A Qualitative Analysis of the Leadership in Energy and Environmental Design:

Assessment of the Catamount Dorm Project

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ABSTRACT

The awareness of sustainability issues has increased the demand for contemporary environmental, social, and economic solutions. The green building movement, with LEED as the primary assessment standard in the United States, is a major focus of urban sustainability and the built environment. The Catamount Center Dorm, an ~3,000 sq. ft. small environmental education dorm at the rural Catamount Mountain Campus, located in Woodland Park, Colorado, underwent a preliminary LEED evaluation during the early construction stage. This qualitative case study identifies three theoretical constructs that address contestable concepts and gaps within the literature, and may be beneficial for directing future study; they include 1) LEED can serve as an effective educational tool for students, building designers, and LEED accredited professionals 2) LEED impacts building design team dynamics, influencing individual roles, advocacy, and group conversations, 3) LEED provides narrow sustainability solutions within the greater scope of green building practices and should be weighted against the larger ambitions of a project.

INTRODUCTION

Sustainability

Sustainability, as defined by Whitehead (2007), addresses economic, ecological and social concerns. It is interdisciplinary with global, regional, and local implications. Although sustainably has a rich history and meaning, sustainable practices extending back to the beginning of architecture, it is only more recently that the term 'sustainability' has been widely recognized and debated throughout policy and social movements. 'Sustainability' gathered momentum in the 1980's and, by the early 1990's, was propelled by concepts of sustainable development (Whitehead 2007). Geographers have played an integral role in interpreting sustainability within geographic climate conditions, as well as within rural, urban, and regional places of the developed world. Whitehead (2007) illustrates the importance of these studies in determining the relationship or gap between the human and geographic world. Since, geographers have viewed sustainability efforts and solutions through various geographic lenses.

With increasing globalization and rapid urban growth, Julie Cidell (2009) used a political ecology lens to demonstrate the role geographers play in connecting concepts of sustainability and the built environment. Political ecology, which encompasses both industrialized and urban environments, can be defined as the "cultural ecology of the developing world" (Cidell 2009, 621). She encourages the study of today's sustainable building practices as well as critiques their ability to address issues of sustainability.

Rising importance of green building

Buildings, a place where Americans spend close to 90% of their time (United States EPA 2008), are relevant to all three sustainability concerns. In the United States, buildings account for approximately 40% of harmful carbon dioxide greenhouse gas emissions, nearly 40% of energy usage, two thirds of non-industrial secondary materials, and above 10% of freshwater sage (United States EPA 2008). Energy and other natural resources concerns are driving society toward increased sustainable building practices and studies have proven their economic viability. Although upfront costs of sustainable buildings are typically greater, studies have proven that a 2% increase in upfront costs are associated with approximate life-cycle savings of 20% the initial construction investment (Azhar *et al*. 2011).

The term sustainable building, better known as green building, does not represent one single definition or single consensus. Guy and Farmer (2011) identify and discuss six major *logics* (Table 1) of green building: eco-technic, eco-centric, eco-aesthetic, eco-cultural, eco-medical, and eco-social. Guy and Farmer (2001) demonstrate, in "*contradictory certainties:* severely divergent and mutually irreconcilable sets of conviction both about the environmental problems we face and the solutions that are available to us" (146), a wide range of competing yet essential perspectives for today's green building. These logics are just one framework for competing, valid perspectives within the greater green building literature.

Other researchers in the field have developed other means of categorizing green building. From the *six logics*, Boschmann and Gabriel (2013) draw a dichotomy of light and deep green practices that provide a framework founded on scale and place. Light green practices are most closely associated with Guy and Farmer's (2001) *eco-technic logic* and rely on advanced technology and new construction to achieve sustainability (Boschmann & Gabriel 2013). Light green practices are best able to address larger-scales such as global scale sustainability due to their emphasis on external solutions (technology). On the other hand, deep green practices are most closely associated with Guy and Farmer's (2001) *eco-cultural* or *eco-centric logics* and rely on locality and place to address sustainability (Boschmann & Gabriel 2013). Boschmann and Gabriel (2013) specifically assert that vernacular architecture and adaptive reuse are key deep green building methods. Historic, regional architecture often presents valid and cost-effective solutions to energy use, lighting and other green design elements. Yet, our culture seems to have forgotten this. Boschmann and Gabriel (2013) present an argument that today's green building practices are unbalanced, tending toward light green solutions, new construction, and must reconsider the value of vernacular architecture and adaptive reuse. Despite a lack of consensus, there is a growing effort to address sustainability and better understand effective green building practices.

Green building, which is not becoming manifest in laws, regulations, and building codes, originally stemmed from voluntary concern for mitigating social, economic, and environmental impacts (Retzlaff 2008, 507). A survey by the American Institute of Architects (AIA) of 661 United States' cities with populations greater than 50,000 found 92 green building programs that are required by law or regulations, which provide incentives or mandate green building construction (Retzlaff 2008). Many of these incentives or mandates are created at a local level due to local initiatives and plans. The current situation presents a tension between local codes, global efforts, various perspectives, and the desire to create a one-size-fits-all solution.

Our study aims to describe where our current practices fall among the gradation of green building solutions and what values they prioritize or support. The green building practices we, as citizens, decide to promote will have profound and varying impacts on our society, ecology, and economy. Knowledge of the perspectives driving and validating our current practices allows us to be advocates through out choices.

Green building rating systems

As green building practices develop, people will become more interested in evaluating and 'validating' just how 'green' a building is. Building assessment systems, also known as green building rating systems, have developed rapidly and become embedded into mainstream building practices. Parallel to the strategies for adding green building practices to local law, "building assessment systems have evolved from being voluntary fro building owners, developers, and designers to being required by many federal agencies and state, county, and local governments" (Retzlaff 2008, 507).

The evolution of building assessment can be separated into four stages (Retzlaff 2008; Lutzendorf & Lorenz 2006). First, building evaluations were primarily based upon construction costs. Then, life cycle cost analyses progressed to include environmental impacts and solutions. Thirdly, building operations changed to not only green building but also sustainable building. Lastly, during the fourth stage, building assessment included several themes such as "water, energy, livability" (Retzlaff 2008, 506) within one system.

Unless otherwise noted for the purposes of this study, sustainable building, sustainable architecture, and green building are used interchangeably. As suggested by Lutzendorf and Lorenz (Retzlaff 2008), current rating systems lie between stages three and four. The major comparable standardized green building rating systems today such as

BREAM, Green Globes, Energy Star, and LEED, were founded within 1990 and 2000 and address rising environmental concerns and policy.

BREEAM and Green Globes are rating systems conceived by various countries *outside of* the United States. Building Research Establishment's Environmental Assessment Method [BREEAM], founded by the UK Green Building Council in 1990, rewards energy efficient and low carbon buildings (www.bream.org). Green Globes, initially based on Canada's version of Bream, was founded in 2000 as an 'online assessment and rating tool' and is operated by the Green Building Initiative [GBI] (www.greenglobes.com). Green Globes is an accepted rating tool in both Canada and the United States.

Green building rating systems founded *within* the United States include Energy Star and LEED. Energy Star, a program conceived by the Environmental Protection Agency [EPA] in 1992, is a "voluntary program that helps businesses and individuals save money and protect out climate though superior energy efficiency" (www.energystar.gov). Lastly, Leadership in Energy and Environmental Design [LEED] is a valid rating system in over 40 countries and is currently at the forefront of green building rating systems in the United States.

Green building practices, especially those promoted through our current green building assessment tools must be studies more extensively. Given their recent and ongoing development, there is foundation of existing literature but there are many gaps and contestable concepts. LEED, one of the most global and greatly utilized assessment tools for sustainable or green architecture in the United States, is the major subject of this study.

Leadership in energy and environmental design (LEED)

Although a standardized rating system, LEED is not static. Since its creation, LEED has undergone several revisions:

> The first LEED Pilot Project Program, also referred to as LEED Version 1.0,was launched at the USGBC Membership Summit in August 1998. After extensive modification, LEED Green Building Rating System Version 2.0 was released in March 2000, with LEED Version 2.1 following in 2002 and LEED Version 2.2 following in 2005. (USGBC Handbook 2009 p. xi)

LEED membership includes "private corporations, federal agencies, state and local governments, industry and professional associations, and nonprofit organizations" (USGBC.org). Each revision of the LEED standards receives input from these members. Thus, LEED is a dynamic system that receives contributions and feedback from an eclectic selection of members. Suggested revisions for the next revision are available for members to comment on and are known as 'pilot credits'.

The current LEED Green Building Rating System, version 2009, is a comprehensive rating system applied to several building classifications: LEED for Core & Shell, New Construction, Schools, Neighborhood Development, Retail, Healthcare, Homes, and Commercial Interiors. These eight building classifications are designed to address "new and existing commercial, institutional, and residential buildings" (USGBC Handbook 2009 p. xi). Within LEED, and its various building classifications, LEED for New Construction (NC) version 2009 is currently the most sought after LEED rating tool. Cidell (2009) states that 80% of LEED buildings are for new construction.

The LEED-NC (new construction) 2009 rating system is comprised of seven major categories. Within each category are credits that a project may achieve. Each credit ranges in value and this value is designated by a point system [Scorecard, Figure 2]. First are five Environmental Categories whose credits form a base of 100 points:

1. Sustainable Sites [SS]
2. Water Efficiency [WE]
3. Energy and Atmosphere [EA]
4. Material & Resources [MR]
5. Indoor Environmental Quality [IEQ]

These are followed by an additional two categories whose credits allow for an additional 10 points:

6. Innovation in design [ID]
7. Regional Priority [RP]

The LEED-NC v2009 falls within Retzlaff's (2008) fourth stage of building assessment evolution, as it addresses five major 'themes' and two additional 'themes.' A scorecard of all seven categories (themes), 58 credits and a total of 110 points [Scorecard, Figure 2] is provided on the USGBC.org website. The point system awards several LEED certification rankings. Basic LEED certification requires 40-49 points, LEED Silver requires 50-59 points, LEED Gold requires 60-79 points, and LEED Platinum requires 80+ points.

The LEED green building rating system has several benefits. LEED increases awareness of the need for green buildings and creates a commercial demand for them (Boschmann & Gabriel 2013). Additionally, owners and businesses recognize LEED as a valid brand name that implies heightened workplace efficiency. Robichaud (2011, 50) references a study of a green facility in Sunnyvale, California that resulted in a 15% decreased absenteeism rate. A separate study in California held that reading test scores of students in classrooms with greater natural light (a common green building and LEED feature) increased by approximately 20%. While one may argue that a ‘brand name’ motivation may deter businesses from fully addressing sustainability issues, and instead pick the lowest hanging fruit, the ‘brand name’ has allowed LEED to gain momentum as part of business strategies.

While scholars have noted the great progress and benefits of LEED, there still exist several major criticisms and contested issues. Boschmann and Gabriel (2013) assert that LEED is not balanced in light and deep green practices. LEED focuses heavily on product and technological based solutions that favor new construction over adaptive reuse and vernacular architecture. Moreover, LEED fails to fully examine full-cycle sustainability. LEED must extend beyond construction and operation to also include demolition (Boschmann & Gabriel 2013). In effect, LEED new construction projects should be re-worked to be less encouraged and favorable than re-use and renovation projects. In addition, there are often greater upfront costs and steep learning curves for a building design team pursuing LEED. Although well documented, LEED is often described as complicated and the documentation onerous. As is common with the other green building rating systems in use today, the point system of LEED allows teams to ‘point grab,’ achieving green goals that require very little cost or effort for points rather than tackling more difficult but impactful LEED goals. Although LEED includes basic baseline standard requirements within their categories, Boschmann and Gabriel (2013) criticize LEED for not punishing unsustainable building practices (e.g. giving negative points).

Within the extant literature, scholars have paid attention to the impact of green building rating systems, including LEED, on members of a building project. For instance, an impact analysis on contractors' contributions to achieving LEED credits (Syal *et al*. 2007) has determined an essential role and importance of Contractors and their cooperation on building design teams' ability to achieve LEED standards. Additionally, Gebken *et al*. (2009) studied the impacts of prime and general contractors whom are dually LEED Accredited Professionals (LEED-AP's) on aiding a design team's LEED goals. However, little to no literature exists that compares the dynamics and perspectives of an entire building design team (e.g. owner, contractor, architect, LEED informant) in achieving LEED goals. It is not only important to ask what each member can contribute throughout the LEED process, but also how the team as a greater whole contributes to LEED certification.

One major contestable concept within the literature, as debated by Boschmann and Gabriel (2013), is the extent LEED creates green buildings and addresses sustainability issues. Is LEED an accurate means of quantifying and assessing green buildings or does it favor a narrow, unbalanced sliver of green building as Boschmann and Gabriel suggest? Furthermore, is LEED economically sustainable? A number of debates have permeated the literature about the cost and economic feasibility of LEED certification. Some discuss life cycle costs, others initial investment costs. Is the cost of additional team members such as LEED Accredited professionals or Energy commissioners as well as increased costs to obtain LEED standards economically viable and sustainable? Based upon the existing literature, several research concerns were identified as the focus for the Catamount Dorm study.

Research Concerns

a. What are builder's (owner, architect, contractor) perceptions of LEED, green, and non-green projects?

b. How have green building and LEED progressed similarly and separately through time?

c. Is it possible to obtain LEED certification on projects that begin post design process?

d. Can a small new construction dorm receive LEED certification within a reasonable budget?

METHODS

Site Description

The Catamount Center Dorm is situated on the north slope of Pikes Peak with views to the south of Raspberry Peak and views to the east of Pikes Peak (Figure 3; Paul Anderson 2013). The Catamount Campus is surrounded by more than 200,000 acres of public forest with the largest holdings in the Pike National Forest by the USFS (catamountmountaincampus.org). The dorm was constructed in an area with the least impact on the surrounding ecology and is only available to those enrolled in the Catamount Mountain Campus programs.

The Catamount Center Dorm

The Catamount Center Dorm was originally designed in a spiral shape with rounded corners (Figure 4-6; Paul Anderson 2013), mimicking and reflecting the movement of the surrounding environment. Great attention to daylighting and views (Figure 7) provides students with a long vertical glass window and glass door in each room. This also allows for passive solar heating and lighting, an advantage in Colorado. Additionally, energy efficiency had a budget of $25,000. A dual biomass and propane burner was chosen to warm the building through radiant floor heating. The wood from forest thinning on the Catamount Mountain Campus will be repurposed as biofuel. No refrigerants were used and natural ventilation is the cooling mechanism. Lastly, the building was designed for minimal square feet per person, maximizing the use of social spaces of the dorm, including the central courtyard classroom, and mitigating the building's overall impact. The dorm was designed to meet a total budget of $500,000.

