INNOVATION IN GREEN BUILDING:
A CASE STUDY OF THE GENERAL CONTRACTOR AT GREENBRIDGE

by

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OUTLINE

INTRODUCTION

In the construction industry, building green is becoming more than a marginal phenomenon. The publication of a variety of building assessment standards is spurring the increase in development by providing a better understanding of what constitutes a green building (Retzlaff, 2008). The standard with the greatest degree of market penetration is the multi-tiered LEED rating system. Its broad and consensus-based formulation laid the groundwork for the conveyance of this standard from creation to industry practice (Kibert, 2007). LEED rating systems which accommodate a wider variety of building and project types reinforce its popularity.

> "Innovation is the wellspring of creativity in the US economy – the capacity to integrate across organizational, intellectual, and cultural boundaries, the capacity to experiment, and the habits of thought that allow us to make sense of radically ambiguous situations and move forward in the face of uncertainty."
> From *Innovation: The Missing Dimension* (2004)

Governments at various levels are responding by encouraging the pursuit of green building certification in new developments. Green building programs in large cities typically originate in comprehensive plans and go on to influence zoning and, though less often, building codes (Frej, 2003). Incentives created by these programs include expedited review, financing for green improvements, density bonuses, permit waiver fees, and property tax abatements (Retzlaff, 2008). The Town of Chapel Hill instituted the pursuit of LEED Silver as justification for expedited review in 2006 with the additional requirement that projects exceed prevailing energy standards by 20% (2006-06-26/R-27). California became the first state to adopt a statewide green building code with CALGREEN, which includes more stringent voluntary provisions to induce greater change at the local level (State of California, 2010).

Other construction industry professionals are reacting to this emergent trend. Architects are pledging the 2030 Challenge with incremental benchmarks for reducing energy consumption on all new buildings, developments and major renovations. This is a welcomed remedy for those who criticize LEED-certified buildings for not living up to their predicted energy savings (Navarro, 2009). An increase in the amount of litigations involving breaches of contract for projects that fail to live up to their promised goals is creating a need for "green" legal counseling (Del Percio, 2007).

Graduate schools of Construction and Engineering are adopting courses in environmental engineering and sustainable design to meet employer demand for students trained in green building strategies (Burt & Tinker, 2003). These graduates enter a job market where LEED-

related spending itself has created 15,000 jobs since 2000 and is projected to support 230,000 jobs through 2013 (Booz Allen Hamilton, 2008).

Building constructors and designers, recognizing the growing market for these spaces, are employing new means to meet nuanced demands. Daylighting strategies, such as passive solar design, are reducing energy demand in schools and offices. Builders are incorporating rainwater harvesting systems to recycle usable water for greywater uses and are employing increasingly-sophisticated solar power technologies to reduce dependence upon conventional energy sources. Despite escalating costs in the market for construction materials, constructors are still achieving LEED certification within budget; in some instances they find success through simple approaches to sustainability such as appropriate building orientation to optimize access to sunlight rather than specifying expensive technologies (Langdon, 2007). Nationwide production of LEED-certified square footage across all building types will balloon to ten times the current rate within a short 4 years to 1.74 billion SF per year (Booz Allen Hamilton, 2008).

Indeed, multi-disciplinary engagement is reinforcing this growing momentum. These disciplines utilize green building as a means for providing a collective response to an array of problems such as climate change, resource depletion, and building-induced sicknesses. Assessment standards such as LEED encourage concrete and measurable solutions to these far-reaching problems. These solutions lead to new products – buildings with renewable-energy technologies, for example – and new processes.

Still, these changes are superimposed onto an established construction environment, and any new requirements must coexist within the traditional restraints of project deadlines and budget allotments. As a result, the very solutions which green buildings create can also become challenges to the green building creation process.

Overcoming these challenges requires new strategies, and new strategies require new knowledge. This new knowledge, actively developed as a response to the challenges of green building, is innovation (Nonaka, 1994). However, innovation in the construction process does not originate from any green building assessment standard. Put another way, there is no template for how to build green. We must look to those involved in constructing green buildings in order to detect new strategies for overcoming green building challenges.

As the construction process dissolves into many sub-processes, these sub-processes become the responsibility of dozens of distinct design professionals and subcontractors. The firm standing in the middle is the general contractor who provides a vital function in managing this web of firms. In seeking to understand innovative green building strategies, examining the

general contractor allows a peak into the middle of a construction project's environment and core of the construction process.

This paper builds our understanding of innovative green building strategies by describing the adaptive actions taken by a general contractor on a local project. This local project is Greenbridge, a 210,000 SF mixed-use building under construction in western Chapel Hill seeking a certification of Gold under LEED for New Construction 2.2. As a building with commercial tenants, these actions have implications for other projects as commercial construction represents 60% of the accumulated square footage of LEED certified buildings through 2008 (Booz Allen Hamilton, 2008). With office and residential components as well, this research provides evidence of how a general contractor can adapt to a project with a variety of intended uses.

