

DESIGN AND CONSTRUCTION PROCESS OF TWO LEED CERTIFIED UNIVERSITY BUILDINGS:
A COLLECTIVE CASE STUDY

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Doctor of Philosophy

by
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DESIGN AND CONSTRUCTION PROCESS OF TWO LEED CERTIFIED UNIVERSITY BUILDINGS: A COLLECTIVE CASE STUDY

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Design and Construction Process of Two LEED Certified University Buildings:
A Collective Case Study

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ABSTRACT

This study was conducted at the early stages of integrating LEED into the design process in which a clearer understanding of what sustainable and ecological design was about became evident through the duration of designing and building of two academic buildings on a university campus. In this case study, due to utilizing a grounded theory methodology a clearer understanding of how LEED influenced the current practices, programming, the design process, the decision-making process, time, cost, and quality are defined. Additionally, how the unique issues that occurred due to the implementation of LEED were acknowledged and addressed in the programming phase. LEED as a program is beneficial on both a professional and global level. It is clear that if the owners, designers, and contractors utilize the LEED criteria to design the built environment, then standards will keep evolving, thereby providing improved design solutions with enhanced overall quality due to conscious design. Acknowledging the unique issues that are revealed through this case study helped to understand the unique problems that an academic setting could encounter.

Chapter 1

Introduction

Sustainability is moving into the forefront of both architecture and interior design. With the implementation of LEED (Leadership in Energy and Environmental Design) and sustainable principles developed through environmental awareness, sustainability through LEED is affecting programming and the design process. Presently, the traditional design process is not adequate for designing LEED certified buildings because between the programming and schematic design phase there is a scarcity of information necessary to develop an efficient design solution. With the implementation of LEED, the design process requires the client and the designers to be committed earlier to facilitate a collaborative atmosphere. By including all the architectural design disciplines in the beginning, more information and research may be compiled to understand the owner's goals, and to develop a design solution that illustrates those goals. However, it has become increasingly apparent that the design process is shifting from linear to a spiral process in which "conceptual shifts and product development in design occur as the result of repeated, interactive movement through three elementary design activities such as imaging, presenting and testing" (Zeisel, 2006, p. 12). Many design firms conduct preliminary programming exercises, followed by a decision to develop two or three initial concepts through 3D visualization. Once the owner decides on a concept, the architects reverse engineer, or work backwards, to design the building; if LEED certification requirements are an additional component of the project after the initial programming, it causes the design process to gridlock and inflates the project cost. To understand LEED, and researching the programming and the design process, a more thorough investigation is necessary for each of the processes being implemented in order to design sustainable buildings.

In order to understand what LEED is, it is necessary to explain how sustainable design principles are connected to the LEED criteria. The definition of sustainable design by the U.S. General Services Administration states, “Sustainable design seeks to reduce negative impacts on the environment, and the health and comfort of the building occupants, thereby improving building performance. The basic objective of sustainability is to reduce consumption of non-renewable resources, minimize waste, and create healthy, productive environments” (GSA, 2011, ¶ 1). Sustainable principles include optimizing site potential which correlates with the Sustainable Sites criteria of LEED; minimizing non-renewable energy consumption that parallels the Energy and Atmosphere criteria; using environmentally preferable products that correlates with the Materials and Resources criteria; protecting and conserving water that correlates with the Water Efficiency criteria; enhancing indoor environmental quality correlates with the Indoor Air Quality criteria; and last, optimizing operational and maintenance practice that correlates with the combination of Energy and Atmosphere and Indoor Air Quality. (U.S. General Services Administration, 2011 & USGBC, 2009). Because LEED requirements mirror principles of sustainability, this study focuses on the integration of LEED requirements into the design process from the outset of two projects.

Presently, LEED is in its third version, and there are extra explicit “points” for Silver, Gold, and Platinum standards. LEED 3.0 has raised the requirements to achieve each rating. There are four levels of LEED certification: Certified, Silver, Gold, and Platinum. There are minimum requirements that every level of LEED certification must incorporate. LEED Certified is the minimum level of certification, in which a majority of U.S. cities has implemented into their building ordinances and codes. LEED Platinum certification is the most prestigious, but requires the most stringent of design criteria and has the greatest cost. LEED certification typically adds 1% to 5% to the total project cost of a building depending on the level of certification

(Schendler, 2005, p. 5). Currently, the LEED program is considered expensive to implement; therefore, some architects and contractors are designing and building to LEED standards, but are not registering the projects for LEED certification. Another issue or concern is that some designers and builders use LEED as a checklist for their design solution but do not fully comprehend the theory and principles behind LEED. Once the project is complete and occupied, it is the owner's responsibility to maintain the LEED status or risk forfeiting certification. Due to the cost to achieve LEED certification, it is necessary for the owner to properly maintain and document any modifications, energy usage, or repairs as per the requirements. Perhaps the initial cost premium for a LEED building will diminish as more cities adopt LEED standards and construct high performance buildings. The integration of LEED into the design process, and the impact of LEED on the final design outcome of two university buildings are the phenomena discussed in this case study performed on the Southern Methodist University (SMU) campus. Using LEED standards for university buildings presents a unique set of challenges.