Although created with the above sustainable goals in mind, it was only in the early construction process that the Catamount Dorm Project explicitly considered LEED certification.

As a result, none of the major building design team members (architect, owner, contractor) had acknowledged LEED prior to the researcher's involvement nor was it in their contracts. Thus, the time and commitment directed toward LEED by the building design team was voluntary but substantial. In conjunction, the student researcher had no prior experience with LEED. In order to initially evaluate the dorm's LEED-NC v2009 certification potential the LEED researcher relied on publically available LEED Green Building Rating System information (USGBC.org) as well as information available only to members of USGBC (leeduser.org). Additionally, the researcher and owner discussed the project with a local LEED consultant. An assessment by the student researcher indicated that the Catamount Dorm had the potential to reach certification between basic and LEED Silver. Although some appropriate actions were taken to modify the construction in order to unofficially achieve LEED certification, the official documentation of the Catamount Dorm remains incomplete.

Research concerns

In order to qualitatively assess the Catamount Dorm Project, we followed Creswell's (2007, 80) 'grounded theory approach' (Figure 8) by developing a series of broad research concerns (as listed in the introduction) based on a preliminary literature review. The research concerns were designed to address gaps or biases within the existing literature and create a foundation of interest for the data collection.

Data collection

Data collection included interviews with 18 standard questions (Appendix II) based on the above research concerns. The student individually interviewed the following major building design team members:

-**Owner**: Director of the Catamount Mountain Campus and student researcher's academic advisor

-**Architect**: Designer of the Catamount Dorm; was hired directly by the owner at the beginning of the design phase in 2012

-**Contractor**: Served as the general contractor and was hired by the owner through a bidding process for the construction phase in 2013. Also holds a degree in architecture.

Additionally, the LEED researcher, who began her work during the early construction phase in July 2013, noted her observations as field notes. Observations include documents, audio, visual, and interview data. All interviews were recorded and transcribed.

Data analysis

Data analysis involved a combination of open and axial coding techniques. Open coding (Saldaña 2009) involves classifying the meaning of the transcribed interviewee responses and LEED researcher observations by individual sentences, groups of sentences or sentence fragments. Each coded element was grouped by a subject the researcher believed to be related to the research concerns. About 46 codes were constructed (Appendix III). Through axial coding (Saldaña 2009), the ideas were narrowed into 12-15 themes by topic. Lastly, the student identified three theoretical constructs by combining common ideas from the 14 themes (Creswell 2007).

Due to the nature of participatory action research, the researcher approached coding and analysis with a constructivist perspective and bias in this study, which is one where "individuals seek understanding of the world in which they live and work" (Creswell 2007, 20). Qualitative social constructivism research focuses on the views of and interactions with the participants of the study (Creswell 2007). The research focuses on complexity, taking into account both the social and historical context. The use of broad questions allowed participants to "construct the meaning of a situation, a meaning typically forged in discussions or interactions with other persons" (Creswell 2007, 21)

RESULTS and DISCUSSION

The results of this study were determined by narrowing the 14 themes (Table I) into sub-themes and three theoretical constructs. The three theoretical constructs aim to provide the context for future research. The results and discussion of each theoretical construct are addressed separately and supported by interview data below.

Theoretical Construct 1: LEED is an effective educational tool for students, building design teams, and LEED professionals.

LEED and education
LEED Informant Roles

Theoretical Construct 2: LEED affects building design team dynamics, influencing roles, advocacy, and conversations.

Design Builder Roles
LEED experiences and advocacy
LEED process

Theoretical Construct 3: LEED provides narrow sustainability solutions within the greater scope of green building practices and should be weighted against the larger ambitions of a project.

Comparisons of LEED, green building, and traditional building
Timing of green design and LEED
Initial Green Design
Personal green goals
Effecting change using the LEED strategy
Practicality of LEED
Functionality of LEED
Future directions for LEED, a conversation
A retrospective assessment of LEED

Theoretical Construct 1: LEED can serve as an effective educational tool for students, building designers, and LEED accredited professionals

The major participants of the Catamount Dorm project acknowledged LEED's educational value as threefold: first for the research student, second for the building-design team, and the third for LEED professionals. The interviewees and LEED researcher felt the educational benefits of LEED present opportunities for service learning that can be extended to projects beyond the scope of the Catamount Dorm. Although none of the initial four research concerns addressed the educational aspects of LEED, we identified its significance through coding analysis.

LEED as an educational tool for students

Due to the nature of participatory action research, the undergraduate thesis student and her thesis advisor were involved as academic researchers and also as members of the building design team. The thesis advisor was also the owner:

> As an educator I was not only very interested in the final result of LEED certification, but I was also interested in you as a student. It just seemed like such an extraordinary opportunity to take someone like you, whom this was such a great benefit for, and create this educational experience. [Owner]

From an academic perspective, the owner found there is enormous educational potential when students are involved in the LEED certification process. Academic advisors (professors) may play a large role in getting these students involved.

During the interview, the owner spoke of his role in lobbying for the LEED Gold rating of the Cornerstone Arts Center at the Colorado College and the involvement of one of his former thesis students (Owner interview 2013; Lipscomb 2007). He explained that the Colorado College Cornerstone Arts building was not originally meant to gain the

LEED Gold rating; in fact, at one point it was not clear that Cornerstone would be LEED certified at all. Due to his former environmental thesis student's initiative as well as faculty and staff support, it gained LEED Gold Certification (Lipscomb 2007). The certification was supported by the signing of the President's Climate Commitment by Colorado College, which included provisions for green building.

Owners and academic advisors may be motivated to engage students in LEED projects for the dual benefit of furthering their chances for LEED certification as well as enhancing a student's educational experience. Although the Catamount Dorm was not officially LEED certified as a result of the student's efforts, the project was still an educational success for the student. The student's experience with LEED and the Catamount Dorm Project was rich and of tremendous value, providing insight into a career path:

> To me that's worth almost as much as the LEED certification – to see a student get a thesis on this and in the end learn so much… maybe change your career even! I saw this as a chance to provide that opportunity. You know that's what I do. I'm a professor, trying to create those experiences. I think that we could contemplate all of the ways of how to be more effective environmentally, but in the end I think we had a very effective educational project and that's pretty cool [Owner].

More broadly, the owner verbalizes the potential of LEED-related undergraduate thesis projects to influence a student's career and education. While the education potential was there, is LEED an appropriate tool for an undergraduate level student to use, with no LEED background? The owner argues, yes.

> LEED's checklist approach and the way they guide you through things seemed very easy so in terms of an academic project… I thought it was a great one for you to learn about because I thought it was easily structured. It was something a student could come into and with fairly clear guidelines you could actually figure this out in a fairly short time. So I like that about the LEED approach. I think it's a good teaching tool. I think for someone who is going into the field like you or

> thinking about it, that it was a wonderful teaching tool and all their website information is really well done. [Owner]

The student agrees with the owner's statement; the LEED Green Building Rating system is well structured. The student was able to learn much of the LEED information she applied to her service learning experience from the public information provided by USGBC.org as well as private membership information provided by leeduser.com.

However, while many of the objectives and avenues to achieve LEED certification were outlined and made straightforward within the USGBC resources, when asked to begin the LEED certification documentation, the student was unable to fully address the building design team's requests. There was simply not enough time nor enough prior experience for the student to both learn the LEED material for documentation, further guide the building design team, and satisfy the different requirements of a senior thesis project. Lastly, as identified by both the owner and contractor, a disadvantage of using a student is that they do not have very much authority or 'clout' (Owner Interview 2013) and thus may not be bold enough to be fully heard by the team (Contractor Interview 2013). USGBC has provided a framework for certifying those with experience and tested knowledge of the LEED rating system as LEED Accredited Professionals (LEED-APs). Although there is a clear difference in authority and experience when using a student as a LEED informant on a project, as opposed to a professional LEED-AP, the student gained insight into the role of a LEED-AP, a professional position she can pursue with further education and experience.

The contractor verifies that LEED is an effective educational tool, highlighting the value of service-learning projects.

> I would recommend that every project that happens like this have a party available that is interested in at least helping. In this case, you did almost all of it. I think that there is … a great benefit for other students anywhere to participate in a project like this, gain that insight, gain real knowledge, and provide a benefit to the real population. [Contractor]

In essence, the contractor saw effective education as one that joins academic theory with applicable experience. Retrospectively, it is clear that the vast majority of the student's thesis data collection and Catamount Dorm Project work was service learning oriented. The student's service learning can best be described by the 'consultant model' (Bohlen *et al*. 1999) of service learning developed at Bates College for their Geology and Environmental Studies students. Although the student did not have enough experience to document the building, the contractor still found it a valuable experience to both the team and a true learning experience for the student.

In summary, the first major educational value that the Catamount Dorm Project provided was a hands-on *student* research and consultant model service learning experience in LEED certification.

LEED as an educational tool for members of the building design team

Secondly, LEED is an effective tool to educate members of a building design team. The Catamount Dorm's exploration of the LEED NC-2009 rating system acted to open up new conversations and perspectives about LEED as well as general green design considerations.

> And I think seeing how you've seemingly changed some of the construction just by some of the questions we've asked, I think has made me a bigger LEED advocate even than I was because I really saw the contractor and the architect seemingly influenced by those questions and I saw us get into conversations that we never had in the whole design of the project … about talking about things that weren't even on the project before that. So if LEED does that and it gets that set

> of conversations going, I think that's a wonderful reason to bring it into the conversation. [Owner]

The owner expanded upon this later during the interview and identified the addition of the energy commissioner (a LEED requirement) to the team in late summer as a key conversation opener.

The contractor shifted from initial hesitancy to greater advocacy and excitement, realizing his key role in implementing many of the LEED credits while analyzing the budget. The architect, however, brought up an important note of caution. He began to take an opposing view, stating that using LEED too early in the process may restrict design considerations and solutions. He also stated that the LEED assessment system is heavily product-based and, as with any standardized point system, a team may go for the lowest hanging fruit over the most appropriate green solutions for a particular project. Although the owner is a strong advocate for LEED, he confirms the architect's thoughts that

> there are a few places where you kind of just play the game. Maybe even four or five points where you're playing the game and you say – that's a stupid point. We can get it, but it really doesn't do anything… we're only doing this to get the LEED pieces. And that's annoying a little bit. [Owner]

In one instance, the Catamount Dorm could obtain points for installing a low-emitting and alternative energy sign to reserve preferred parking for these vehicles. However, this campus does not anticipate many vehicles. Moreover, a parking lot was only installed as part of the building codes and signage seems superfluous. There are only five spaces at the Catamount Dorm and thus only one space would require a preferred parking sign. The budget and effort to install a preferred parking sign could be better put to use on purchasing renewable energy credits or other more project-specific and appropriate sustainable solutions. Thus, the team began to learn not only about the LEED system, but to think about it critically, and also to investigate or gain insight into the overarching values of the project.

Learning LEED from a professional

A third perceived educational value was the experience of learning LEED from a professional. Although fairly new, the USGBC has developed an infrastructure served by numerous LEED professionals. Two LEED professionals worked with various team members over the course of the Catamount Dorm Project: a consultant and energy commissioner. First, the researcher and owner spoke with a local LEED consultant to get the student acquainted with the processes and resources available to her. The owner had previous experience with this particular LEED consultant and

> …actually got involved with [the LEED consultant] and teaching a class about LEED certification in which the students looked at every possible building at CC and what the cost factors might be. And we learned, in that class, that a LEED Silver building wouldn't cost us any more and would probably lead to a better product. [Owner]

The owner's positive educational experience with this LEED consultant suggests the role LEED professionals may play within undergraduate courses. Additionally the owner notes his positive experience at the less formal meeting for the Catamount Dorm:

> I think I understand the LEED process a lot better. I think when you and I went up to speak to [the LEED consultant] this summer I think we both learned a lot. I think you've been educating me. I think at first I educated you about the whole thing and what it's about but I think now we're going back and forth sort of as colleagues. [Owner]

LEED professionals may help students and service learning project participants better understand the role of a LEED accredited professional on a building design team. Secondly, it was the LEED consultant who stressed the need for an energy commissioner, an often-overlooked person on a building design team. The initial Catamount Dorm Project team came to value the need for an energy commissioner who was dually a LEED certified professional. The energy commissioner played an integral role toward the end of the summer, mid-way through the construction process. The commissioner helped the team identify several questions they should be asking when choosing certain energy systems and other seemingly minor yet important details in order to maximize the dorm's energy efficiency.

In summary, the Catamount Dorm study demonstrated that a LEED project has the potential to be an effective tool for three groups: the student, building design team, and LEED professionals. It is important to further discuss and study how one may allow all three groups to become more involved in a LEED project.

Discussion

As found in the Catamount Dorm study, academic advisors play a role in involving undergraduate students in service learning projects. Service learning not only enhances the student's education and professional skills, but also provides service benefits for the community. Due to the accessible and organized LEED information provided by USGBC (e.g. USGBC.com and leeduser.com) as well as the growing numbers of LEED professionals, LEED projects are one means of providing students with the benefits of service learning. In conjunction, LEED projects are a tool to help inform building design teams about green building practices and open up new conversations. On college campuses, LEED or green building labels further educate others of campus values and its commitment to addressing sustainability issues. While we found no literature specifically focusing on the benefits of LEED service learning projects, this study suggests the importance of LEED Projects for undergraduate service learning.

In the following discussion, I contextualize the Catamount Dorm Project within the Bates College consultant model of service learning. We can then understand why the Catamount Dorm Project is classified as a subset of service learning and the utility of following an already established model of service learning for improved results of applying the service-learning model to LEED projects. The Bates College consultant model of service learning outlines three major goals:

1. Teaches students professional skills
2. Fuses application and learning
3. Follows a tri-archetypal framework (Figure 9).

The consultant model of service learning aims to familiarize students with several professional skills including but not limited to time management of ‘immutable deadlines’ which is integral to a professional environmental consultant’s job as well as “understanding and analyzing the needs of a specific group” outside of the professor and his or her course (Bohlen *et al*. 1999, 40). While on the Catamount Dorm Project, the student primarily worked as both a LEED researcher and an environmental consultant to the building design team. She was able to learn new skills outside of the classroom that are pertinent to the professional experience and aligned with those outlined within the consultant model of service learning. The thesis student learned the task of researching LEED requirements and advising the owner and contractor how to meet LEED goals (e.g. specific water reduction fixtures or the albedo of the roofing materials) by the immutable deadline of their installation time. Throughout the construction process, the student was responsible for arranging individual and group meetings to discuss the prospects of each credit, what each building team member could contribute, and how the student could best aid the process. Thus, the student was given the opportunity to test the responsibilities of environmental consulting and work with the LEED Green Building Rating System. The Catamount Dorm project and Bates College's consultant service learning model aligned during this first aspect and the design team confirmed the educational benefits. Although we recognize the limitations the student encountered, these limitations are discussed in the upcoming paragraphs as they apply specifically to LEED.

