern United States to the process outlined in the ANSI/MTS 1.0 Whole Systems Integrated Process Guide (WSIP)-2007 for Sustainable Buildings & Communities© (WSIP Guide). The project observed for this case study included a feasibility assessment regarding achievability of three green building certifications (LEED®, Living Building Challenge and 2030 Challenge) and the development of up to three conceptual designs. The design firm hired to lead the project facilitated a firm-developed integrated design process. While the design firm included many of the practices recommended in the WSIP Guide, there were also points where the process deviated from recommended practice.

Key Words: integrated design, whole building design, sustainability, green building

Introduction

Over the last 15 years, the construction industry has seen a considerable increase in discussion around, research on, and certification of the "sustainability" or "greenness" of buildings (Kibert, 2008). As municipalities, funding bodies and consumers expand the demand for green buildings, there is much debate about how to design and build higher performing, more efficient structures, centering around everything from which delivery system is best suited to green projects to the latest selection of interior finishes. It is generally accepted that the successful design, construction and use of a high performing, economically feasible green building entails a more cooperative, more cohesive project team (Pulaski & Horman, 2005; Rohracher, 2001). To engage project partners in this cooperative practice, the USGBC's Leadership in Energy and Environmental Design green building rating system, currently the leader in the green building certification market, encourages the use of an integrated design process (IDP) on projects seeking certification. Other rating systems, including GBI's Green Globes rating system, the National Association of Homebuilders Green Building Program and The Living Building Challenge, also encourage and/or award points for an integrated design process. However, in an industry as historically fragmented as construction, there are few professionals with experience leading or working with an integrated design team – especially in smaller markets. Many teams are looking for answers to basic questions like, how the integrated design process is defined and how to put the process into practice on a given project. This paper explores both of those questions through the lens of the ANSI/MTS 1.0 Whole Systems Integrated Process Guide (WSIP)-2007 for Sustainable Buildings & Communities© (WSIP Guide) and the practice of an integrated design process in a mid-sized, Midwestern community. The WSIP Guide provides a map for conducting an integrated design process, but how closely did the practice of IDP as practiced in this case resemble the map that has been laid out on paper?

The Integrated Design Process

The integrated design process is also known as *whole building design* or *integrative design*. This type of process assumes that construction, design, and engineering specialists have distinct and complementary knowledge bases and can work together to achieve higher levels of performance, simplify construction, decrease costs, and shorten the build schedule (Popcock, Kuennen, Gambatese, & Rauschkolb, 2006). These are desirable outcomes on any project, and are particularly germane for construction projects weighing cost, time, and performance concerns related to a sustainability certification as a project goal. An integrated design process endeavors to engage project stakeholders on three levels. First, stakeholders work to develop a shared vision for the structure. Second, they become able to envision the structure holistically. Finally, they commit to serving as subject matter experts at each phase of a project (Popcock, Kuennen, Gambatese, & Rauschkolb, 2006). Integrated design is not a new concept, nor is it one unique to the green building industry. The recent history of this philosophy is solidly housed in the literature related to sustainable design and construction. The process seeks to include experts from a number of disciplines, as well as building end-users, in the earliest phases of the planning and design process. Team members work together through design Charrettes and other communication channels to clarify project performance goals, owner requirements and to begin brainstorming design ideas. As the process progresses, brainstorming sessions and other forms of communication become more technical in nature with each team member contributing her/his expertise to the design of the highest performing building possible within the constraints of the project goals and objectives (Kibert, 2008).

Designers, engineers and constructors all bring distinct knowledge bases to the design process. For the last 50 years, common practice in the United States has been for the architecture firm to take sole responsibility for design, involving other specialists on the project team after the design phase is complete. In this system, any consultation happens too late for specialist knowledge to have a significant positive impact on design, materials and assembly choices. There is little data documenting how frequently the integrated design process is used on green building projects. That professional organizations and standards bodies are creating guides suggests that there are practitioners employing IPD on individual projects or as part of general practice. The basic process includes six elements, practiced through a design process with five to seven phases. Early involvement of a diverse stakeholder group, project visioning, targeted design meetings (sometimes referred to as Charrettes), multiple modes of communication, and iterative process are included as process elements in each of the process guides. According to these guides, the design process begins at what is termed the proposal or concept phase and concludes as early as the finalization of construction documents and as late as the beginning of actual construction activities. The processes guides all encourage the inclusion of the owner, design firm, construction experts, estimators, system engineers, operations and maintenance professionals, technical specialists and end users (ANSI & The Institute for Market Transformation to Sustainability, 2007; AIA, 2007; Busby, Perkins + Will, 2007). Bringing team members into the conversation early serves a number of purposes. First, it provides the opportunity for the project team to establish a common vision for the project and to clarify project goals. Second, a strong sense of the importance of collaboration among the team members is established and a tone of partnership, which is assumed to carry on throughout the duration of the project, is established at initiation (Kibert, 2008). Finally, each player brings both an established skill set and a fresh perspective (at least on matters outside her area of expertise) to the design process. This mix of expertise and inexperience sets the stage for the team to explore building systems in new ways with a different understanding of the building as a whole (McLennan, 2006).