After describing these technical changes, I discuss the role of general contractors in inducing innovation within the construction industry by positioning them in the middle of a web of design professionals and subcontracted firms. In coordinating a complex construction process, they are vital to the successful execution of green building projects. As seen in this case study, they may also assume a role as an educator for subcontracted firms and as a communication hub among design professionals, building owners, and laborers. Finally, I will make suggestions for practices that have the potential to induce further innovation within the green building industry.

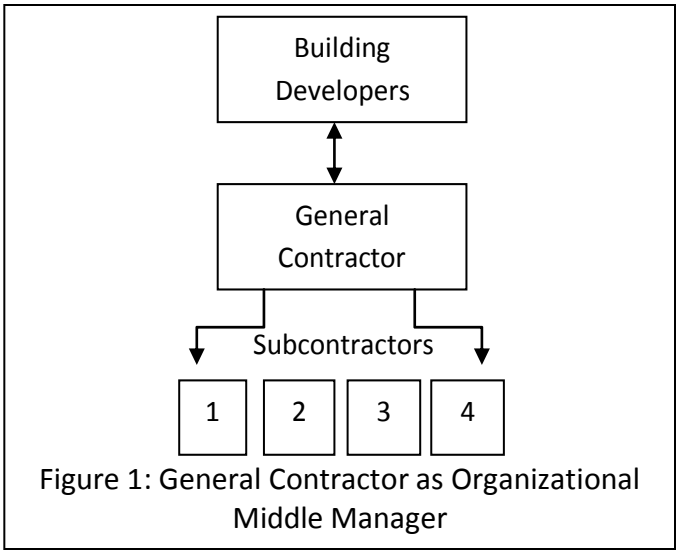

Figure 1: General Contractor as Organizational Middle Manager

As indicated earlier, this study situates the general contractor as middle manager. Middle managers lie at a crossroads for communication between executive management and front-line workers, bridging the visionary ideals of the top and the often chaotic reality on the frontline of business (Nonaka, A Dynamic Theory of Organizational Knowledge Creation, 1994). Our understanding of the role of middle managers in strategy development has evolved from a view where they take direction from, and provide input to, top management to one which places them at the center of two processes vital to strategy formation – knowledge creation and the development of core competence (Floyd, Schmid, & Wooldridge, The Middle Management Perspective on Strategy Process: Contributions, Synthesis, and Future Research, 2008).

Research has examined middle managers as individuals. Nonaka (1994) attributes the individual as both the origin and the prime mover in the upward-spiraling process of organizational knowledge creation. With this understanding, it is possible to usefully examine innovation at two levels. First, the general contractor, as an organizational unit, mediates between top management and laborers at the operational levels (Figure 1). Generally, the general contractor translates the goals and values of building owners into operating procedures for subcontractors. As the general contractor acts as this vital intermediary, it is evident that this firm is integral to success on single projects.

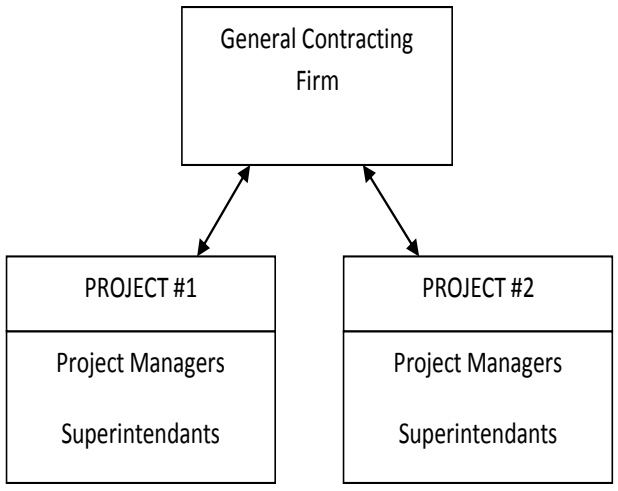

Figure 2: Subunit employees of General Contracting Firms as Individual Middle

Secondly, analysis can be scaled down to the level of the individual. Even as the general contractor is a unit intervening between building owners and subcontractors, the employees within this unit are themselves a subunit of the general contracting firm (Figure 2). Stated differently, general contracting firms manage several projects simultaneously which segments human resources. Within middle management research, this may find a corollary to the branched or satellite structures of organizations found in other industries i.e. multi-national telecommunications firms with several semi-exclusive product divisions. However, the ramifications for knowledge creation are similar. As subunits of employees – Project Managers, Executive Project Managers, and Field Superintendants – are divided among several projects, intra-firm communication faces obstacles. Senior executives may be too distant from any one project to detect new micro-strategies. As a result, on-site Project Managers and Superintendants are key sources and reservoirs of novel green building strategies.

This fragmentation forces general contracting firms to adopt methods to absorb best practices from single projects so that they feed back into the organization and become or enhance core capabilities. To this end, general contracting firms must find ways to communicate across project boundaries in order to progress as a whole enterprise. When general contracting firms accumulate knowledge within its own organization, it is able to deploy improved strategies on future building sites. Despite the various contexts in which buildings are constructed, projects which seek LEED certification face similar goals: a clean indoor environment and the diversion

of reusable materials from the waste stream, among others. As a result, the solutions to green building challenges on one project become proven strategies for the next.