Furthermore, the Bates College consultant model approach asks students to "develop a relationship with a client and apply their specialized knowledge and skills they acquire through their class work to address community needs" (Bohlen *et al*. 1999 39). Bohlen stresses the importance of students learning to apply classroom experience to the projects for the greater community. A successful consultant model of service learning must have this characteristic. When comparing the Catamount Dorm Project to the Bates model, it is clear that this second aspect is missing. One instance where the Catamount Dorm Project's educational success may have been improved is if the student had gained previous experience with LEED in the classroom prior to beginning the consulting work.

Several years ago, a one and a half week long 'half block' course, " was taught at the Colorado College by a LEED consultant. Within this course, the students applied the LEED rating system to the current buildings on the campus. The objective was to familiarize the students with LEED and enable them to gain an understanding of how the buildings could gain LEED certification and the associated budget implications. Had I worked with this LEED professional in this supplementary undergraduate level course, I would have been more familiar with the LEED checklist and evaluation process. I would have gained confidence and been able to apply that base of knowledge to the Catamount Dorm construction and community service. I do not believe an undergraduate can fully document a building within the span of an internship; it is nonetheless important for students to see how they may apply their undergraduate studies to real services and careers. Although I had informally met with a professional LEED consultant to talk about the Catamount Dorm project involvement, there was little guidance beyond that point.

Although we found almost no literature about including LEED material in undergraduate education, California State University has developed a LEED elective course and workshop for their undergraduate construction management students (Brown 2009). Originally, the special topics course initiated by students and a professor used USGBC resources to self-teach from LEED-NC v 2.2's 'Reference Guide.' The goal of the course was to prepare the students to take the LEED AP exam and gain LEED credentials. Although initially self-motivated, the professor began to employ quizzes. After poor quiz results, the course collaborated with two Clark Construction LEED accredited professionals who provided a full-day LEED review session with the students. The study indicated the ability for students to self-teach using the materials provided by USGBC, but also indicated a lack of awareness of how much the students understood and retained the material. Brown (2009) states that working with the two LEED professionals gave the students confidence, and was an incredibly valuable part of the course. In this instance, LEED professionals used LEED as a tool to teach others about the process and were described as valuable resources. This supports the results of the Catamount Dorm study.

The California State University's elective course is now called *Green Building Practices and LEED Certification* and offered to construction management majors for one of their business credits (Brown 2009). The course aims to introduce students to green building practices and applies LEED to several actual case studies. Students are trained to document several credits and perform the associated calculations in order to be proficient enough and encouraged to take the LEED-AP exam. In addition, the course stresses the important role construction managers have in green building practices. Grants provided by the Construction Employers' Association (CEA) have enabled both the construction students and construction professionals to successfully learn LEED. The collaboration between the university and the construction industry has contributed to an increase in constructor awareness of green building practices and greater numbers of LEED accredited professionals. Although Colorado College, a small liberal arts college, would be unlikely to implement a similar program, California State University presents a convincing case that LEED can be a successful educational tool for undergraduate level students. Additionally, the California Sate University case indicates the importance of linking academic coursework to applicable experience. It may not be unreasonable for an undergraduate college to create an elective course that uses LEED as a education tool; instead of preparing the students to go directly into the professional field at the level of a LEED-AP, the course may prepare students for the rigor of an effective service learning internship on a LEED project. The college would determine what an effective internship entails and the corresponding course curriculum. The use of LEED professionals in the classroom combined with their students' service learning with a building design team would better integrate all three educational aspects found in the Catamount Dorm study.

At the Colorado College, where the owner and student teach and study, a 3.5-week block plan class or a 1.5-week half block might enable a LEED professional to co-teach without having to commit to an entire semester. The learning would be intensive and the students could easily take trips off-campus to case study sites or other educational resources such as the Colorado Springs Utilities Conservation Center.

Furthermore, the Bates model (Bohlen 1999) asserts the necessity to clarify and reach a mutual agreement of the expectations of the student and the community members involved in a service-learning project. The consultant model of service learning acknowledges the risk that "students may lack the expertise to do work of the caliber that clients had hoped for" (Bohlen 1999, 50-51). As a solution, Bates College recommends service-learning projects that can be broken up into several independent parts. If a student is incapable of carrying out one task, they may still be able to carry out the subsequent parts and provide services for the community. Had the thesis student gained experience in the classroom with LEED professionals prior to the Catamount Dorm Project, she would have been better able to set reasonable expectations of herself for the team, be more aware of her limitations, potentially increase her understanding of the material, and better understand her role as a LEED consultant. In addition, setting mutual agreements with the clients prior to beginning the project may have given her more clout.

Thirdly, the Bates model is organized by an integrated "tri-archetypal system" (Figure 9). Bates College identifies three endpoints that every project hopes to address within the consultant model of service learning: classroom learning (e.g. classroom projects), research learning (e.g. REU), and life experience (e.g. internship). A successful service-learning project that may culminate in a thesis integrates all three to some extent.

Although Bohlen *et al*. (1999) note that not all service learning thesis projects are equally concentrated on each of the three endpoints (e.g. a service learning project could simply focus on one), the best educational benefits are seen when service learning includes all three to some extent. Thus, an undergraduate student consultant service-learning project should strive to connect all three archetypes along the process; "indeed it is the very practice of tying coursework to research and life experience that makes these projects so effective" (Bohlen *et al*. 1999, 48).

When framing the Catamount Dorm Project under the Bates College consultant model of service learning tri-archetypal system (Figure 9), we find that the project has additional room for improvement. The Catamount Dorm service learning and thesis project addressed two of the three archetypes. First the student gained life experience working with the design team to address LEED goals. Second, the thesis performed qualitative research including interviews and coding analysis, which is documented in this thesis. Although, as identified before, the student did not bring the classroom project experience to the internship, the student *did* bring the life experience and research back into the classroom setting. The student presented a 15-minute oral presentation to the Environmental Program students and faculty about her summer work as LEED consultant and the findings of her thesis. Additionally, the student gave a presentation about LEED and the Catamount Dorm Project to one of the design courses her second thesis advisor was teaching. As stated previously, one of the major components of the consultant model of service learning that the Catamount Dorm Project did not address was classroom experience prior to the service learning. If an elective course had been implemented along with an assisting LEED Professional, the Catamount Dorm Project would have been a great success based on both the Bates model and the results of this study. It is important to note that the Bates model does not suggest bringing the internship experience back to the classroom as the student did.

As identified by Colby College (Firmage & Cole 1999), the ten standards outlined in the Alliance for Service Learning in Education Reform (1993) are essential to a service learning experience. The third standard emphasizes the role of preparation, which "uses lectures, discussions, and readings as well as visits by outside experts to provide students with the background they need" (Firmage & Cole 1999, 36) and was wholly lacking in the Catamount Dorm Project. Additionally, the third standard prescribes that a successful project must include student reflection, which can be accomplished in several means, such as oral presentations or a final report. The Catamount Dorm project included both areas of student reflection, which enhanced the student's learning and enabled her to synthesize what she had experienced. If the Colorado College were to implement a thesis program for service learning (e.g. with one tool being LEED), it should continue to require its students to self-reflect through a presentation or written report. Not only did the student researcher of Catamount Dorm find that it benefited her, but she found she was able to help educate others within the Environmental Program.

All in all, LEED is a promising, effective service learning and undergraduate educational tool for students, building design teams, and LEED Professionals. LEED service learning programs should be further developed, implemented, and studied in order to identify the full scope of its educational benefits.

THEORETICAL CONSTRUCT 2: LEED has a significant impact on building design team dynamics, influencing individual roles, advocacy, and group conversations.

The act of implementing the LEED Certification Green Building Rating System is a collaborative effort for everyone involved. The researcher found that the dynamics of the Catamount Dorm team shifted as LEED was introduced. Using interview data, she identified a change in perceived role of major team members (owner, architect and contractor), their advocacy, and the scope of their conversations.

Owner's role

The owner describes his basic role as the member who makes the ultimate decisions. For instance,

> ..as the owner you need to make cost decisions all of the time. And as the owner you're the bottom line person. So if you don't like what the architect says, as the owner, then you fire the architect or make the architect re-design… You say – "that's not the environmental concept. You're not building an energy-efficient building like the one I want to." You have the contractor coming to you and you say … "look, the shower heads are another $500 for the building. Are you willing to spend that?" And so as the owner it sits right in your decision to say, "Yeah, that's an important enough decision. Water use on this campus in a fairly arid place is really important. So we're going to spend the money." So as the owner, I think you have more control over what the environmental nature of the building is than anyone else on the project because you're hiring everyone to build it. [Owner]

The owner is responsible for pushing the green or LEED goals on a project. In conjunction, the owner reviews his motivations for picking each member of the design team. The architect was chosen for his past environmental design and education work. Then, through a bidding process, the general contractor was hired post-design stage. The owner had worked with the contractor previously and the contractor brought 30-plus years of experience to the project (Owner Interview 2013). The owner lists the qualities he was looking for and found in the contractor stating that the contractor is “very open, he’s very honest, and he’s very clear about how his budgets work” (Owner Interview 2013). The owner feels his role is not only to make the ultimate decisions, but also to bring together a balanced building design team that will best enable him to meet his goals.

Owner’s advocacy

The owner identifies his advocacy for green buildings and for LEED buildings. The owner’s motivation is driven by his educator and environmentalist values. First, “as an environmentalist, I think anyone should be an advocate for green building ” [Owner Interview 2013] due to, for instance, the reduction in energy use and utilization of local materials. Additionally, the owner has been an advocate of LEED for several years. He previously displayed his advocacy for three buildings on the Colorado College campus: Tutt Science Center, Cornerstone Arts Center, and the Children’s Center. While both the Tutt Science Center and Cornerstone Arts Center gained LEED certification and LEED Gold respectively, the Children’s Center did not receive enough support to address LEED. One easily perceived benefit or motivation behind any LEED project is the certification label. The Owner saw the green label as a “statement” on the Cornerstone building, a means of educating others about the College’s values and sustainability efforts.

While speaking of his advocacy, the owner mentions his decision to apply LEED to the Catamount Dorm project. Prior to reaching his decision, the owner noted the pressure he faced from his colleagues as a result of his previous advocacy on the Colorado College campus:

> …I felt, coming into this project with the Catamount Dorm, that I'd be hypocritical pushing the [CC] campus for two sustainable buildings on a somewhat environmental campus but then having our own environmental campus [Catamount] and having people look at me and say you know, "you've pushed at Colorado College for somebody else's money and for those buildings to be LEED. How come you aren't pushing it on your own?" [Owner]

It was during these conversations that the owner concluded it was simply the right thing for an environmental educator to do and explains:

> One of our board directors who's an advisory director, asked during one of our meetings fairly early on in the [Catamount] design process, "Are you getting LEED certification on this building?" And I think I was thinking about it a little bit before but when he specifically asked that, and he's a professor at UCCS, it made me think that much more… we should be doing a little bit more even than just thinking about whether or not it's LEED – let's try and give it a shot. [Owner]

Once LEED was explicitly added to the Catamount Dorm Project goals, the owner felt his advocacy grow:

> I guess I was surprised in a good way about the conversation it started among the different groups that were here, the owner the architect and the contractor, in some of the discussions that we had and how animated those discussions became and how what looked like opinions were sort of changing. [Owner]

The owner found that the new conversations, whether supportive or controversial to LEED, were beneficial to the project.

As an environmental educator, a LEED advocate, and lastly an owner with the ultimate budget purchasing power, the owner addressed the responsibility he felt of determining how green the Catamount Dorm would be. He identifies LEED as one way to best tools to achieve green goals beyond his initial efforts.

Architect's role

Throughout the interview the architect identified his role as an innovative designer (Architect interview 2013). Although the architect did not identify specifically as an environmental or green designer, he made clear his commitment to his clients. In essence, if it is the client's goal to be green, the architect strives to find solutions to his client's requests or problems in new ways. This allows the architect to contribute to the client's project-specific needs and contribute to the architectural design as a whole.

While the architect understands his potential role in green building and has participated in other green building projects, he is hesitant to accept LEED and other current standardized rating systems as a means of reaching sustainable goals. The architect prefers to investigate his own solutions for sustainable design rather than the prescribed solution of LEED and other rating systems. He expresses concern for architects using green building assessment systems and asserts that many of the prescribed practices of LEED should eventually be integrated into basic building design codes:

> I think that [environmental] issues are very important and I think that every architect on every project should be as environmentally responsible as it can be but I don't think that is the biggest contribution that architecture can make to the world. … my point is a lot of these evaluations and design strategies will become…just part of the building code eventually so that everyone is meeting or exceeding these standards, … they just get folded into practice [and] it's just something that everyone does. [Architect]

The architect identifies required green building codes as a hopeful solution to his critique of LEED. Most importantly, he argues that an architect's traditional role should be preserved in order to maintain design flexibility and contribute the most to any given project. Currently, rating systems may be a hindrance if implemented too early in the design process.

Architect's advocacy

The architect is not a strong advocate for LEED. When asked whether or not he would use it in future projects, the architect says, "if it matters to [the client] and how they market their institutions or then what they believe in personally than I'll do it. If not, I wouldn't" (Architect Interview 2013). One of the primary reasons the architect hesitates to be an advocate for LEED is due to LEED's design constraints; LEED changes his basic role. Furthermore, he identifies LEED's prioritization of product-based solutions (Architect Interview 2013).

> But if you're just, if you're going for LEED points there are lots of places where you kind of like choose a certain product or, you know, there, it sort of drives architecture in that direction, sort of more like a product selection profession than an inventive design profession. [Architect]

Following his work with the Catamount Dorm, the architect identifies an ideal balance for LEED that he could advocate. For example, on the Catamount Dorm project

> ….ideally our role would be to, on one hand, try to meet and exceed those [LEED green] standards where we could in the design but then to also evaluate those standards against the larger ambitions of the project … to [determine] 'where they were supporting those ambitions, where they were neutral, and where they might have been detrimental to those ambitions.' [Architect]

From an architects view, LEED as a green building tool detracts from his role and contribution to both the owner, project, and design world. LEED should remain secondary to the overarching goals of the project. LEED points should be achieved if in conjunction with the larger ambitions of a project and a team should not simply 'point pick'. A team should also retain the integrity of going beyond LEED goals if called for in its greater ambitions. Therefore, early conversations about major sustainable project goals and other goals must be made clear before pursuing LEED.