The literature on collaborative design processes is seated in both the social sciences and in technology, with some work in business related to learning organizations and learning teams. Senge’s The Fifth Discipline stands as the seminal work on learning organizations and knowledge management literature frequently cites Senge. Work teams, termed *Communities of Practice* by Senge, are becoming the standard organizational unit in all business sectors and require professionals to collaborate more intensively on projects (2006). For every team member, work on a high level green building means facing challenges to long held assumptions, reorienting from a focus on work in a specialized area to a focus on the building as a system. Kibert asserts, “Green buildings are a new concept to the industry and it is necessary to orient all members of the project team to the goals and objectives of the project that are related to issues such as resource efficiency, sustainability certifications and building health, to name a few” (2008, p. 85). Rohracher describes teams on building design and construction projects as “loosely coupled systems” and asserts that the tightening of such teams includes both social and technical elements (Rohracher, 2001, p. 143). The processes used for communication serve as tightening social elements, which can introduce new methods, and means, encourage integration and stabilization of the project team, and provide team members with a deeper understanding of sustainable building (Rohracher, 2001). McLennan refers to this tightening as team members beginning to “understand how to make connections between people, their ideas and their solutions” (2004, p. 89). Some transformation from a loosely coupled system to a tighter system takes place as the project vision unfolds within the integrated design process. According to Peter Senge, the vision of a project or company is the “what” team members see when they envision the future or outcome of an endeavor (p. 208). This shared vision serves to create a sense of community among the project stakeholders and orient the team to work as an integrated body. The concept of the building as a whole should lead team members to re-envision not only the design process as a whole, but also the Community of Practice and the more tightly coupled system of the project team in the context if that whole (Mc Lennan, 2004).

At least a small number of teams began this integrated practice long before process guides were developed. In 2005, a multidisciplinary team recognized the need for guidance and standardization of the practice of IDP and met to begin defining and setting standards for use of the integrated design process in the United States. This meeting resulted in the 2007 release of the ANSI/MTS 1.0 Whole Systems Integrated Process Guide (WSIP)-2007 for Sustainable Buildings & Communities©, essentially, codifying one “map” for the practice of IDP (2007). That same year, the American Institute of Architects released their guide to integrated project delivery, which includes use of an integrated design process (2007). The BC Green Building Roundtable also released the Roadmap for the Integrated Design Process in 2007 (Busby Perkins + Will & Stantec Consulting). This paper will explore only the process as detailed in the WSIP Guide.

The Whole Systems Integrated Process

The WSIP Guide recommends bringing a diverse team of stakeholders to the table during the conceptual design phase through both face-to-face and virtual communications. The WSIP Guide describes an iterative process combining research, workshops and analysis involving the team of experts at every point in the process. Beginning with research, this process moves through phases that include Goal Setting and Alignment of Purpose, Concept or Early Schematic Design, Mid-Schematic Design, and Late Schematic Design/Early Design Development. After the fourth workshop (Late Schematic/Early Design Development), the process shifts from design to analysis and refinement. The iterative research/workshop cycle outlined in the WSIP Guide assumes up to four workshops, one after each phase of research (2007). Design Charrettes are one piece of this process, however, the process guide warns against relying on Charrettes as the only team interaction. Charrettes originated as an educational tool at the Ecole de Beaux Arts during the nineteenth century. The word “Charrette” refers to the carts used to collect students’ work. In modern usage, the word generally refers to a gathering with the purpose of creating a plan. Often used in urban planning, Charrettes have recently gained popularity in the world of building design (Kibert, 2008; McLennan, 2004). Focused design meetings alone are not enough to create a truly integrated project team and allow potential for work to progress between meetings with little input from key team members (ANSI & The Institute for Market Transformation to Sustainability, 2007). The framework includes the use of design Charrettes as only one mode of communication among project team members, but does not explicitly define additional communication tools. Continued and frequent communication during each research and analysis phase is recommended.