METHODOLOGY

A great deal of this research cites the perspectives of professionals who can be divided into 2 groups: employees of the general contractor and professionals working with the general contractor. These include:

- A building developer, hereafter referred to as building owner
- The Architect of Record, hereafter referred to as the Architect
- The Interior Designer
- The President of the minor-partner general contracting firm
- A Lead Real Estate Agent
- A Project Manager of the minor-partner general contracting firm
- A Project Coordinator of the minor-partner general contracting firm
- A Purchasing Manager of the plumbing supplier
- The Director of Sustainable Design of the major-partner general contracting firm
- The Project Executive of the major-partner general contracting firm
- The Senior Vice President for Pre-Construction for the major-partner general contracting firm
- A green building Consultant

I completed all interviews between July, 2009, and March, 2010, during the project's construction phase. Certainly, including other professionals involved on the project could have added to this writing. I based the selection of interviewees upon access to the appropriate individuals which was, at times, difficult due to time constraints of this research and the project itself.

THE GENERAL CONTRACTOR

> "(Alliances) must yield benefits for the partners, but they are more than just the deal. They are living systems that evolve progressively in their possibilities."
> From *Collaborative Advantage: The Art of Alliances* (2000)

Greenbridge is a multi-use, $30 million project under construction on the western edge of Chapel Hill. With architectural designs by William McDonough and Associates, the project is achieving national prominence. The concept includes ground-level retail and restaurants, office space on lower floors, and condominium units in remaining spaces. 15%, or 15 units, are set aside as affordable housing units. At its maximum height of 135 feet and 10 stories, it will be Chapel Hill's tallest building. Its two-story profile and stepped-back façade present a configuration unique to surrounding structures.

While many individuals and organizations are involved in the making of this project, the focal point for this research is the general contractor.

In the summer of 2007, the building owners selected Weaver Cooke Construction of Greensboro as the general contractor. By that time, Weaver Cooke was already moving to the forefront of green building in the Triad region. Its corporate headquarters, completed in January of 2007, was the first commercial building in the Triad to achieve LEED Gold certification (Weaver Cooke Construction, 2007). At the time of its selection for Greenbridge, Weaver Cooke was providing preconstruction and construction phase services for The Proximity, an 8-story luxury hotel and the first in the hospitality industry to achieve a LEED Platinum rating.

However, Weaver Cooke is not the single general contracting firm, which is instead a joint venture between itself and CT Wilson Construction Company of Durham. The joint venture formed before planning and estimating stages, and both firms participated in each process. As a result, the general contractor of Weaver Cooke Wilson is a unique corporate entity formed for this single project and combines the resources of both firms into one unit. This joining of resources signifies a strategic alliance and what has been called a company's *collaborative* advantage (Kanter, 2004).

The President of CT Wilson cites the joint venture arrangement as forming for two reasons. First, the merger of the two separate corporations increased the bonding capacity on this single project. Bonding companies ensure the performance of the general contractor and protect owners against contract default. General contractors are bonded in two ways: per dollar amount of a single project and per dollar amount of all projects in progress. At Greenbridge, Weaver Cooke is a 70% partner and CT Wilson is a 30% partner, which

Advantages to Joint Ventures in Construction

- Pools Risk in proportion to each member's interest
- Combines Specialized Abilities
- Increases Accuracy of Bid Estimates
- Permits partnership with contractor with local knowledge
- Increases ability to bid more projects through expanded bonding capacity
- Pools human capital and equipment
- Exposes members to new project environments

indicates major and minor shares of responsibility for resources such as start-up capital, materials, and labor. CT Wilson has 3 employees on site: 2 Project Managers, 1 Site Superintendant, and no non-managerial laborers. This indicates a mutual service partnership in which similar companies in similar industries pool their resources to gain a benefit too expensive to acquire alone (Kanter, 2004).

Secondly, the execution of the project benefits from the joint venture as general contracting firms are becoming more niche companies and, effectively, less 'general'. While both Weaver Cooke and CT Wilson have experience in green building, Mr. Wilson, the President of CT Wilson, cites Weaver Cooke's extensive experience in multi-family development as one of its core capabilities. Meanwhile, CT Wilson has a successful track record of completing large renovation projects. As Mr. Wilson has eschewed projects he called 'standard, big box' buildings, his personnel gained experience in managing more complex projects. Moreover, the combination of the two firms expanded the pool of subcontractors from which to choose for the project. In all cases where the general contractor chose a subcontractor through a negotiated bid, members of either or both general contracting firms knew the company quite well. These outcomes depict a joint venture which forms in pursuit of an opportunity that requires a capability from each partner (Kanter, 2004).

The President of CT Wilson cites these very reasons for its invitation to the project. Although Greenbridge is a project that either firm could construct on its own, managing the project as a single firm would have stretched resources 'quite thin'. Regardless, a general contractor entering into a joint venture must be financially sound in its own right. Even with the increased bonding capacity created by the joint venture, a surety company must feel assured that either contractor is singularly capable of completing the project. This is due to what is called the 'last man standing rule', which assigns responsibility for contractual performance to one party should the partnering company default.