Although interviews with members revealed that the initial green design goals and features would likely not have changed with official LEED certification, this may have been due to LEED's late integration into the Catamount Dorm project. It is essential to note that several of these sustainable design solutions of the Catamount Dorm, not registered within LEED, would not exist had the architect's role been constricted early on in the design phase. The building might be less sustainable if strictly following LEED. The architect's level of LEED advocacy is connected to his perception of an architect's role and voice on any team.

Contractor's role

The contractor saw his role as straightforward. In any project, he aims to help the designer and owner implement the building elements they seek while maintaining a reasonable budget. Once LEED enters a project, the contractor must also balance budget considerations and achieving points.

Our job is to help the team say, "How do we keep this look, this shape, this amount of glass, this view, this product, whatever it is that's important, but, amp the cost down to where it's affordable…for the client. And that happens…on almost every project we do…having nothing to do with green building or LEED… It sometimes might be magnified or become a little bit more important here because were not just trying to change a detail and say if you use this granite here its going to cost $1000. It's if we use this here were going to lose points. And that is a bigger deal in the LEED process sometimes than changing the design. So sometimes … it, certainly was harder and I think it is harder on a LEED project. Because you not only have a client's pocketbook and the designer and owner's goal for the project, but you've got a third category of these sort of necessary points that you have to somehow work your way into. [Contractor]

Contractor's advocacy

The contractor acknowledged a benefit of the LEED assessment system. Following his work with LEED on the Catamount Dorm Project, he concludes that it allowed him to get a feel for sustainable practices and how he could replicate them in future projects given a client's interest. Although the contractor did not have any green building rating system experience prior to the Catamount Dorm Project, he had done his best within his client's budgets to build sustainably (Contractor Interview 2013). In a conversation with the contractor, I observed that he inherently values green building. He saw green building as something that promotes sustainability, defined in his mind as efficiency. He asserted confidently that most efficient practices should, in theory, be those that are naturally the most economically, socially, and environmentally viable. In contrast to some peoples' views, he argues that economic concerns and environmental concerns work in conjunction rather than in opposition. For instance, using native, regional materials will require no additional cost, support local businesses, and require less transportation energy if ordered in advance. This was the case for the Catamount Dorm project as well, however, the project did not consider LEED with enough advance to purchase the materials at a low cost.

He acknowledged that in one sense, standardization, although limited in certain aspects is important for efficiency. For instance, if a beam is originally cut at a standard size that fits with a particular type of construction, there is no need to put the extra cost and energy resources into cutting it a second time to the right length. Beams are able to fit together in a standardized, efficient way. Likewise, the contractor felt that LEED's standardization was useful in providing guidelines and specific VOC goals to achieve or flush rates that were considered most sustainable and reasonable to achieve. The LEED assessment system credits gave the contractor a new perspective on his role in achieving sustainability and efficiency.

Discussion

The results of this study suggest that the LEED assessment system requires owners, builders, and designers to adjust their individual, traditional roles. The owner found he was held responsible for deciding the extent of the building's sustainable goals and at what budget he would accommodate those goals. He also identified his second role as bringing together an effective team to meet these sustainable goals. Overall, his responsibility increased. The architect felt projects that follow LEED from the beginning of the process might constrict his ability to invent project-specific sustainable design solutions and thus the team needs to be aware of its major goals prior to LEED assessment. The architect felt his new role was to balance the overarching goals of the project with LEED goals, or to bring these conversations to the rest of the team. The contractor found he was an indispensible member of the team, contributing greatly to several of the major LEED goals during the construction phase. Additionally, LEED changes the dynamics of the team as a whole, calling for new conversations and requiring the addition of other valuable team members such as energy commissioners or LEED accredited professionals.

Recently, several scholars have argued that successful LEED and other green building practices require a greater integration between project members. In order to achieve better integration, the team must recognize the importance of greater and earlier contractor involvement (Syal *et al*. 2007; Robichaud & Anantatmula 2011); a contractor must be included in team discussions from the planning or feasibility phase during green building projects as opposed to post-design phase during traditional building projects. If included early enough and with greater involvement, contractors can contribute greatly to successful sustainable practices.

In fact, Syal *et al*. (2007), recognizing a contractor's value, have prototyped a Microsoft Office Access query database tool and presentation for contractors (constructors) pursuing LEED projects. The query tool was formulated from an impact analysis study asking which LEED-NC credits contractors felt they had a 'major impact,' 'moderate impact,' or 'some impact.' The level of impact was decided upon the following construction management factors: "estimation decisions and project cost, scheduling activities, durations and logic, project administration and documentation, contracts and agreements, field operations and subcontractor coordination, and other constructor-related aspects" (Syal *et al*. 2007, 179).

The database query tool (Figure 10) allows contractors, for instance, to navigate major impact credits, select a specific credit within that group, and look at what role they play in each of the following five areas ('estimation' 'scheduling' 'project administration' 'contracts and agreements' and 'field operations and subcontractor management') for that credit including major discussion points and examples. The constructor may also look at information sorted by LEED category (Figure 11). Lastly, Syal *et al*. (2007) presents a contractor having greater or earlier involvement in a project with a tool to understand how they may contribute to exemplary performance points or innovation and design points beyond the standard LEED credits (Figure 12). The literature confirms the importance of the Catamount Dorm contractor and suggests a team maximize the benefits of this member in every phase of a LEED project.

As Syal *et al*. (2007) suggest, the contractor of the Catamount Dorm may have had even greater success and played a larger role had he been involved earlier and used the database query tool. In her interview with the contractor, the Catamount Dorm LEED researcher explained that is difficult to "know when [to] bring up the [LEED] information and how to present it so that everybody can get an idea of what's happening. [Because] a lot of the process is so detailed.. it's hard to know how…to share it (LEED Researcher)." In fact, she observed that it was oftentimes easiest to know what to do with the information and what team member(s) could best apply it after speaking with the contractor or the architect. Impact analyses and query tools may bring greater clarity to LEED projects.

Little has been studied or published about architects' roles during LEED projects. The majority of the conversations have been placed on contractor roles or the approach of the entire team; no prototype tools have been found for architects during the literature review. It would be interesting to run a similar impact analysis for architects and owners and combine all three analyses to form a table (e.g. Figure 13) where the team can look up which members may have the greatest role for achieving specific credits. Future studies must focus on architect roles and involvement in a LEED project. If supported by the studies, architect-specific tools should be modeled. The Catamount Dorm study results remind us that LEED does have a major impact on an architect's role and is not to be overlooked.

Had the query tool been applied on the Catamount Dorm project, not only would the contractor have had easy access to the information, but the query tool may have been able to assist or even abbreviate the role of a undergraduate LEED researcher. Due to the lack of a LEED AP early on in the Catamount Project and the late introduction of LEED, it is difficult to ascertain whether or not it would have been more effective to use a query tool or to use a LEED AP to guide the contractor. It would be useful to apply the Syal *et al*. (2007) database query tool on several future case studies and compare the results to similar case studies using a LEED professional. One perceivable advantage to using the query tool is the contractor's immediate and easily navigable access to LEED material without relying on a meeting with a LEED-AP. However, an advantage of a LEED-AP is the guidance they provide to other members of the team who may not have as many tools available to them.

An impact analysis of LEED accredited professionals (Gebken *et al*. 2010) has been conducted comparing the responses of architects/engineers (A/E) holding LEED-AP credentials to all others in non-A/E organizations holding LEED-AP credentials. Of eight questions proposed for the study, addressing how LEED has impacted their careers, the study concluded that LEED-AP credentials have benefited those working for A/E firms less than those working for other organizations. In fact, six of the eight questions showed those working for 'other' firms benefited significantly more than for A/E firms.

When answering, "Do you feel more knowledgeable as a result of becoming accredited?" both the A/E and 'other' group responded affirmatively greater than 80% of the time. However, when asked "Do you feel more confident in your ability to do your work, approximately half of each group responded 'yes', lower than 30% of each said 'no difference' and generally 20% of both said no. One of the major barriers the Catamount Dorm LEED researcher faced was a lack of experience and thorough understanding of LEED. One of the major qualities the contractor noted was the need for the LEED researcher to be confident, bold, and be heard by a team. The study performed by Gebken *et al*. (2010) unveils that the credentials greatly increased knowledge, but only about 50% of those with LEED-AP credentials felt more confident as a result.

Furthermore, the owner stated that the LEED researcher of the Catamount Dorm project lacked 'clout' on the project. Three questions within the survey (Gebken *et al*. 2010) relate to the topic of 'clout': "Being a LEED-AP has impacted you career by increasing your prestige among superiors within your organization," "Being a LEED-AP has impacted your career by increasing your prestige among individuals within your organization," and "Being a LEED-AP has impacted your career by increasing your prestige among individuals outside your organization." Tellingly, the data provided by Gebken *et al*. (2010) reveals that the three highest average response values (scaled 1(strongly disagree)-5(strongly agree) of all eight questions for both A/E and 'other' were for these three questions. Thus, the greatest average impact the LEED-AP credential had for those working in A/E and 'other' organizations was increasing their 'clout' or 'prestige.'

In retrospect, a LEED-AP on the project, as opposed to a student LEED researcher, may not have fully increased the confidence or boldness of the team member, but would likely have increased his or her knowledge and clout. The results of both the LEED-AP impact analysis (Gebken *et al*. 2010) and the Catamount Dorm results make implicit the use of a LEED-AP to more effectively share LEED information with other team members. Another question remains: is it more beneficial to hire a separate LEED-AP member such as a LEED consultant or have the owner initially choose a contractor or architect or energy commissioner who also holds LEED-AP credentials? Is there a specific member having professional LEED experience that would benefit the team most?

Robichaud and Anantatmula (2011) suggest that a team hire a LEED-AP project manager. As a result, LEED projects will have a member whom knows the LEED material overseeing the integration of the team and the major discussions throughout each phase of the project. Another recommended strategy (Robichaud & Anantatmula 2011) is for the owner to select a building design team that is "built for success" as the owner of the Catamount Dorm similarly selected. On a LEED project it may be beneficial to create a team where all members are familiar with green building or with LEED. This is called differentiating, allowing only those members to be selected from a pool of builders and designers with prior green building experience (Robichaud & Anantatmula 2011). This strays from the typical hard bid process and requires that LEED be written into the members' contracts. Had the owner of the Catamount Dorm explicitly considered LEED before selecting members of the team, he may have been better able to find members with LEED experience or potentially LEED-APs and achieved his LEED goals more effectively. In summary, if an owner of a green building project is required to 'differentiate' or choose a project manager with previous LEED or green building experience, it is best that the owner establish his LEED and green goals as soon as possible.

The second role of the Catamount Dorm owner was to commit to LEED decisions based on costs. A largely contested concept within the literature is to what extent LEED certification, LEED Silver, LEED Gold, and LEED Platinum affect a project's initial investment budget and to what extent it affects lifecycle costs. While it is debated whether or not LEED increases the initial investment or decreases lifecycle costs significantly, it is widely held that an owner or business' perception of increased economic risks is one of the major barriers to LEED as well as general green building. Robichaud and Anantatmula (2011) present a convincing argument; regardless of whether or not lifecycle costs of LEED may make up for initial costs, progress should still be made to decrease initial costs, decreasing perceived risks of green buildings and better enabling developers without "long-term interest in operating or leasing a building (50)" to engage in LEED projects.

While the discussion of theoretical construct two has thus far focused on the roles of individual members and their individual contribution to LEED projects, it is essential to comprehend the dynamics of the entire team. The literature suggests the reframing of project management practices for complex green building and assessment tools in order to effectively integrate each member's role into the greater team goals and increase economic viability. Currently, building designers, such as architects and contractors, "tend to be highly specialized and deliver services in technical isolation. This 'silo effect' makes it difficult to manage changes, mitigate risks, and contain costs with a holistic view of the project" (Robichaud & Anantatmula 2011, 50). For instance, traditional building processes are fragmented; a contractor is traditionally brought into the project after the design phase through a bidding process. More recently, many argue that the contractor (Syal *et al*. 2007) as well as all other major members must be brought into the discussions from the beginning of the planning and feasibility stage (Robinchaud &

Anantatmula 2011; Wu & Low 2010) for green projects in order increase time and economic efficiency. Although hiring all team members earlier on in the process may appear cost-prohibitive (Robinchaud & Anantatmula 2011), it prevents delays and the costs of re-working a project later on within the process. It enables the team to have a clearer picture sooner about what goals they can feasibly achieve with a minimal initial cost. Contractors and project managers play a large role in these cost reductions.

In fact, much of the literature calls for a holistic approach when dealing with green building where all major members are a part of the team during all the phases of the project. As proposed by Robinchaud and Anantatmula (2011), all members should be included during the feasibility, design, implementation and closeout (operation) as seen in Figure 14. Likewise, Wu and Low (2010) argue, "instead of simply regarding green building as an assembly of new materials, technologies, and other pieces of environment-friendly innovations, it should be a holistic solution to achieve the concept of sustainable development in the project life-cycle including project planning, designing, constructing, and operating" (64). All in all, green building and our current assessment systems (e.g. LEED) must demand greater attention to integrated and early project management.

In order to initially involve all team members in the discussion and increase the commitment to and agreement of the major goals of the project, the literature suggests meetings, workshops, or a charrette. A charrette is an integrated "planning process that harnesses the talents and energies of all interested parties to create and support a buildable Smart Growth plan" (National Charrette Institute 2007; Robinchaud & Anantatmula 2011) and may last several days. The initial meeting should broaden project participation (Kaatz *et al*. 2005) and involve as many major stakeholders as possible (Robinchaud & Anantatmula 2011; Wu & Low 2010; Kaatz *et al*. 2005) as possible.

Although the results of the Catamount Dorm study and the recent literature advocate for a new and more integrated project management strategy, there is evidence for successful LEED building using traditional project management practices. Of the already established and traditional project management strategies (design-bid-build (DBB), construction manager at risk (CMR), and design-build (DB)), a study by Molenarr *et al*. (2009; Figure 15) suggests that CMR "is the most successful project delivery method with a 94% success rate and exceeding owners' expectations half the time." In partial conjunction with the scholars who call for greater team integration through project management strategies, the CMR strategy is the only traditional strategy (Figure 15) that includes both a construction phase and the green decision period within the segments of the design phase. However, CMR fails to overlap both aspects at the same section of the design stage and does not introduce the contractor as early as DB.