In the Proposal Stage of the WSIP Guide’s suggested process structure the design firm and prospective client meet to establish outline the initial scope of the process, design team structure, building program and sustainability objectives. A design team that includes professionals with the necessary expertise, given the project objectives is then formed. This stage is followed by a research phase where base conditions are identified and core project programming is initiated. Once this research is completed, Stage One of the design process begins with a workshop involving the entire design team to set project goals and align the team with the purpose of the project. The team identifies the “deep reason” for the project and for their involvement, as well as design drivers. The team then creates a process flow diagram, reviews the project program in light of the sustainability objectives, and sets a meeting schedule. If the delivery method for the project is not yet determined, it may be determined at this point. After this workshop, the next research and analysis phase begins. The analysis of flows, relationships and economics between the program and the base conditions are refined during this phase. Costing work then begins and metrics, benchmarks and project scope are revisited to check for alignment. Stage Two of the process includes a design workshop involving the entire team, where a conceptual or early schematic design is developed. This workshop is followed with another research and analysis phase where the design is tested against the core purpose, design drivers and project objectives. Stage Three begins with a design Charrette where the initial design is further refined into a mid-level schematic design. According to the WSIP Guide at this level of schematic design “broad issues of the scheme should be essentially 'locked'" and the team should be working to confirm alignment with goals and objectives, refine the design further, and begin value engineering as necessary (2007, pg. 14). Again, a research and analysis phase bridges stages three and four. During this phase, non-building related sustainability issues are addressed and design concepts are tested against project goals and metrics. Stage Four includes a final workshop where the schematic design is developed further, resulting in the final design. During the analysis phase that follows the team develops detailed drawings and specifications. Once these drawings are completed, design is complete and the bidding and construction process begins.

IDP In Practice

The municipality involved in the case study in this article was one of the first in the country to require LEED® certification for new commercial construction projects, targeting projects in a specific area sited for redevelopment. In early 2008, municipal sustainability certification requirements expanded to include projects in both the community's inner urban core and along a major commercial corridor. The community is in the early planning stages of the renovation of a former residence into the first green model home and education center in the region. The project is a partnership between the municipality and a not-for-profit environmental education center. The municipality purchased a former residence located between a park, the primary pedestrian/bicycle trail and a municipal amphitheatre to improve access among these amenities. Community leaders later identified the former residence as an additional asset and potential new home for the regional environmental education center. The first phase of the project includes a feasibility study regarding achievability of three green building certifications (LEED®, Living Building Challenge and 2030 Challenge) and the development of up to three conceptual designs. The firm retained to complete the feasibility study and initial design work is a well-established architectural and urban planning firm practicing throughout the United States, with practice concentrated in the Midwest. A self-developed integrated design process, involving numerous subject matter experts (SME's) from project initiation through completion, is a key service offered to clients. The use of an integrated process was required by one funding source providing a grant earmarked to pay for the planning process. In addition to the grant requirement, the goal of up to three different green building certifications, each encouraging or requiring that the team employ an integrated design process, served as motivating factors in the choice to employ an integrated process from the outset of the project.

The integrated design process as practiced on this project included an initial research and planning phase, as well as visioning and goal setting work in the form stakeholder meetings that resembled focus groups. The vision and goals developed in these meetings informed the work at three subsequent design meetings focused on more technical considerations including the development of a program of spaces and uses, preliminary goals related to building certification, and, eventually, conceptual designs that included basic energy models and costing information. The entire design process included eight meetings: Five of the meetings focused primarily on the development and communication of project vision and goals, three focused on the creation of a conceptual design and a vetting of the feasibility of achieving various sustainability certifications. The first set of meetings generated project principals and informed the attendance plan for the subsequent meetings, including the design Charrettes and Stakeholder Breakfast (Design Firm, 2009). This process lasted roughly seven months, though the final design review and presentation of work products to the municipal governing body have not taken place at the time of this writing.