Regarding the combination of core capabilities, Mr. Wilson feels that his company would have been subjected to a longer learning curve had it been contracted as the single general contracting firm, even though this is not the company's first experience with partnering. In the early 2000s, the company formed a joint venture with a general contractor from Greensboro in the construction of Rams Head Plaza, a $72.3 million multiuse project on the campus of UNC Chapel Hill. In part, this experience led to their invitation to Greenbridge as Dan Estes, current President of Weaver Cooke, was Division Manager with the partnering firm and formed a friendship with Mr. Wilson during the Rams Head project.

Bonding capacity, niche capabilities, and personal relationships are all components that led to the creation of the Weaver Cooke Wilson partnership. However, it appears that the building owners did not merely assume that a merger would form naturally and easily. Several orientation meetings were held where Project Managers and Site Superintendants from the general contracting firms, along with representatives of the engineering and architectural firms, convened in order to 'hammer out' issues. By that time, the building's conceptual designs were considerably developed and, for the most part, resembled its presently-constructed form.

This attention to the 'softer' side of organizational partnerships is an important point. The approach to construction management, engineering, and architectural design has traditionally favored rational and technical analyses while attention to the human aspect of design – called a social-psychological approach – is a relatively new and complementary theory in design management (Sebastian, 2005). Successful company relationships nearly always depend on the creation of a comfortable personal relationship among senior executives (Kanter, 2004). Mr. Wilson provides evidence to these assertions in stating that a good joint partnership requires two companies with compatible cultures, a characteristic which helps to avoid future 'personality conflicts'. An indication of compatible cultures is the ability of one firm to sense and fill the gaps of a partnering firm without both parties arguing about *what* the gaps are.

The diagram on the following page illustrates the labor structure of the joint partnership. In subsequent sections, references to representatives of the general contractor will refer to an employee working within the joint partnership of Weaver Cooke Wilson without distinguishing the single firm to which they belong. The next section introduces the first example of innovation by the general contractor.

The Labor Tree of Weaver Cooke Wilson

70% General Contracting Partner

30% General Contracting Partner

Executive Project Manager
Oversees Finish

Project Executive

Executive Superintendant

Project Manager
Oversees Interior Trades

Project Manager
Oversees Exterior Trades and Finances

Site Superintendant
PME, Sprinklers

Site Superintendant
Finishes

Site Superintendant
Framing

Assistant Superintendant
Exterior

Site Superintendant
General/Safety

Carpenter
Miscellaneous Assignments

DOCUMENT CONTROL

Project Coordinator
LEED "Point Person"

Project Coordinator
RFIs, Submittals

Project Coordinator
Closeouts

PRE-BID ORIENTATION

> "The most difficult elements of this project will be the building's exterior skin, with its high level of articulation, many areas of transition, and complex mechanical systems. Success will require all parties to keep information out in front, ask questions before they occur, plan, and *plan*!" (Project Executive of the General Contractor)

As an intermediary between executive decision makers and operational levels, general contracting firms provide an essential function by translating broad strategies and technical data into language that is useful for everyday operations. They must import the goals and values established in earlier design stages into the construction phase. Also, the general contractor articulates the technical language of architectural specifications into scopes of work and other protocols for subcontractors. At Greenbridge, the general contractor facilitated the introduction of the project to subcontractors by holding a pre-bid orientation session with a select group of firms.

Two executive representatives managed the session: Ms. Cockerham, Director of Sustainable Construction, and Mr. Carroll, Senior Vice President of Pre-construction. The general contractor convened the session in order to create an optimal list of potential bidders and an informed base of companies from which to choose. The companies in attendance were invited upon the recommendation of either of the general contracting firms, building owners, or the architectural firms. The trades represented at the meeting included HVAC, painting, drywall, and floor covering. Specifically, the intention was to educate subcontractors regarding LEED requirements and how it impacted their scopes of work. They also learned what documentation may be required, such as submittals for waste management and sorting. Ms. Cockerham attempted to dispel any fears associated with the LEED submittal process.

> *"When subcontractors understand such expectations, we can expect to see the best numbers in bids without 'fear factor' pricing." (Wendy Cockerham, representative of the general contractor)*

Indeed, such "hassle factor" pricing can add up to 20% to bids (7Group & Reed, 2009). Although the certification process may have been daunting to some, the documentation required by LEED was not a new responsibility to others. One Project Manager of a subcontractor, who had worked with Weaver Cooke on prior projects and has assisted approximately 10 projects seeking LEED certification, is an example.

> *"As a subcontractor I'm used to doing so much paperwork in order to get paid that paperwork required by LEED is just a bat in the eye" (Project Manager for a subcontractor)*

During the meeting, the representatives of the general contractor explained LEED requirements trade by trade. For painters, they explained the specification of lo-VOC paint

and how to dispose of paint cans. For plumbers, they discussed Indoor Air Quality credits and how they impacted their use of PVC glue and primers. In this case, the plumbers understand the general requirements of LEED (regarding Indoor Air Quality) using information that may not be found in their bid documentation.