The Catamount Dorm owner followed a DBB process. Molenarr *et al*. (2009) found that DBB and CMR focus the majority of liability on the designer and owner. DBB strategies are successful when "owners that desire to achieve a specific LEED level at a fixed price prior to construction [and]…specify the LEED level in the procurement documents" (ii). While the Catamount Dorm owner did not explicitly consider LEED prior to the construction process, he did set a fixed price and four major green design goals. Molenarr *et al*. (2009) suggest that the Catamount Dorm would have more likely received LEED certification had the owner pursued LEED earlier. In contrast to the previous assertions (Robinchaud & Anantatmula 2011; Wu & Low 2010; Kaatz *et al*.

2005), data provided by Molenarr *et al*. (2009) suggest that DBB (a linear and the least integrated process (Figure 15)) may still be successful.

During the Catamount Dorm Project, the LEED researcher estimated the dorm had the potential to achieve LEED certification or LEED Silver, in part, due to the alignment of the already established green design. However, the team found they needed a LEED AP working on the project earlier in order to complete the documentation and better assist the team. As indicated by the Catamount Dorm study's results and the existing literature, one of the greatest flaws in the project's ability to meet LEED expectations was the lack of project management and late consideration of LEED. However, the lack of attention to project management of the Catamount Dorm may be a common flaw of many projects pursuing LEED.

A study by Wu and Low (2010) compares LEED 2.2, Green Globes, and the BCA Green Mark 3.0, noting the level of project management as the greatest difference between the three assessment systems. The study determined what credits and then percentage of points addressed either project management process or project management practice within each rating system. Wu and Low (2010) define project management process as relating to non-technical related issues "which can ensure the smooth flow of the practices (65)" and as something currently overlooked. They define project management practice as the more technical components of the assessment systems and sustainability such as energy efficiency or material management. Current green building assessment systems and common perceptions of project management have prioritized practice over process whereas project managers should choose a system that balances both (Wu & Low 2010).

Of the three assessment systems, Green Globes allocated 62.7 % of the project management points to process, GBI suggesting strategies such as a charrette, while LEED 2.2 and BCA Green Mark 3.0 only attributed between 20-30 points to non-technical processes (Wu & Low 2010, 68). Furthermore, of the management process points that LEED and Green Mark allocated, almost all targeted commissioning and certification, but not planning and coordination (68). While another study should be conducted for the most updated versions of LEED, BCA Green Mark and Green Globes (e.g. LEED v2009), the LEED researcher of the Catamount Dorm notes that LEED v2009 has not increased much of its attention in points to planning and coordination of the management process since LEED version 2.2. However, with the launch of its leeduser.com website in 2009, members have greater access to checklists, suggestions, and hints for how to best achieve each credit. Teams that are engaged and take initiative in exploring the website will learn how to better plan for each credit. Although USGBC suggests that a project consider LEED as early on in the process as possible, there is no recommended or point-motivated model of project management processes for LEED.

Finally, Wu and Low (2010) make an integral assertion that each of the three major green assessment systems have their own positives and negatives and a project might receive certification using one but not the other two. Although it may seem minor or obvious, this observation is essential in reminding us once more that there is no agreed upon definition of how to build sustainably and to some extent projects must not solely rely on a building assessment to create a sustainable building. Teams must also rely on what the architect of the Catamount Dorm states as common sense and good ethic. If a team were to merely ‘point grab’ or select only certain credits using Green Mark, a team could fulfill the requirements without obtaining any points or addressing concerns for water efficiency or indoor environmental air quality (Wu & Low 2010, 67). While LEED has mandatory requirements in each category, LEED is the most stringent of the three rating systems and is viewed highly as an “all-or-nothing approach;” if you do not meet the exact standard, you cannot receive partial points (Wu & Low 2010, 67). This may prompt teams to more willingly ‘point grab,’ selecting credits that are easy or most cost-effective. Lastly, although Green Globes is the most balanced in both practice and process of the three assessment systems; and also allows for partial points, encouraging a team to at least try for the credit; it is often regarded as less stringent or more flexible and often taken less seriously (67). Alternatively, Wu and Low (2010) assert that all three assessment systems can help inform teams of sustainable practices. Of the three, Wu and Low recommend Green Globes for its balance in project management.

In summary, the green building practices and the assessment systems that currently drive them both voluntarily and also by regulations are greatly affecting the roles of architects, owners, contractors, LEED professionals, project managers, energy commissioners, stakeholders and other members. Project management that promotes the greatest team collaboration is argued to best maximize the team members’ roles in achieving sustainable goals. The Catamount Dorm project and recent literature has unveiled the necessity to study team dynamics and project management further in order to make sound choices and create successful frameworks for projects to follow.

THEORETICAL CONSTRUCT III

Defining green buildings versus LEED buildings

The Catamount Dorm team distinguished that LEED is part of green building but that green building encompasses sustainable practices beyond those included within LEED. The contractor lends his opinion:

> Well, I guess my first response is LEED building is certainly green building and I think there are some other … some parts of 'green building' that are different from LEED. LEED is focused on points and any time you have a set of guidelines or rules that are focused on one objective, they can't by definition, include every other aspect. So I would say for the most part, they are very similar. I think the same objective. [Contractor]

The objective shared by LEED and green building is sustainable development. However, due to its standardization, LEED is a subset of green building. LEED's focus is narrower because it is only capable of promoting a limited subset of the total green building practices available. The architect identifies LEED's primary focus:

> I think that the LEED system pushes too much towards the selection of products to be used in the building design and not enough towards inventive solutions for a given problem. And I understand that that's difficult because LEED is meant to be a standardized system and to standardize you can't really evaluate projects on an individual basis. You have to have standards, but I think that there are disadvantages to that. Like, for example, certain projects may be very inventive with the way they deal with certain environmental issues but there is no place in the LEED to register some of that invention. [Architect]

LEED's strategy is largely product based, enabling it to accommodate a wide variety of building styles in a variety of places. The architect of the Catamount Dorm foresees the current LEED system negatively molding future architects' professions from a 'design profession" into a 'product-selection profession.' The architect feels that LEED's standardization is not flexible enough to encompass some innovative or even simply 'common sense' sustainable design solutions and ethical sustainable design solutions.

As discussed in the Introduction, sustainability addresses social, environmental and economic concerns. In the following section, the Catamount Dorm's initial green building goals are compared to the LEED assessment system and how well each addresses social, ecological, and economic sustainability.

Social concerns

The most direct route by which LEED addresses social concerns is within the health and comfort of its building occupants. The majority of LEED social concerns directly impact the occupant's health (Scorecard, EQp1-2 & EQC1,2, 3.1-2,4.1-5) and comfort (Scorecard, EQc6.1-2, 7.1-2, 7.1-2); these social concerns are addressed within the *Indoor Environmental Quality* category, totaling 15 of 110 possible LEED points.

The owner recalls his first-hand experience working and teaching in the Tutt Science Center at Colorado College and exclaims, " it is one of the nicest buildings on campus" (Interview 2013). Moreover, the Owner attributes some of the perceived occupant benefits of the Tutt Science Center to its LEED certification.

> I don't think that's a complete coincidence. I think that it's related to the fact that it's a nice building to work in and the fact that there is LEED Certification. [Owner]

In agreement, the architect adds that more recently, business owners have wanted LEED certification as an 'advertisement' that their LEED certified buildings contain nicer working environments and enhance employee efficiency.

The contractor identifies the health benefits of LEED's indoor air quality standards. As someone who primarily assists medical and dental office construction, the contractor discloses that his clients "in the last five years have asked for, for instance, low VOC [emitting products for] paints and glues and plastics" (Contractor Interview 2013).

Although the contractor has not served any previous LEED-seeking clients, he expresses excitement that their low-VOC demands are registered within the LEED rating system (Scorecard, EQc4.1-4.4). On the other hand, the contractor's clients "haven't always wanted the costs of [other] products that relate directly to LEED points" (Contractor Interview 2013). LEED addresses incredibly relevant social health concerns, mainly indoor air quality, but the cost of LEED certification may dissuade clients from addressing other social concerns mitigated through LEED. The contractor's clients are willing to utilize a few green building practices that they feel contain values that outweigh costs. Here, green building social concerns and LEED social concerns may overlap, but not necessarily.

The architect argues that there are additional social benefits not included within LEED. He states that the Catamount Center dorm was designed for socially sustainable spaces (Architect Interview 2013). Examples include

> …the courtyard, that is semi-enclosed; the areas around the perimeter, some of which have sort of larger gaps and gathering places; and the common room [in order to] integrate the building in a, kind of seamless way. [Architect]

As mentioned earlier, the Catamount Dorm will primarily house undergraduate environmental education students. The central courtyard provides a project-specific outdoor classroom space. The architect relates his own design for social sustainability to his constant pursuit of innovative design, finding

> …ways to occupy the building [with the greatest] flexibly over time so you could have different groups of people, people of different types and different sizes coming through and occupying the building in different ways over time, something that allows it to be a lot smaller than it could have been. And that doesn't really show up in LEED, for example, whereas that definitely makes a huge difference. [Architect]

Recognizing that a dormitory with a capacity of up to 24 students could be built in a range of sizes (Architect interview 2013), the architect remarks: "In the early … programming phase of the design, where we were having discussions with [the owner]- there was a point where we were determining how big the building should be." The Catamount Dorm's original social sustainability concerns assisted one of four pre-LEED major design goals: to minimize the square footage of the building. Not only did minimizing the size of the building increase the occupant benefits and efficiency of its social and educational spaces, but it also addressed environmental concerns.

> Just the quantity of space that you're constructing and conditioning, making and maintaining certainly has a huge impact on the environmental performance of the project…if you can make it smaller it's going to take less to build it and run it, less resources. [Architect]

At the Catamount Dorm (designed for environmental education and surrounded by thousands of acres of protected land), building small in order to maximize the use of its spaces and minimize its footprint is a logical and ethical design.

Environmental concerns

In addition to minimizing the square footage per person of the building, the Catamount Dorm's remaining three pre-LEED goals address environmental concerns. During the design phase,

> We did not go through … the LEED checklist, as we were designing and say here's a point, there's a point, that's what we ought to be designing. We had [our own] definite environmental considerations. We knew we wanted it to be a very energy-efficient building, we were hoping that we would have some sort of alternative energy. We actually had a budget. We had a $25,000 budget for some sort of alternative energy to go into the building. We knew that we wanted to use daylighting. We knew we wanted it to fit into the land. We didn't want to destroy too much land and we're an environmental institute so making a building that did not fit into the site would have been totally against our mission. So we did not go through the LEED checklist in any way, shape, or form before we [began

> construction], but we certainly had considerations that we thought were environmental considerations that were very important. [Owner]

The Catamount Dorm's energy efficiency goal was partially accomplished with a dual biomass propane burner. As stated in the Methods, the burner enables the Catamount Campus to repurpose the wood from tree thinning in order to heat the dorm through a combined radiant floor heating system. The radiant floor heating provides comfort to the occupant, making them feel warmer than traditional heating systems.

> The floor slabs actually sort of retain the heat, so that once they're heated … it takes a low level of energy to keep them heated and then on top of that… having contact with the… warmth of the floor actually makes people feel a lot warmer in the space than if you're heating the air. So, the air temperature typically, in a building where you have radiant heat, can be kept lower and people in the building will still be kept comfortable. [Architect]

The architect placed several design considerations into the energy system. For instance, the dorm's spiral design [Figure 4; Paul Anderson 2013] actually splits the building into two pieces that flow together. If the dorm does not reach its full occupancy and only one half required, the other half can remain unheated.

Generally, both LEED and the Catamount Dorm Project placed a large value on the energy efficiency and energy system of the building. As outlined on the USGBC LEED-NC v2009 scorecard [Figure 2] the *Energy and Atmosphere* category is worth more points than any other category: 35 points of 110, 32% or roughly a third of the evaluation system. Furthermore, the *Optimize Energy Performance* credit within the *Energy and Atmosphere* category is worth a total of 19 points and is based on the percentage of mitigation from a baseline standard. This is the most valued credit in LEED-NC v2009. Overall, the Catamount Dorm reserved part of the budget solely for the most suitable energy-efficient heating system, includes no mechanical cooling system, and uses daylighting to further reduce the need for electricity. Had the Catamount Dorm team not prepared for optimizing energy efficiency early in the design process, we may not have been able to easily translate the dorm into LEED certification. We argue that one of the major components of LEED (energy efficiency) must be planned for before the construction stage in order to be sustainable and thus minimize the cost of redesigning a significant component of the building. A project that waits until the construction stage to consider LEED must only do so if already designing with green building practices in mind, in particular energy efficiency.

The third Catamount Dorm goal, to maximize daylighting and views, was chosen and emphasized by the team's values:

> The other piece that [the architect] kind of presented and that I think we debated a while was - we said 'people are in the outdoors so do they need good views? … And I was kind of pretty insistent that because we were outdoors in such a spectacular place, having views all around in the different aspects of the building, [that] when you're in your room you should be able to see them and you shouldn't be looking across a corridor. So one of the design considerations for the building really became not having any corridors. And so that really became an interesting piece for [the architect] – never pass through a corridor going to any place in the building. It's all exterior and all the different rooms have different views that look out. So they're all day-lighted, they all have nice views; the site itself is beautiful. [Owner]

Much like energy efficiency, both the initial Catamount Dorm green design and the LEED green building rating system specifically address daylighting and views. The Catamount Dorm was able to translate its daylighting and view goals into LEED points easily within the *Indoor Environmental Quality* category (Scorecard, EQc2, EQc6.1-2, EQc8.1-2). While providing social benefits, daylighting and views also provide ecological/environmental benefits.

During the design phase, the Catamount Dorm team seized the opportunity to mold the daylighting and views into what became a spiraled corridor-less building [Figures 4-7]. This enabled the dorm to uniquely

> …use natural light as best [it] can. For example, there are parts of this building where it steps up to a second story space height which provides views, which is really important to the quality of the rooms themselves but also, just to provide additional light to those rooms. I know natural lighting is something that kind of shows up in LEED but it's just common sense. If you get more natural light in a room you'll have to use less electricity. [Architect]

The final major pre-LEED environmentally sustainable design was to integrate the building into the landscape. The owner renders the team's dedication: "the general shape of the building that the way the building flowed with that land that sat into the landscape was something that we really came to do a year and a half of designing (Owner Interview 2013). Visually, the Catamount Dorm flows with the landscape, detailing rounded corners, not an inexpensive feature but one the team felt encouraged its place within the surrounding environment. Here, the Catamount Dorm team's sustainable goals went beyond what LEED considers sustainable, yet what one may consider green.

In addition, the team was careful to select the best area of the campus to place the dorm.