Project planning began about two months prior to the first meeting. This planning work took place via telephone calls and electronic communication, and involved only the municipality and design firm, this format for the proposal phase reflects the WSIP process, which encourages the design team to work closely with the owner to begin establishing project goals and objective. An in-person meeting with the owner did not take place prior to the first workshop – one place the practice of IPD differed from process guide recommendations.

Key-person Interviews

Key-person interviews (KPI) are the first step in the architectural firm's integrated design process and served the purpose of the initial owner-designer meeting recommended in the WSIP Guide. The purpose of these interviews was two-fold. First, the firm hoped to gain information about the customer vision for the project. Second, the interviews were thought of as a way to gain buy-in from major project partners (Design Firm, 2009). For this project, interviews took place with groups of up to six participants. Four KPI's were held over the course on one day, with each session lasting about two hours. The WSPI calls for one only workshop, including primary project partners, for the purpose of goal setting and alignment of purpose. The owner, architectural firm and the primary future tenant generated a list of participants, each were invited to one session. Participants were loosely grouped by area of expertise and each session included a town staff member, a member of the town council, a tenant representative and the design firm representatives. Because this project is a municipal endeavor, rather than a for-profit building venture, council members were included to ensure that public officials understand and support the project. These choices related to meeting structure and invitees represent another deviation from the letter of the WSIP Guide, however, the choices seem appropriate given the unique circumstances of the project.

The basic format of each session was very informal. The architectural firm representatives facilitated each meeting, with one person acting as primary facilitator and the other as scribe. Reference and resource materials were provided for each session, the materials packet included: house plans for the existing structure, an aerial photo of the property, a summary of the Living Building Challenge rating system, a summary of the LEED Homes rating system, information about the 2030 Challenge and information on The Sustainable House (Minnetonka, MN). The materials provided served as process tools, as guides to the design areas to be addressed in the meetings, and as examples of vision statement and goals on similar projects (Arditi, Elhassan, & Toklu, 2002). At this point in the integrated design process, plans and photos aided participants in conceptualizing the building, as it currently exists. Sustainability rating systems served to inform participants of the design areas to be addressed throughout the process and to orient less experienced participants to more detailed concepts related to sustainable design (McLennan, 2006; Pulaski & Horman, 2005; U.S. Green Building Council, 2008).

Each meeting was framed as a conversation about the vision for the house and property, and served to set some preliminary project goals. Throughout each meeting, the facilitator noted the articulation of "project principals" – described as statements that included information related to project vision and priorities that will guide the design team in their work. The materials packet was referenced through the course of each meeting. A number of these strategies, including provision of a meeting framework, orientation to sustainable design as a concept and activity, and the tagging of "project principals", are included in the literature on the integrated design process (Kibert, 2008; Arditi et al., 2002; Lindsay, Todd, & Hayter, 2003). The WSIP Guide includes a research and analysis process after the initial workshop. During the three-month period following this meeting, the firm compiled the information generated into the project vision and goals for use in subsequent meetings, with virtually no communication among project partners. That they did this independently rather than involving project partners represents another deviation from recommended practice. The firm and municipality also worked together over this period to document the existing building, thus some collaboration on work related to the project did take place.

Expert Design Charrette

The Expert Design Charrette involved about thirty people in one three-hour work session – a much broader stakeholder group than is recommended by the WSIP Guide. Some participants had been involved in the KPI process; for others, the Charrette served as their introduction to the project. This meeting represented the first step in creating a Community of Practice on the project (Senge, 2006). The design firm provided a range of materials, including: large-scale house plans for the existing structure, an aerial photo of the property, a summary of the Living Building Challenge rating system, a summary of the LEED Homes rating system, information about the 2030 Challenge, large sheets of tracing paper, large flipchart pages, and drawing/writing tools. Visual cues were included in the form of flipchart pages, plans and photos, as were the materials necessary for participants to begin to create drawings of potential design features. These participant-generated drawings serve as both visual cues and as brainstorming opportunities (Arditi et al., 2002). Design areas were once again established by reference to and availability of sustainable building rating systems (McLennan, 2006; Pulaski & Horman, 2005; U.S. Green Building Council, 2008). The design firm opened the meeting with a short presentation, focused on some sustainable building basics, the firm's credentials, work thus far, and the project principals developed during the Key-person Interviews. The WSIP Guide recommends the development of a project goals matrix. Rather than a matrix provided to participants showing interaction between goals, the firm provided a short list of principals as part of the presentation. This presentation oriented new members of the group to the project and provided a review for those who attended KPI's (Lindsay et al., 2003). The group was then given a virtual tour of the project site and an introduction to techniques used in the design and construction of high performance buildings. The presentation ended with three prompts. Participants were encouraged to break into groups, with an eye toward including diverse skill sets, and then work as a team to answer these three prompts. Both graphic and textual answers were encouraged and the groups were directed to the materials on each table as brainstorming aids. The firm representative recorded results on the large flipchart pages and collected them at the close of the meeting. The structure of this group work was consistent with recommendations in the work of Lindsay et al., (2003) and Pulaski et al., (2005). The final exercise involved each participant coming up with what the firm termed an "elevator pitch" for the project. These pitches were brief descriptions, one to three sentences, of the project. This project visioning served the purpose of gaining understanding about how the group concept of the project is developing (Arditi et al., 2002; Design Firm, 2009; Pulaski et al., 2005). The information gathered by the firm in this workshop was used to develop a program of spaces and uses in collaboration with the primary future tenant, and to begin work on a conceptual design scheme.