Interestingly, a full range of attendees were present at the orientation. While some subcontractors had experience with LEED and understood its impact on their scopes of work, others had never heard of LEED. The personnel who attended these meetings included project managers, estimators, owner representatives, and company owners. Ms. Cockerham stated her surprise at the number of company owners in attendance as she didn't see how they would be directly involved with Greenbridge, though it did suggest a high-level curiosity with green construction.

> *"Since green construction is still new to most everyone, the important goal at this point is to educate everyone." (Wendy Cockerham, representative of the general contractor)*

The representatives also advocate a responsibility for reaching across organizational boundaries within the green building industry to teach others.

> *"There is reason to bring on subs new to green building. The more they understand green building the better. Anything we can do to improve the industry is good." (Eddie Carroll, representative of the general contractor)*

Through the orientation, the general contractor translated non-specific credit requirements into specific, on-site protocol. This suggests a contextualization that enables subcontractors to see how their actions affect the larger goals of the project (Mantere, 2008). Their willingness to follow these established protocols can impact the feasibility and potential cost impact of a number of LEED credits (Langdon, 2007).

Though it is beyond the scope of this research, it appears that knowledge of the overall sustainable nature of the project did not filter down to the level of the laborers for these subcontractors, or at least not consistently. Employees of subcontractors acknowledged varying degrees of awareness regarding changes to the construction process as a result of LEED certification. This may be due to the fact that workers are only seeing minor changes on green building projects in the way of materials. While this indicates a shortcoming in the transfer of knowledge, this also suggests an opportunity for the general contractor to expand its role in educating laborers. In this sense, the general contractor has another platform to induce worksite innovation and higher standards on green building projects.

At the same time that Weaver Cooke engaged this select group of subcontractors, they assumed a risk coincident with the advent of new green building strategies. The education process can add time to the development schedule, and in real estate, time is money (Carlis, et al., 2006). Nevertheless, the pursuit of LEED certification does impose responsibilities upon subcontractors. As the assessment standard is pliable to site-specific concerns and

accommodating to several building types, the credits pursued will vary to some degree from one project to the next. Moreover, certain LEED credits may affect subcontractors to a larger degree than other credits and have more weight on projects pursuing higher levels of certification over projects seeking lower levels.

Even the LEED standard itself remains a dynamic tool and will influence the green building construction process in new ways. LEED Version 3, released in April 2009, utilizes a weighted point scale and includes regional priority credits which allow the standard to respond to environmental concerns down to the scale of the zip code in which a project is constructed. As the LEED standard and other assessment standards evolve, these changes suggest a greater opportunity on the part of the general contractor to facilitate the preparedness of subcontractors as they bid on green projects. Through these actions, the general contractor reinforces its own capabilities by creating an informed and prepared base of subcontractors.

MOCK-UPS

> "Construction is a little safer than slot machines but it's still a risky business." (President of minor-partner general contractor)

The general contractor is in a pivotal position to shape the quality of work performed by subcontractors on a construction site. On large commercial projects, general contractors often use mockups and review of first-works as processes of quality control. In some cases, simply reviewing construction drawings or merely hoping that a dense list of specifications will be carried through in the construction process cannot adequately predict the quality of workmanship. Mockups and first-works are quality control measures which alleviate these concerns.

Mockups are pre-construction representations of the exterior wall system erected for purposes of evaluation and testing (Architectural Testing, Inc., 2010). These devices are common to commercial construction projects and typically remain erected throughout the construction phase, serving as a model against which installed work can be compared. They are useful for any finished area which requires the workmanship of several distinct trades. They are also useful for installations with a low tolerance for error whether these demands be for aesthetic or technical purposes. Aesthetic purposes include transitions from tile flooring to cabinetry, while technical purposes regard exterior skin surfaces, such as window borders, where temperature regulation is of concern.

The review of mockups at the Greenbridge site is a team effort. The Interior Designer and Architect are heavily engaged in this process. The Interior Designer requested mockups for floor transitions – where wood flooring met carpeted areas – and edge/detail mockups for cabinetry and countertops. In the latter case, a complete mockup of the cabinetry required a review of the cabinetry with hinges, drawer glides, and overhang.

> *"You want to make sure that what you have designed is carried all the way through. There is a major checking process which means that we are looking at hundreds of submittals from Weaver Cooke Wilson and their suppliers and their subcontractors. One of the most intense is with the MEP subcontractors and reviewing the shop drawings of the plumbers and mechanics to make sure it matches our ceiling heights." (Interior Designer)*

In at least one instance the Architect demanded a second and more complete mockup. Although he had specified a full mockup of the exterior, he felt that the initial erection of only three brick columns was insufficient. As a result, laborers completed a more thorough mockup (Figure 3) consisting of rails, windows, metal banding, and brick. Several parties were involved in the review of the exterior mockup, including representatives from two architectural firms and several of the owners.

In this review process, the general contractor acts as a communication hub between these professionals and the laborers. While the Architect did communicate directly with subcontractors creating the mockup, most communication occurred via the general contractor who provided procedural guidance to the subcontractors. Also, the general contractor is responsible for ensuring the best possible workmanship on the actual project. In this case, the mockup sets the standard for installation procedures performed by subcontractors, and the enforcement of these standards is the job of the General Contractor's Site Superintendants. Even when the mockup itself leaves room for improvement, the general contractor must ensure that subcontractors make the necessary adjustments in subsequent installations on site.