> Long before [the architect] and this building ever came to be we had a landscape architect working with our old architect, probably fifteen years ago when we first started. And we had so many different designs for the landscape architecture about where buildings would sit. And we really went through the process of trying to build on disturbed lands that were already a bit disturbed… not going into nicer parts of the forest. And so where the building sat was also a pretty big design consideration and about how much earth we would have to move. [Owner]

LEED does allot points for buildings sustainable placement within its surroundings using the *site selection* category (Scorecard, Figure 2). However, it was noted in the LEED researcher and owner's early observations that the points you can gain in this category are almost pre-determined. For instance, the Catamount Dorm would not be able to achieve brownfield redevelopment points by default. However, those credits that do apply are relatively simple to achieve at a low cost.

Economic concerns

The contractor and owner (Interview 2013) recognize that two of the major costs associated with LEED were diminished greatly in the Catamount Dorm project. First, the owner did not hire a LEED-AP to coordinate the team and document the LEED certification. The owner estimates the value of a LEED-AP or LEED consultant as approximately $20, 000 minimum for the Catamount Dorm (Owner Interview 2013). The contractor states that the undergraduate student completing a service-learning project as LEED researcher took the role of a LEED-AP, and at relatively little to no cost (Contractor Interview 2013). It must not be dismissed, as found in the previous theoretical construct two results section, that the LEED researcher lacked the experience to fully document the dorm. In order for the Catamount Dorm to be officially LEED certified, proper documentation would have required the team hire someone with LEED experience earlier on in the process at a higher cost. Secondly, the project was able to hire an energy commissioner at a small fraction of the cost of a typical energy commissioner due to their previous connections.

Without hiring a LEED professional for documentation and without hiring an energy commissioner at the typical cost, the Catamount Dorm would have been able to meet all other LEED requirements for certification or LEED Silver with an estimated 1.5% budget increase. However, the owner estimates that would rise to approximately a 5% budget increase had they hired a LEED professional and energy commissioner at a traditional rate. Both the results and literature define a LEED professional and energy commissioner as advantageous members in obtaining LEED certification. When discussing the cost of these additional team members, the contractor questions why LEED is so expensive if it is meant to promote sustainability.

On the other hand, the Catamount Dorm team felt there would be net payback due to the energy efficiency of the dorm including lighting, heating, and the energy commissioner services. The team asserts that both the initial Catamount Dorm design and general LEED buildings would decrease the lifecycle cost during their operation as a result of increased energy efficiency.

> So [those are] the big ones: the lighting and the heating of the building especially when you're running at 9500 ft in a cold climate. Those are not insignificant costs. So I imagine that the thousand dollars we pay for commissioning, if [the energy commissioner] finds a few things to change, could easily pay back in a very short period of time. [Owner]

Understanding the confluence of LEED and green building

Not only does this study aim to compare how LEED versus green building address sustainable development, but it also asks how or when LEED and green building should intersect for maximum sustainability.

> I think the experience has taught me that looking at the checklist a little bit earlier, a lot earlier…I think [the architect] has a point that if you're driven just by LEED in the beginning in the very beginning of the design process that might not be good. But I think there's a place fairly early on, maybe when you have your concept down and you're starting to design rooms but before the final plans are in there, at that point and coming in and looking at the LEED things and making sure they're in the specs, and having your commissioner come in at that point. So I don't know that LEED needs to come in at the very beginning of the conceptual design phase. But I tend to resonate a little with [the architect's] argument, that it can be constraining perhaps when you're looking for points. But I definitely know that I would have taken it earlier in the process than we did. Probably six months earlier than we did in terms of starting that conversation. [Owner]

In fact, the owner asserts that not having the energy commissioner as early was "something, the one thing, I think we really lost out on a little bit" (Owner Interview 2013).

From a design perspective the architect acknowledges, "possibly, there might have been some minor differences, but, for the most part, I think the larger concepts would have been the same [regardless of whether or not LEED was considered in the design process]" (Architect Interview 2013). He then explained, "a lot of [our original design elements] did register with LEED and that was nice ... it was somehow… relevant and showed up in the scoring." In fact, the owner…

> …kind of had and inkling based on the design we did, who we hired to design, the energy efficiency pieces of the building, the prior work on LEED, that we might be close to LEED certification –or- I was hoping that we'd be happily surprised that we're well beyond LEED certification. [Owner]

In summary, the Catamount Dorm project involved a more integrated and site-specific approach to addressing sustainability, whereas LEED was less site-specific and more categorized. There were several instances where our initial green goals intersected with LEED in a surprising and interesting way. There were other instances in which our project-specific sustainable design was advantageous but was not a part of LEED. It is for precisely these reasons that our unique project examines and contributes to the study of the confluence between general green building practices and LEED practices. In order to provide solutions for the given problem of green versus LEED building, this study would have presented several strategies to maximize the use of LEED in combination with other green building practices in a following discussion section given more time to complete theoretical construct three.

CONCLUSION

The Catamount Dorm study established three major theoretical constructs indicating the significance of future study in each of the following areas. First, this study finds that LEED can serve as an effective educational tool for students, building designers, and LEED accredited professionals. The results reveal that undergraduate students, building design teams, and LEED professionals may be able to use LEED as an educational tool as a group via service learning projects. The Catamount Dorm study suggests using the Bates College's consultant model of service learning (Bohlen *et al*. 1999) as a framework to introduce LEED to students and building design teams with the further guidance of LEED professionals. Although there is a great lack of information regarding LEED within undergraduate education, future study may want to focus on the Bates College consultant model of service learning; LEED within undergraduate education; or LEED as applied to undergraduate service learning and linking students, building design teams, and LEED professionals.

Secondly, the Catamount Dorm study found that LEED impacts building design team dynamics, influencing individual roles, advocacy, and group conversations. Of the proposed project management strategies for green building and LEED within the existing literature, Robinchaud and Anantatmula's (2011) approach appears to most thoroughly address and explain solutions to the results of the Catamount Dorm project's. This literature emphasizes the necessity of early team conversations, found to be essential and beneficial to the Catamount Dorm team, through an initial charrette for all project members and major stakeholders. Robinchaud and Anantatmula's (2011) approach addresses the Catamount Dorm's concern that teams may blindly follow LEED without establishing and comparing it to their 'larger ambitions.'

Although little literature exists on the role and importance of the architect in LEED projects, the general literature has insisted the need for greater and earlier contractor involvement. The Contractor will not only be able to play a valuable role of implementing LEED credits, but will be able to assist in decreasing the initial costs of the green building. Lastly, Robinchaud and Anantatmula (2011) have supported the Catamount Dorm project's observations that owners have more responsibility in choosing a team that can effectively carry out more complex green building project goals. Owners are advised (Robinchaud & Anantatmula 2011) to hire a project manager with LEED experience or to differentiate between those with LEED and green building experience or no experience when they look for the architect or contractor position. Each member is required to be included within each phase of the project for maximum efficiency and results, a holistic approach that is not based solely on the resulting product or technology but that is process and practice based.

It is apparent that LEED requires greater attention to project management strategies in order to be most successful but allots fewer points for it than other similar rating systems such as Green Globes (Wu and Low 2010). Whether or not LEED will incorporate greater project management within its point system is uncertain, but the Catamount Dorm study suggests that Robinchaud and Anantatmula (2011) have proposed the most comprehensive alternative framework available for LEED projects to follow. Of the current major and traditional project management (delivery) strategies, CMR was found to be the most successful at meeting or exceeding LEED goals and exceeds owner expectations half the time (Molenarr *et al*. 2009).

The Catamount Dorm study found that LEED produced a change in team dynamics and the roles members played in achieving sustainability goals. These changes and the solutions to best utilize each member's shift in role are recognized within Robinchaud and Anantatmula's (2011) new project management strategy. However, the CMR traditional project management strategy appears to work well. Future studies should compare the use of Robinchaud and Anantatmula's versus CMR strategies on similar case studies in order to determine in what ways each promotes the best team dynamics and achieves LEED and other sustainability goals.

Third and last, green building is vast and multifaceted while LEED is limited. LEED's standardization by default 1) can only focus on a few green building strategies although trying to reach the same sustainable objective; 2) LEED values many product-based solutions rather and fails to adequately address project and site specific design solutions. Moreover, this imbalance (as LEED grows in popularity and the total square footage of LEED buildings increases) will create a built environment based on technology and will undervalue adaptive reuse and vernacular architecture (Boshmann & Gabriel 2013). When determining LEED's reliance on the most technologically advanced products to achieve sustainability goals as well as the lack of flexibility in design through standardization, the architect indirectly asserts that LEED is dominated by light green practices. Our results provide evidence that a balance between establishing initial sustainable building ambitions and using LEED would maximize the overall sustainability of a building and better influence our built environment.

One major benefit of creating green buildings without following a rating system (e.g. LEED) is the flexibility within the design process and the ability to pursue strategies that are particularly advantageous for the specific project. It allows architects to develop unique design solutions. On the other hand, green building is so undefined and vast that it may be difficult to know where to start or what questions to ask.

The Catamount Dorm team found LEED an incredibly valuable resource in opening conversations that could have been asked during the design stage or early on in the process. In addition, LEED was an excellent source in assisting the construction process and guiding the contractor to look for products that are most efficient or best for an occupant's health and comfort. However, LEED may value product selection and inflexible standardization too heavily.

As LEED and other standardized green building rating systems undergo revisions, it is essential to be aware of the discrepancy between LEED and the larger green building practices. Future studies on these discrepancies may further inform USGBC and others and allow them to reflexively maintain a balanced rating system. One means of combining green and LEED building practices involves a full team discussion during the feasibility phase to identify the project's 'larger ambitions' and then identify what LEED goals enhance, deter, or coincide with the team's ambitions.

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Tables and Figures

Logic	Image of Space	Source of Environmental Knowledge	Building Image	Technologies	Idealized Concept of Place
Eco-technic	global context macrophysical	technorational scientific	commercial modern future oriented	integrated energy efficient high-tech intelligent	Integration of global environmental concerns into conventional building design strategies. Urban vision of the compact and dense city.
Eco-centric	fragile macrobiotic	systemic ecology metaphysical holism	polluter parasitic consumer	autonomous renewable recycled intermediate	Harmony with nature through decentralized, autonomous buildings with limited ecological footprints. Ensuring the stability, integrity, and "flourishing" of local and global biodiversity.
Eco-aesthetic	alienating anthropocentric	sensual postmodern science	iconic architectural New Age	pragmatic new nonlinear organic	Universally reconstructed in the light of new ecological knowledge and transforming our consciousness of nature.
Eco-cultural	cultural context regional	phenomenology cultural ecology	authentic harmonious typological	local low-tech commonplace vernacular	Learning to "dwell" through buildings adapted to local and bioregional physical and cultural characteristics.
Eco-medical	polluted hazardous	medical clinical ecology	healthy living caring	passive nontoxic natural tactile	A natural and tactile environment which ensures the health, well-being, and quality of life for individuals.
Eco-social	social context hierarchical	sociology social ecology	democratic home individual	flexible participatory appropriate locally managed	Reconciliation of individual and community in socially cohesive manner through decentralized "organic," nonhierarchical, and participatory communities.

Table 1: The Six Competing Logics of Sustainable Architecture (Guy and Farmer 2001, 141)

LEED for New Construction and Major Renovations (v2009)

SUSTAINABLE SITES		POSSIBLE: 26
SSp1	Construction activity pollution prevention	REQUIRED
SSc1	Site selection	1
SSc2	Development density and community connectivity	5
SSc3	Brownfield redevelopment	1
SSc4.1	Alternative transportation - public transportation access	6
SSc4.2	Alternative transportation - bicycle storage and changing rooms	1
SSc4.3	Alternative transportation - low-emitting and fuel-efficient vehicles	3
SSc4.4	Alternative transportation - parking capacity	2
SSc5.1	Site development - protect or restore habitat	1
SSc5.2	Site development - maximize open space	1
SSc6.1	Stormwater design - quantity control	1
SSc6.2	Stormwater design - quality control	1
SSc7.1	Heat island effect - nonroof	1
SSc7.2	Heat island effect - roof	1
SSc8	Light pollution reduction	1

WATER EFFICIENCY		POSSIBLE: 10
WEp1	Water use reduction	REQUIRED
WEc1	Water efficient landscaping	4
WEc2	Innovative wastewater technologies	2
WEc3	Water use reduction	4

ENERGY & ATMOSPHERE		POSSIBLE: 35
EAp1	Fundamental commissioning of building energy systems	REQUIRED
EAp2	Minimum energy performance	REQUIRED
EAp3	Fundamental refrigerant Mgmt	REQUIRED
EAc1	Optimize energy performance	19
EAc2	On-site renewable energy	7
EAc3	Enhanced commissioning	2
EAc4	Enhanced refrigerant Mgmt	2
EAc5	Measurement and verification	3
EAc6	Green power	2

MATERIAL & RESOURCES		POSSIBLE: 14
MRp1	Storage and collection of recyclables	REQUIRED
MRc1.1	Building reuse - maintain existing walls, floors and roof	3
MRc1.2	Building reuse - maintain interior nonstructural elements	1
MRc2	Construction waste Mgmt	2
MRc3	Materials reuse	2
MRc4	Recycled content	2

MATERIAL & RESOURCES		CONTINUED
MRc5	Regional materials	2
MRc6	Rapidly renewable materials	1
MRc7	Certified wood	1

INDOOR ENVIRONMENTAL QUALITY		POSSIBLE: 15
EQp1	Minimum IAQ performance	REQUIRED
EQp2	Environmental Tobacco Smoke (ETS) control	REQUIRED
EQc1	Outdoor air delivery monitoring	1
EQc2	Increased ventilation	1
EQc3.1	Construction IAQ Mgmt plan - during construction	1
EQc3.2	Construction IAQ Mgmt plan - before occupancy	1
EQc4.1	Low-emitting materials - adhesives and sealants	1
EQc4.2	Low-emitting materials - paints and coatings	1
EQc4.3	Low-emitting materials - flooring systems	1
EQc4.4	Low-emitting materials - composite wood and agrifiber products	1
EQc5	Indoor chemical and pollutant source control	1
EQc6.1	Controllability of systems - lighting	1
EQc6.2	Controllability of systems - thermal comfort	1
EQc7.1	Thermal comfort - design	1
EQc7.2	Thermal comfort - verification	1
EQc8.1	Daylight and views - daylight	1
EQc8.2	Daylight and views - views	1

INTRODUCTION/OTHER		POSSIBLE: 6
IDc1	Innovation in design	5
IDc2	LEED Accredited Professional	1
Introduction/OtherIntroduction/Other		

REGIONAL PRIORITY		POSSIBLE: 4
RPc1	Regional priority	4

TOTAL	110

40-49 Points	50-59 Points	60-79 Points	80+ Points
CERTIFIED	SILVER	GOLD	PLATINUM

Figure 2: LEED Scorecard (USGBC)