Stakeholder Breakfast

Due to the unorthodox nature of the funding plan, the firm chose to hold a stakeholder meeting to share the project vision and provide information about project progress. The collaborative nature of the facility opens the door for a wide range of stakeholder involvement. Invitees included representatives from local universities and colleges, banking professionals, local politicians, economic development organizations and construction industry professionals. The structure of this meeting was relatively formal, with the firm presenting the project vision, information about the planning and design process, and opportunities for stakeholder involvement identified thus far. This meeting was brief, lasting about one hour. The WSIP Guide does not include a meeting of this kind; however, this additional meeting was not focused on design work and represented a valuable addition to the process given the project's unorthodox funding plan.

Integrated Design Charrette I

The most structured of all the meetings in the process, this work session was also the longest lasting about five hours. This first integrated design Charrette closely resembled the second workshop called for in the WSIP Guide, the purpose of which is to begin developing a conceptual design and may include the development of an early schematic design. Participants included local code officials, the design team, a mechanical engineer, an energy consultant, the owner, future tenants, a renewable energy expert, and a local residential contractor. This meeting further defined the players who will make up the CoP on the project (Senge, 2006). A robust materials packet was provided to participants. The packet included; the initial program developed with the primary future tenant, floor plans and section views of the existing structure, two preliminary design scenarios (space configuration only), preliminary LEED® Homes checklist, and energy use information for the existing structure. Heavy on visual cues and including a number of models in the form of axonometric representations of potential designs, the materials packet was geared toward work on a building and site level (Arditi et al., 2002; Pulaski & Horman, 2005). In alignment with the WSIP Guide, this work was completed during the research and analysis period between workshops. During this research and analysis phase, the firm had more interaction with the project team, involving subject matter experts in the form of energy consultants (one local energy auditor and a systems designer who works with the firm frequently) and the future tenant for program development.

The meeting began with a short presentation about the process to this point, project principals identified through previous meetings, the goals for the meeting and an orientation to the design scenarios provided by the firm. The firm provided seven major deign choices, which would significantly influence design work from this point. The firm oriented the group to the work goals for the meeting and clearly defined the decision making process during a Charrette (Lindsay et al., 2003). The firm vetting process is simple; a topic is raised for discussion, a proposed solution/design idea is put forward, the team vets the proposal, the group then decides by a "thumbs up or down" vote on whether to explore the proposal further or to shelve the idea. This process is repeated for each design choice. The firm led the group though discussion related to four of the seven choices over the course of the morning. Participants were encouraged to use many communication forms including brainstorming, sketching, and examining virtual models of the structure (Arditi et al., 2002). A working lunch provided an opportunity for some information sharing on energy analysis. Design work continued after lunch, with the same vetting structure, and the remaining design choices were addressed.

Integrated Design Charrette II

The final working meeting involved thirteen participants, all of whom had been present at other project meetings, and included owner representatives, code officials, an energy consultant, future tenants, a local residential contractor and facilities management professionals. The meeting lasted four hours and time allowed for the resolution of a number of key design decisions. The firm representatives opened the meeting with a review of consensus decisions and set out questions and design proposals for group discussion: The firm then presented their design work to this point. This work was completed during the research and analysis phase with little involvement of project team members, other than the firm affiliated energy consultant. The materials packet consisted of photos and floor plans of the existing structure, a short section of the existing structure and proposed levels, a long section of the existing structure and proposed levels, wall sections showing proposed insulation plan, area drawings of three program options (labeled A, B and C), sketches of three roof options and an energy budget. Materials included more building and site information, and less information about project vision and goals (Arditi et al., 2002). The group reviewed the proposed program options, discussing circulation and the needs of the future tenants. Group members worked together as a large group, as well as in side conversations assessing the pros and cons of each program option. The firm used few formal facilitation tools. Participants relied heavily on the visual cues provided by the firm and work included much sketching as a primary communication tool (Arditi et al., 2002).