Figure 3: Exterior Mockup

MATERIALS SELECTION PROCESS

The selection of materials is a time-intensive process through which everything installed on the building, 'down to every last nail', passed. Here, the general contractor serves a complementary role to the selective processes employed design professionals and building owners. Also, subcontractors are able to influence the choice of materials through the agency of the general contractor.

> "We utilize a palette of products to produce our buildings. However, products are of limited value if viewed only as things that are added to a building to make it green."
> From *The Integrative Design Guide to Green Building: Redefining the Practice of Sustainability* (2009)

At Greenbridge, LEED credits regarding recycled-content and regional sourcing influenced choices made by the Interior Designer. While others dismissed the assessment standard as a guiding factor in their daily work, the Interior Designer saw such credits as steering her choices for materials.

> *"Materials credits were very much in the forefront of our thinking and planning. We've fought all along to gain extra points for recycled-content and reclaimed materials. From the get-go we were looking at materials for cabinetry and countertops and lighting that would help us to meet some of those credits." (Interior Designer)*

The search for a wood for the cabinetry began long before breaking ground. The Interior Designer found a source of FSC-certified hardwoods in Greenville, SC, that eventually would win the bid for Greenbridge. The wood for the fronts of the cabinet doors and drawers is more expensive, not widely-available, and therefore harder to source[1].

When a material is selected for consideration, the Architect performs a code review using details such as fuel contribution ratings and flame spread ratings. Once any product passes the code review, it is then subjected to a formal review process. Selected products are then written into specifications.

At this point the general contractor peruses the marketplace to find availability and pricing of specified materials. Here the general contractor provides a check-and-balance function by adding cost estimates to the materials selected by the cadre of design professionals on the project. Here, subcontractors are able to provide their input through communications with the general contractor.

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[1] Unfortunately, the plant that produced wood for the cabinetry went out-of-business. The outgoing executive was put in contact with the subcontractor who had the bid at Greenbridge, who then took over plant operations. Even though they are now producing the cabinetry from the same FSC-certified wood, the LEED credit is unattainable as the subcontractor does not have the proper certification conforming to USGBC requirements.

> *"The Architect or Interior Designer may say 'let's use X product'. We'll go to our subcontractor and say 'they're thinking about using X product. Can you price this for us?' They'll say 'Yes, and by the way, we found another carpet pad which is more environmentally friendly', and for the same price or less, whichever the case may be. Then we'll take that back to the Owners and to the designers and let them decide what they want to do with it." (Project Manager for the general contractor)*

This cost-checking function is only more necessary on green projects, where a growing menu of new technologies and an improving state of currently-available technologies places an array of design choices in the hands of building designers. In some cases a product is so new that scant information exists to aid the selection process. This growing palette has resulted in what some have called 'green-washing', or even 'LEED-washing', where manufacturers make unsubstantiated claims about their products' ability to conform to certification standards (Barista, 2008; Frej, 2003).

In applying LEED standards to the design of green buildings, the design team has the opportunity through the materials selection process to aid the pursuit of one or several LEED credits. In some cases, designers take the opportunity to surpass these standards. These extra efforts help to capture economic and other benefits that are not directly circumscribed by the LEED standard.

An example from the Interior Designer is illustrative. Ms. Spuria understood that LEED defined a locally-sourced material as produced within a 500-mile radius but held her sourcing of materials to a higher standard.

> *"We understood that local meant within 500 miles but we took it further than that and tried to source things from the Triangle, too. The plumbing fixture supplier would have been a contact of the general contractor from Greensboro but we fought really hard to use our local supplier because it feeds our community." (Interior Designer)*

The local supplier selected was Wilkinson Supply, a plumbing distributor with warehouses and showrooms in three locations within the Triangle region. An employee of the Interior Design firm worked with Wilkinson's branch in Carrboro in selecting fixtures that included tubs, toilets, sinks, and faucets. In all, Wilkinson estimates that the contract, its largest single-source agreement in the past year, will amount to over $200,000 by the end of the project. The local presence of the plumbing supplier provided an advantage over regional competitors and helped to earn discounted pricing from its suppliers.

In summary, just as with mock-ups, the materials selection process is a team effort. The general contractor assumes a role as intermediary between the marketplace and design choices and a conduit for communication among design professionals and subcontractors.

LEED CORRESPONDENCE

The complexity of the green building design process requires a large amount of communication. At Greenbridge, the institution of a communications network proved critical to bridging negotiations across organizational and geographical boundaries. A partnering architectural firm served as an information clearinghouse by managing an FTP site which facilitated the electronic exchange of product submittals and drawings.

The establishment of the network indicates the degree to which communication is important to green building. While this communication format was reproduced from an earlier project, it had an interesting effect at Greenbridge as the general contractor adapted its internal structure to facilitate this higher level of information exchange. To do this, Weaver Cooke Wilson established a 'field team' of on-site Project Coordinators primarily dedicated to handling the flow of information between itself and all other parties. Consequently, the general contractor became an information hub and a critical interface among project designers and subcontractors.