View of Site

View from Site

Figure 3: Catamount Dorm Site

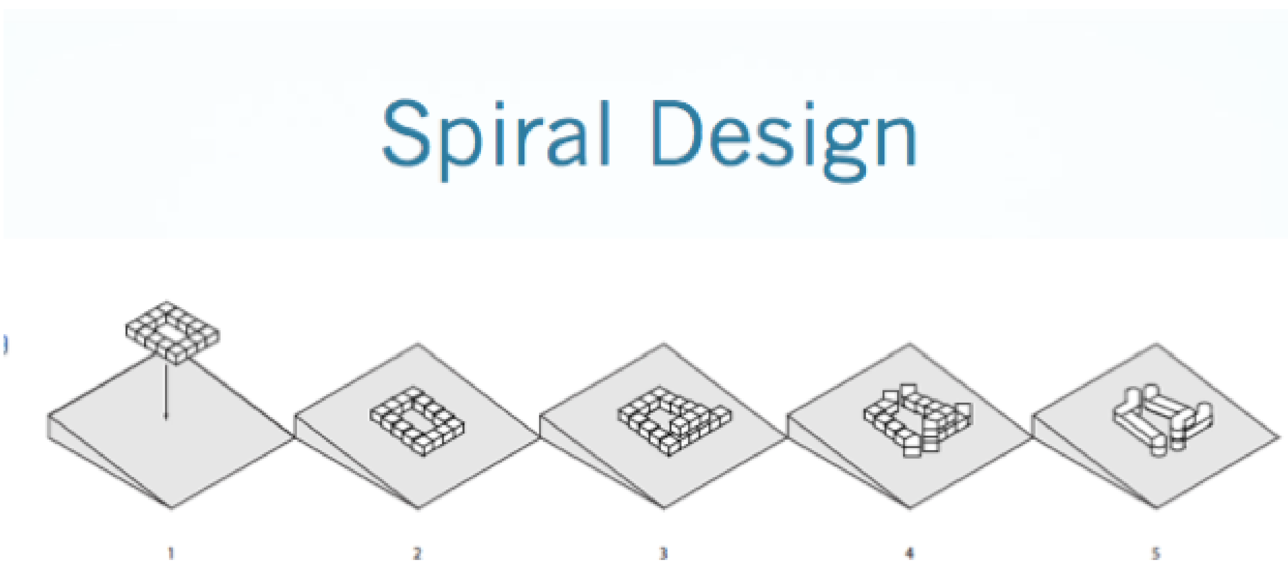
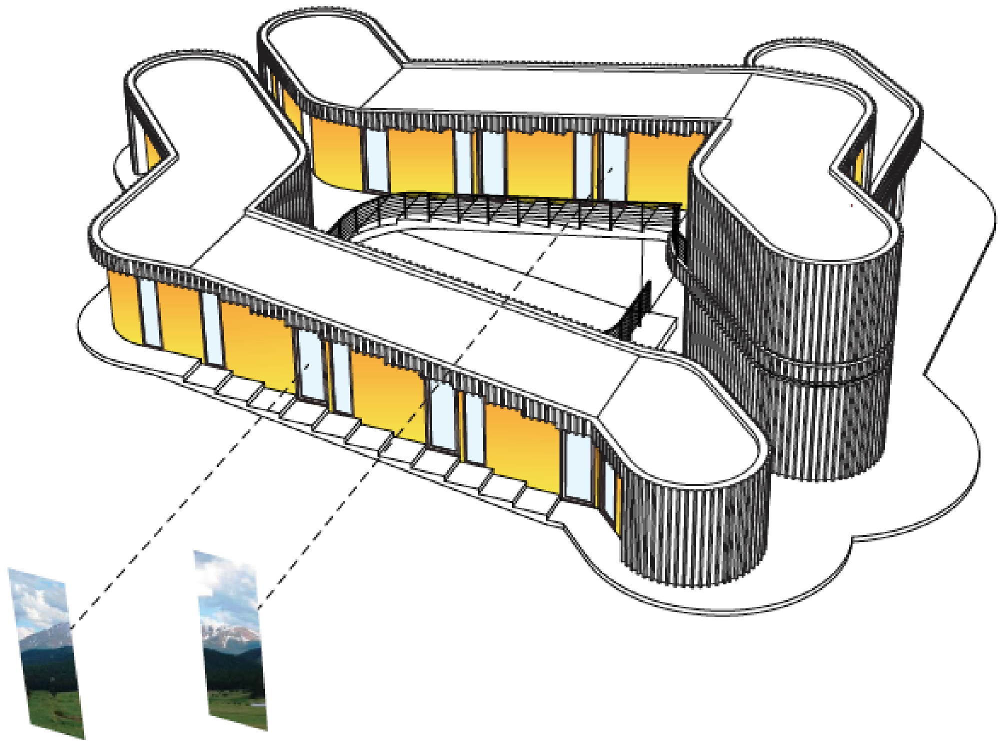


Figure 4: Catamount Dorm Spiral Design

Figure 5: Catamount Dorm

Figure 6: Catamount Dorm



Views from Units

Each dorm room has two vertical openings that frame views of Pikes Peak and the surrounding wilderness. Rooms to the south follow the natural grade of the mountainside. Rooms to the north step up to look out over the southern wing of the building.

Figure 7: Catamount Dorm Daylighting and Views

Table 4.2 Reporting Structures for Each Approach

Reporting Approaches	*Narrative*	*Phenomenology*	*Grounded Theory*	*Ethnography*	*Case Study*
General Structure of Study	• Introduction (problem, questions) • Research procedures (a narrative, significance of individual, data collection, analysis outcomes) • Report of stories • Individuals theorize about their lives • Narrative segments identified • Patterns of meaning identified (events, processes, epiphanies, themes) • Summary (Adapted from Denzin, 1989a, 1989b)	• Introduction (problem, questions) • Research procedures (a phenomenology and philosophical assumptions, data collection, analysis, outcomes) • Significant statements • Meanings of statements • Themes of meanings • Exhaustive description of phenomenon (Adapted from Moustakas, 1994)	• Introduction (problem, questions) • Research procedures (grounded theory, data collection, analysis, outcomes) • Open coding • Axial coding • Selective coding and theoretical propositions and models • Discussion of theory and contrasts with extant literature (Adapted from Strauss & Corbin, 1990)	• Introduction (problem, questions) • Research procedures (ethnography, data collection, analysis, outcomes) • Description of culture • Analysis of cultural themes • Interpretation, lessons learned, questions raised (Adapted from Wolcott, 1994b)	• Entry vignette • Introduction (problem, questions, case study, data collection, analysis, outcomes) • Description of the case/cases and its/their context • Development of issues • Detail about selected issues • Assertions • Closing vignette (Adapted from Stake, 1995)

Figure 8: The Grounded Theory Structure Among Other Qualitative Research Approaches (Creswell 2007, 80)

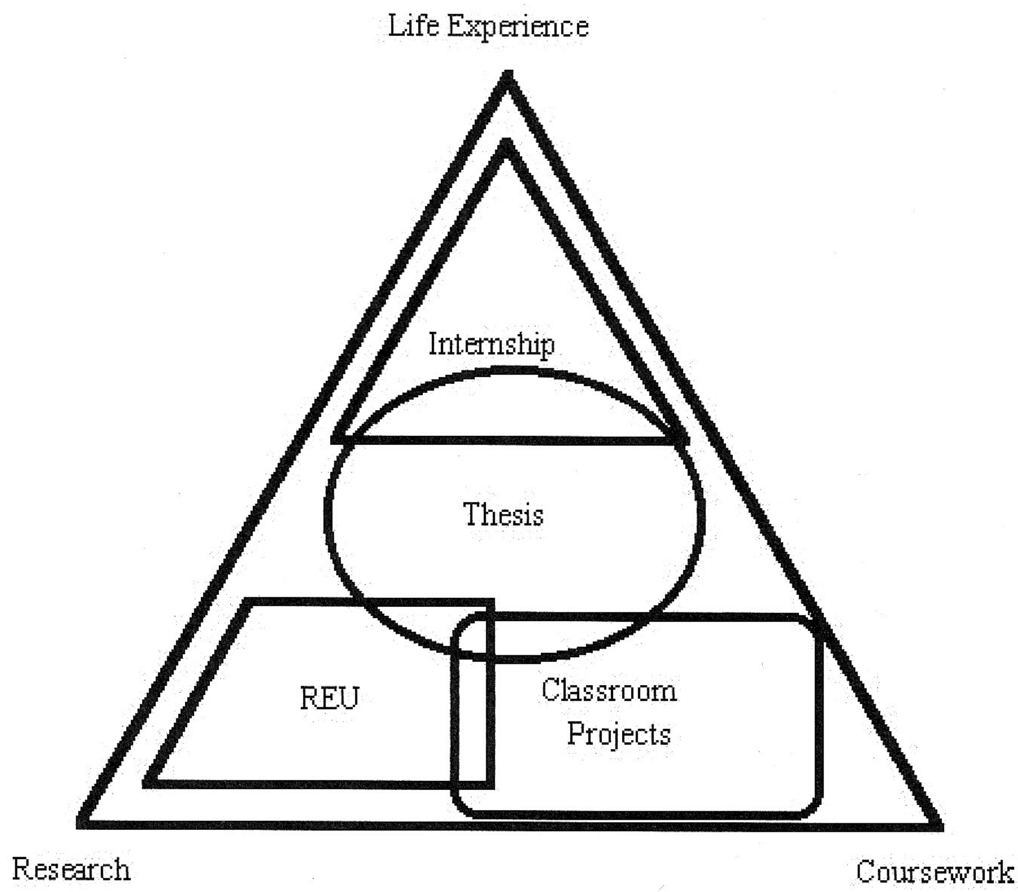


Figure 8: Tri-archetypal system (Bohlen 1999, 44)

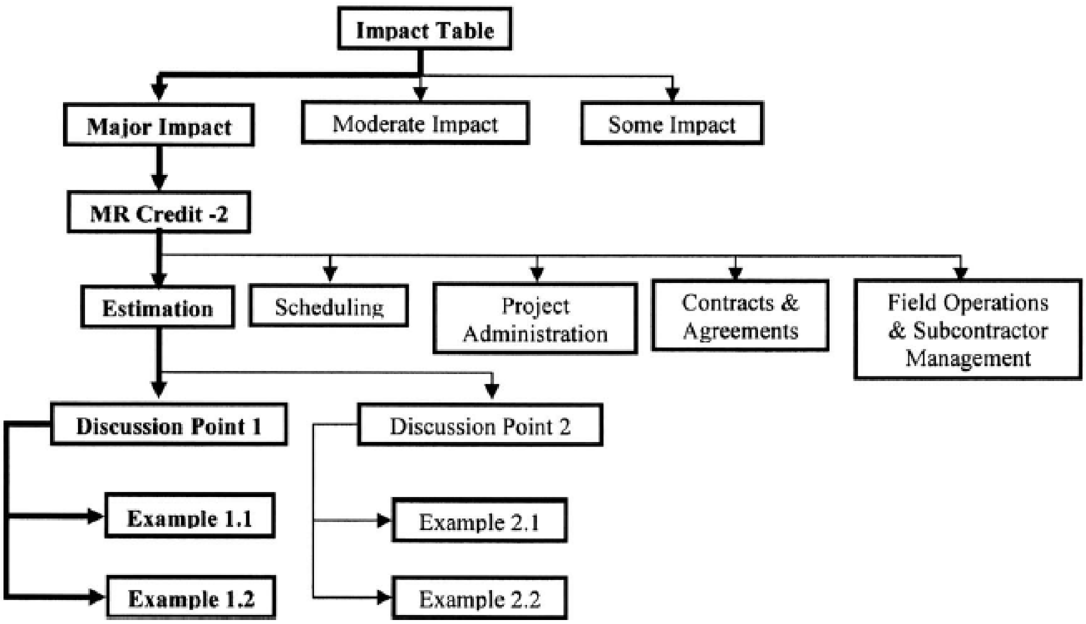


Figure 10: "Query mechanism for retrieving estimation impacts for a sample LEED-NC credit _MR-2" (Syal *et al*. 2007)

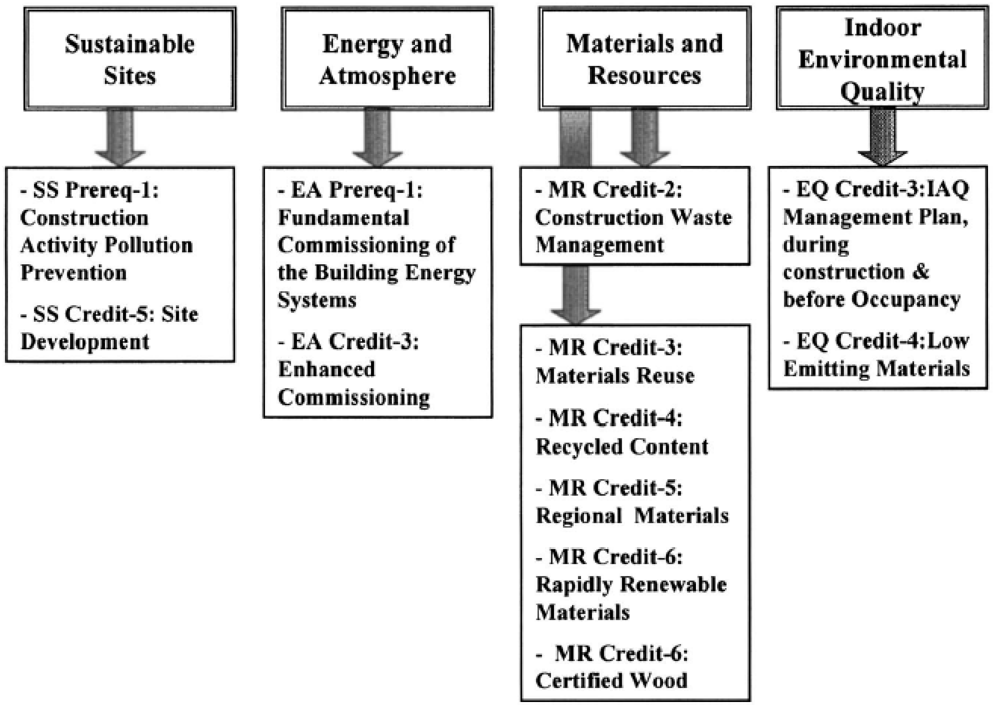


Figure 11: "Grouping of Major Impact LEED-NC Credits"(Syal *et al*. 2007)