Design Review Meeting and Presentation of Work Products

At the time of this writing, there are no scheduled dates for the Design Review Meeting and Presentation of Work Products. The participatory phase of the design process is complete, however the municipality and design firm are facing scheduling difficulties due to unrelated projects. The two meetings that will provide closure for this phase of the process have been put on hold until the issues related to outside projects are resolved. The firm did submit the final work product packet, which included one conceptual design scheme (DS1), a Cost Estimate Report for DS1, a Cost Breakdown by Systems for DS1, an Energy Cost Budget for DS1 and a Mechanical Narrative for DS1. These materials were developed during the final research and analysis phase, and involved only firm affiliated subject matter experts (an energy consultant and costing expert).

Conclusion

The integrated design process as practiced on this project included an initial research and planning phase, visioning and goal setting work in the form stakeholder meetings that resembled focus groups. The vision and goals were used to inform the work at design meetings. The entire design process included eight meetings spread over four working days. Five of these meetings focused primarily on the development and communication of project vision and goals, allotting a significantly greater proportion of time to visioning and goal work than recommended in the WSIP guide. Three meetings focused on the creation of a conceptual design and a vetting of the feasibility of achieving various sustainability certifications – a number that is more in line with recommendations for practice detailed in the guide. Design development on the project progressed only to the schematic design phase and did not include the Early Design Development phase that is part of the WSIP Guide process. At this design phase, the WSIP Guide includes three workshops in the recommended process, with research and analysis phases between each. The firm developed process as practiced on this project reflected an adherence to the WSIP best practices in its inclusion of three workshops similar in form to those detailed in the guide and some limited contact between project partners during research and analysis phases. The design firm added a number of activities to the process that were not included in the activities detailed in the WSIP Guide. The Stakeholder Breakfast more closely resembled a marketing event, than a design related meeting and significant portions of the five earliest meetings were dedicated to education of participants about green building principals and practices, as well as certification systems. These additional activities, while outside of the map outlined in the guide, made sense in the context of this particular project.

The integrated design process practiced by this firm included many of the best practices detailed in the WSIP Guide, while accommodating the unique challenges that grew out of the nature of the project. The firm made choices that deviated from best practices in two primary areas. The first was the level of project team involvement during research and analysis phases. The design firm worked more independently during the first and final research and analysis phases than is recommended. Whether this choice was a calculated decision to manage time or staff resources, or simply a step back into a more common form of architectural practice is unclear. If in the study of future integrated design processes this choice surfaces repeatedly, it may indicate a need for further study related to the practice of cooperative work and the dynamics of Communities of Practice. The second deviation was the firm's choice to include significantly higher levels of community stakeholder involvement in the development of the project vision than recommended by the WSIP Guide. This choice seems very appropriate given that the project is a public-private partnership that can only be completed with significant community support and involvement. These high levels of stakeholder involvement would be unnecessary on most commercial and residential construction projects, though replicating this model might be advantageous for municipal projects and projects hoping to rely on fundraising campaigns, grant writing and private sponsors as funding sources.

This second choice illustrates one way in a team may consciously choose to deviate from "paper" guides based on the circumstances of the project. This case raises a number of questions related to the choices design teams make based on the larger context of the project. Here an unorthodox funding structure, significant political exposure, and the need for participant education may have had significant effects the choices made by the design firm. It makes sense to consider other contextual elements of design projects that might compel design teams to deviate from recommendations outlined in guides like the WSIP Guide. The relative inexperience of participants necessitated high levels of education within workshops, taking time away from design development work. This choice represents a tradeoff between increased community awareness and buy-in and work efficiency, which may be acceptable on one type of project but not on others. The design of high performing building systems poses challenges and often necessitates trade-offs. The real world practice of integrated design seems to mirror this dynamic, requiring teams to make choices about where to follow process guides to the letter and where to deviate based on the context of their project.

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