One Project Coordinator is responsible for submitting LEED documentation to USGBC for purposes of verifying conformance to LEED credits. While Mr. Phoenix, a LEED Accredited Professional and one of the building owners, and other design team members manage submittals pertaining to the majority of LEED credits, the Project Coordinator oversees 9 credits distributed among 4 categories.

To improve the maintenance of LEED documentation for his own benefit, the Project Coordinator created an Excel spreadsheet as a reminder of what information remained pending from subcontractors and as a way to track any submittals made to USGBC. He cites an experience on a prior project as the impetus for change at Greenbridge where he waited until the final weeks of construction to request documents from subcontractors only to find that it became overwhelming. At Greenbridge, he decided to draw this process into earlier phases and uses email exchanges, the spreadsheet, and face-to-face meetings to keep subcontractors on task with submittals pertaining to LEED.

Later, he felt that the spreadsheet might be useful to subcontractors themselves and provided it to their project managers and field supervisors. As project-wide costs associated with administering the certification process and documentation of LEED credits are estimated to range from $20,000 to $40,000 (Nicolow, 2008), this spreadsheet may have been a source of relief to inexperienced subcontractors. Even with the specification and installation of green materials, LEED credits may be lost in the absence of proper documentation. This occurred at the US EPA National Computer Center at Research Triangle Park, where the use of FSC-certified wood could not be verified by USGBC due to a lack of documentation from the supplier (BuildingGreen, Inc., 2008).

The Project Coordinator also used this opportunity to teach project managers about the specifics of LEED credits and the details ultimately required in submittals to USGBC. And this training had an effect. For example, subcontractors impacted by regional materials

requirements submitted data which indicated the distance from the factory which processed a material to the project site. The Project Coordinator noted their oversight and instructed them to submit additional information to indicate the distance between the point of extraction and the location of the processing plant.

Additionally, the Project Coordinator refined the spreadsheet since its creation. While early editions were useful in indicating the status of submittals required from each subcontractor, these did not provide means for inputting actual numbers. A later edition included columns for credits which required more detail and allowed for numerical input. For example, MRc4 Recycled Content requires data on the post-consumer and pre-consumer content of all building materials with recycled raw materials. The Project Coordinator expanded the spreadsheet to include columns for both categories, and collected data on many materials, including steel joists, concrete, hinges, and asphalt.

DISCUSSION

These examples are evidence of innovative behavior taken by the general contractor on a green building project. Using these examples, we can work backwards to understand the challenges that each strategy intended to address.

> "The overarching condition required for managers to produce innovation is this: they must envision an accomplishment beyond the scope of the job."
> From *The Middle Manager as Innovator* (1982)

LEED and other assessment standards, to some degree, alter the process of constructing green buildings. In some cases, LEED credits only substantiate what are already best practices. An example is the use of filters on open air ducts during the construction process to protect against the infiltration of dust and other debris. In this case, EQc3.1 Construction IAQ Management Plan: During Construction references another industry standard – from the Sheet Metal and Air Conditioning National Contractors Association IAQ Guidelines for Occupied Buildings – as a strategy for achieving this credit. Other credits may force subcontractors to revise their own on-site activities such as disposing of certain waste materials in dedicated rather than co-mingled bins. These burdens create a list of 'unknowns' for subcontractors who often hedge these risks by submitting inflated bid prices.

Weaver Cooke Wilson addressed this challenge through a pre-bid orientation. The session eased the transition of subcontractors onto the project and served to educate a number of top managers regarding the LEED assessment standard. Despite the focus here on the LEED standard, several subcontractors working at Greenbridge downplayed LEED's influence on their everyday activities. However, these subcontractors did indicate changes regarding the management of materials and disposition of waste. With the pre-bid orientation, the general contractor acted as facilitator through supporting these 'fringe' requirements that are unique to green building projects.

Secondly, buildings are complex. Exterior wall systems are complex skins which regulate air and thermal exchanges as well as display the building's personality. The requirements for performance leave little room for error, while aesthetic expectations lead design professionals to experiment with distinctive products. These systems become harder to access and costlier to modify as construction progresses (Epstein & Hughes, 2004).

At Greenbridge, the use of exterior mockups – as well as interior mockups, for other cases – addressed these challenges. Weaver Cooke Wilson aided this process by providing procedural guidance to workers who constructed them. Site superintendants are vital caretakers of the shared understanding created by these mockups as they enforce high standards of workmanship in subsequent installations. In this sense, the general contractor has a role in both synthesizing numerous design choices through the creation of mockups as well as implementing the standard of workmanship specified by the Architect.

Third, innovation in the green building process is largely a function of new materials and technologies. The growing popularity of green buildings is stimulating a supply chain full of cutting-edge products of both standard and superior aesthetic quality and performance. These products must survive a meticulous selection process. Many do not survive the value engineering which eliminates unessential materials in favor of lower-cost products.