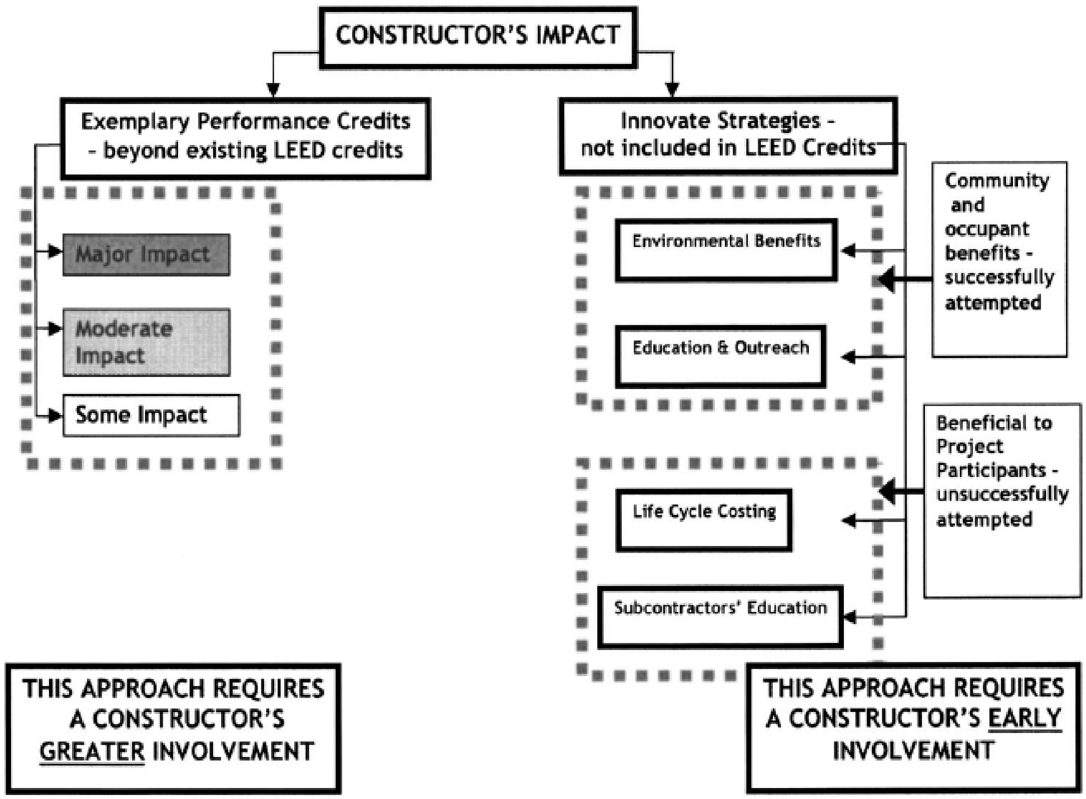


Figure 12: "Constructor's role in achieving innovation and design credits" (Syal *et al*. 2007)

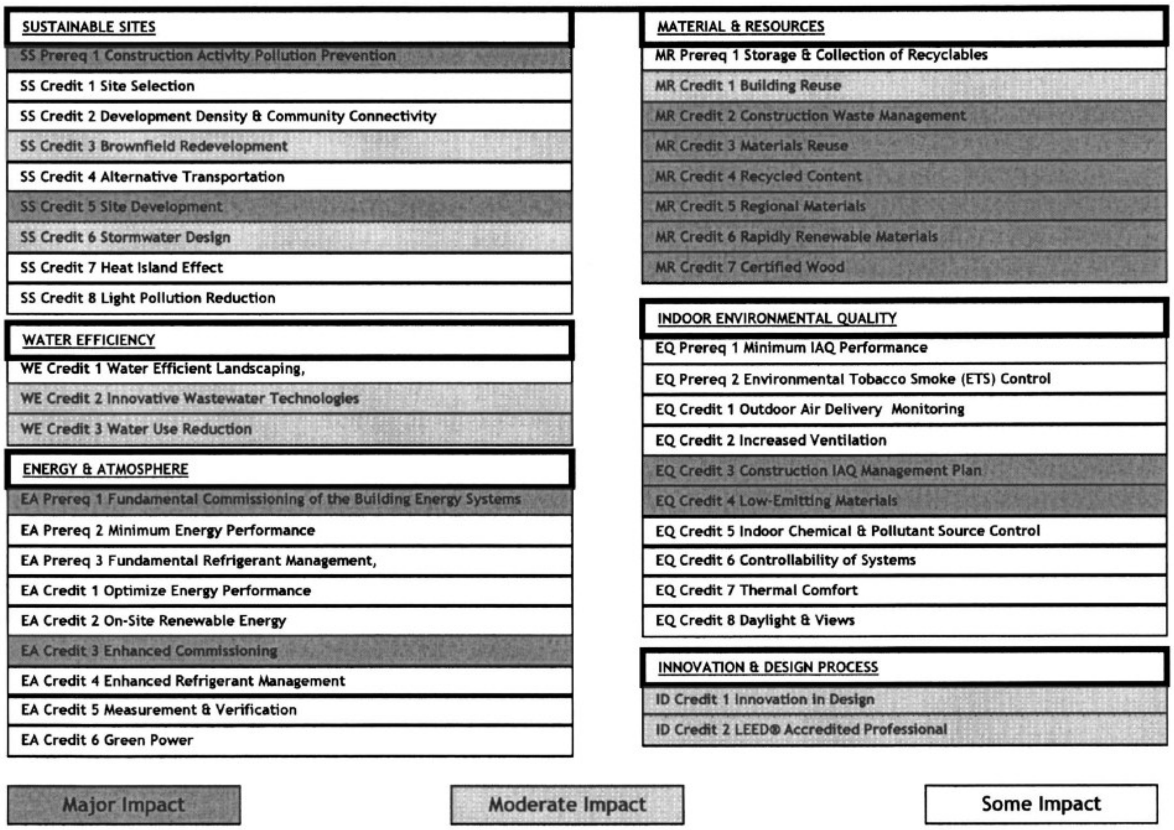


Figure 12: “Categorization of LEED credits as “major,” “moderate,” and “some” impacts” (Syal *et al*. 2007)

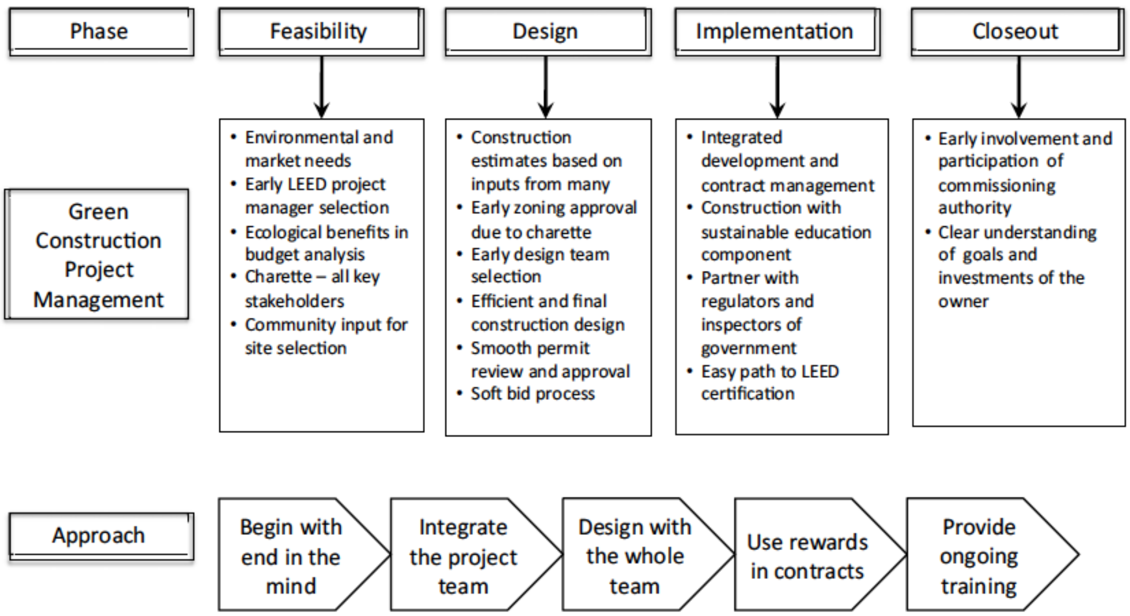


Figure 13: "Greening project management" (Robinchaud & Anantatmula 2011)

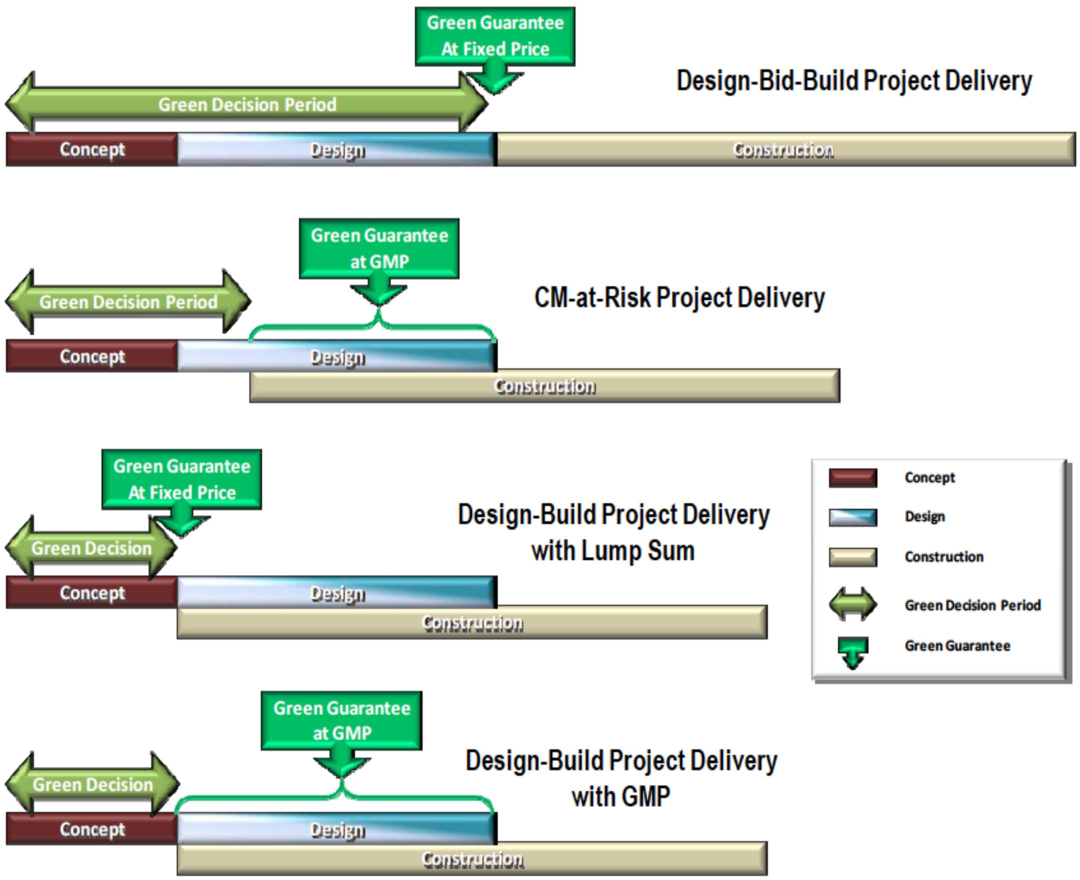


Figure 14: "Green Guarantee Model" (Molenaar *et al*. 2009)

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Appendix I: Interview Questions

1) Do you see any difference between green building and LEED?

2) What was your impression of green buildings or LEED buildings before beginning the Catamount Dorm Project?

3) Was green building considered in the design process?

4) Do you feel LEED certification for the Catamount Dorm Project is an appropriate and feasible option?

5) Had the Catamount Dorm project considered LEED earlier in the design process would you expect a different outcome?

6) In what ways do you see the LEED certification adding to the cost of the project?

7) Are there ways that LEED will feasibly reduce the net cost of the project? I.e. the overall efficiency of the building?

8) Were there LEED goals/credits that you believed were not useful for the specific green goals of this project?

9) Were there any green considerations for the Catamount Dorm beyond the scope of LEED certification?

10) Do you think LEED is the best tool available to build sustainably on the catamount project?

11) How has your impression of green design and LEED changed after the building's LEED certification potential was evaluated?

12) To what extent do you believe you will consider green architecture or LEED certification in the future? To what extent do you believe you will act to pursue LEED in the future?

13) Were you surprised by anything while following the LEED process?

14) What was the most challenging part of the project for you?

15) What is the most challenging part of the green construction field?

16) In what ways did working with me affect your process and view on green design?

17) How do you see your role in helping achieve LEED standards in the Catamount Project? (As an architect, contractor, owner).

18) How could I have been more effective?

Appendix II: Codes

1. Similarity between LEED and green buildings
2. Differences between LEED and green buildings
3. Perceptions of LEED/green buildings vs. non-LEED/green buildings
4. Favorable pre-conceptions of LEED
5. Favorable post-conceptions of LEED
6. Reason for supporting green building
7. Experiences teaching the LEED process
8. LEED as a teaching tool
9. Importance of what stage LEED is considered in a project
10. Importance of what stage green design is considered in a project
11. Major personal motivations for pursuing LEED
12. Major personal green goals: energy efficiency
13. Major personal green goals: design fitting into landscape
14. Major personal green goals: views and lack of corridors
15. Green design vs LEED design in the design, not construction, process
16. Surprises in the LEED process
17. Past LEED experience
18. Knowledge of other LEED projects
19. Perceived occupant benefits of LEED
20. Perceived economic benefits of LEED

21. Role of the designers: architect
22. Role of designers: LEED researcher and informant
23. Role of designers: energy commissioner
24. Design roles: owner
25. Design roles: contractor
26. Design roles: additional team members and dynamics
27. LEED informant effectiveness
28. LEED accredited professional vs basic LEED advisor
29. What it means to be sustainable
30. Feasibility of LEED certification for the Catamount Dorm project
31. Perceived outcome [similarities] of project if LEED was considered earlier
32. Perceived outcome [differences] of project if LEED was considered earlier
33. Initial green elements' positive effect on budget and net cost
34. LEED certification's positive effect on budget and net cost
35. LEED certification's negative effect on budget and net cost
36. LEED credits that were not useful for achieving our project's green goals
37. If LEED could be tailored to more site specific points then…
38. Contestable concepts of LEED
39. Changes in perceptions of LEED over the course of the project
40. LEED vs. other rating systems
41. LEED as a tool for sustainable building
42. LEED as a tool for the Catamount Dorm
43. Catamount Dorm Project challenges

44. Personal use of LEED in future green buildings

45. Contractor vs subcontractor involvement

46. Surprises in the LEED process found while working on the Catamount Dorm