At Greenbridge, the general contractor fulfilled a role complementary to that of design professionals by advising on product cost and availability. They are also an intermediary through which subcontractors can advocate for the specification of their own preferred materials. In this example, general contractors are accessory to design professionals and subcontractors who 'champion' new ideas in the materials selection process.

Finally, USGBC verifies the achievement of LEED credits remotely. This requires the transmission of a great deal of information which usually originates from manufacturers and collects in the hands of one or several central coordinators within a project. However, this central coordinator must handle information in a variety of formats and from a variety of sources. Moreover, it is essential to handle the collection and transmission of this information in a timely manner to avoid surprises. For example, a general contractor on a 2002 construction of an elementary school in Statesville, NC, cites complications resulting from a lack of clear deadlines for the collection of LEED-specific documentation (BuildingGreen, Inc., 2008).

To address these challenges, Weaver Cooke Wilson took innovative steps to streamline the submittal process by creating and later refining a spreadsheet to manage LEED-specific documentation. This created an opportunity for field representatives of the general contractor to teach subcontractors about the LEED assessment standard and for subcontractors to use the spreadsheet to its own benefit.

CONCLUSION

This research focused on innovative practices undertaken by a general contractor on a green building project. As shown, the general contractor is a vital channel of communication for subcontractors and also has a role in educating these firms as the state of green building progresses in coming years. These roles and the innovative actions of general contractors, including the small sample of practices discussed above, are transferable to other firms engaged on green building projects. The educator role faces such obstacles as language barriers, time constraints, and more. However, the general contractor is in position to overcome these barriers by adopting a third strategy of metaphor creator.

To strengthen their role as educators in the green building industry, general contracting firms may find the use of metaphors helpful. Product designers use metaphors in the invention of new products by reframing problems in order to move towards solutions. Nonaka (1994) describes metaphor as "a way for individuals grounded in different contexts and with different experiences to understand something intuitively through the use of imagination and symbols without the need for analysis or generalization". The term green building itself is a metaphor which characterizes a built structure as a solution to environmental challenges rather than a building of a certain color. But metaphors can be taken to a more practical level in order to overcome specific challenges encountered on green building projects.

At Greenbridge, several laborers for subcontractors understood that there were high standards for site cleanliness. However, they rarely described these standards as being for environmental purposes. In fact, they understood these standards more often in terms of safety. For example, a Helper would explain that he cleaned his worksite daily to keep himself and others from tripping over debris.

Such responses indicate that safety is a well-understood concept among subcontractors. A few examples from the Greenbridge site are illustrative. Weekly "toolbox talks" were a common practice where Field Superintendants discussed various safety topics such as the proper use of personal protective equipment and best practices for using heavy machinery. Also, subcontractors were required to submit Safety Plans at the beginning of their time on site. As a third example, all workers new to the site attended a 20 to 30 minute safety orientation where representatives of the general contractor discussed requirements which exceeded OSHA standards such as requiring a full body harness for fall protection. Each of these examples indicates established methods for conveying an understanding of safety to subcontractors and for maintaining safe behavior throughout the construction phase.

So why is safety so well understood by subcontractors while awareness of green building strategies is less consistent? Perhaps there is an obvious justification. Safety is quantifiable. This makes it easy to establish safety goals and to gauge success through measures such as number of work hours lost due to injury and number of accidents in the prior year.

Environmental performance is becoming more quantifiable, and there is progress towards linking personal behavior with environmental impact – at least for consumers. Home monitoring systems allow consumers to track their energy usage and help to make this impact measurable and explicit. LEED 3.0, released in 2009, places more emphasis on energy performance and requires building owners to report energy usage data post-occupancy. This indicates a closer relationship between consumer behavior and building design and a closer association between consumer awareness and building strategies.

So what are the benefits to ensuring that laborers are more aware of green building strategies? Laborers who are aware of project-specific green building strategies are able to understand their own role in the project's larger strategy. This contextualization may encourage them to do their part to achieve a given strategy, whether a strategy may be disposing of waste materials in a dedicated bin or not bringing food and food packaging on site. Through abiding by these strategies, laborers aid the general contractor in achieving LEED credits and successfully delivering green projects.

Using metaphor may help to extend green building knowledge to laborers through reframing the reasons for doing green building at all. Through other research I have seen how another general contractor used metaphor to reinforce safety standards. This general contractor convened an off-site orientation before the start of a local project and many immigrant laborers attended this orientation. It was interesting to see how a representative of this general contractor framed safety in terms that seemed to resonate with the laborers. He explained that safe behavior on the construction site is the same as being responsible to one's family. Many immigrant laborers are working in the construction industry primarily to support their families in their native country or in the United States – and oftentimes both – and the link between safety and familial responsibility is a powerful connection.

The green building industry, at least in terms of how it is defined by LEED, appears to be moving in the direction of educating workers at all levels. The USGBC took steps within the past year to make their rating system more accessible to the immigrant workforce by releasing its Green Building Basics course in Spanish. As shown in this paper, general contractors are capable of innovation when faced with green building challenges. Innovation, when seen as the development of new knowledge within all levels of the workforce to solve green building challenges, remains an obstacle which general contractors are in position to address.

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