The design process traditionally consists of four phases: programming/conceptual design, schematic design, design development, and construction documents. The programming/conceptual design phase engages the designers, the owner, and the end users for the project. The programming is designed to ask specific questions to determine special requirements, i.e., storage requirements, furniture, etc., in order to understand the program necessities that will reflect the owner's goals. Both programming and LEED requirements are essential before the schematic design phase commences. In the schematic design phase, initial concepts evolve reflecting the programming requirements of the owner. Once the schematic design reflects the owner's requirements, then the design solution transitions into the design development phase. The design solution is then documented and clarified in the construction

document phase. A determination of for what level of LEED certification the project will be designed must happen at the beginning of the programmatic phase of the design process.

By reconsidering the traditional design process as a whole, and researching LEED and its principles, the design process can improve in order to meet the demands of sustainable design. Additional research in programming, and how decisions affect the outcomes for the building is considered a necessary part of the design process. It appears that the present design processes are not adequate, and must be restructured in order to satisfy the goals of the owner and sustainability principles from the beginning.

Problem

Through observations within the interior design profession, it is clear to this researcher that there are flaws within the traditional design process at the time of this investigation, the amount of satisfied owners experiencing the process of designing and building multistory buildings, let alone a LEED certified building, were decreasing. Therefore, through the exploration of this case study of two LEED certified buildings at SMU, the researcher observed current practices in real time to uncover evidence to solve the problems within the traditional design process. Therefore, the concept of having a clearer understanding of the LEED criteria and the integration of these guidelines into the existing design practices, the designer's problem solving abilities should increase to deliver a more satisfactory product. With greater owner participation, like SMU, in LEED projects, more efficient, functional, and sustainable buildings can be designed and built. Overall, the design/build experience should become more efficient, thereby reducing the design time and construction costs with a final product of better quality and efficiency. The "owner" in academic projects may be a small group including the president, the donors, and deans.

The LEED program requires prerequisites and specific design criteria for the site plan, water and energy efficiencies, material and resources, and indoor air quality for the design and construction of a building. This provides a challenge to all the project team members.

There are inconsistencies within the application of the design process for LEED certified buildings excluding the concept of initially assembling the design team. By exploring the design process implemented by a particular set of professionals at SMU, more information has been obtained and may be collectively distributed within the design industry, which will improve the process, making design more optimal and affordable.

Understanding of the process for designing LEED certified buildings on college campuses and incorporating sustainable practices is part of the evolutionary process of design.

Understanding in general, that the concept of environmental design encompasses all environments, and not just the built environment, is crucial to protecting our natural resources. Utilizing LEED as a tool to accomplish the undertaking of building high performance, sustainable efficient buildings, and incorporating these practices into the current design standards is a “green” necessity. This case study illustrates enhanced economic and environmental design solutions for academic buildings.

Case Study: Southern Methodist University

As a preface to this case study, it is important to discuss the J. Lindsay Embrey Engineering Building that houses the environmental, civil and mechanical engineering programs because it was the first LEED Gold building on SMU’s (Southern Methodist



Image 1.1 Embrey Hall

University) Dallas, Texas campus. The design and construction of this

building set the precedent for Caruth and Simmons (the sites of this investigation) as well as for all new LEED construction projects on campus. Embrey has become a great example of sustainable design that has made an impact on the teaching and learning environments for the occupants (See Image 1.1). Embrey is an example that inspires students, professors, and departments to work more collaboratively than in their previous building. For example, the use of glass for partitions gives the Collegiate Georgian architectural building a more open space plan encouraging interaction. Actually, *Texas Construction Magazine*, an industry leading commercial construction publication, awarded the Lyle School of Engineering's Embrey Engineering Building, a *2006 Excellence Award in Higher Education*. Additionally, the professors and an alumnus promoted a study in alternative energy by collaborating with Green Power Partnership, developed with Green Mountain Energy, to help reduce traditional power usage (Zisk, 2007, p. 4). Despite not being able to obtain a LEED point in daylighting because of the Georgian Architecture style windows, the use of the light column centrally

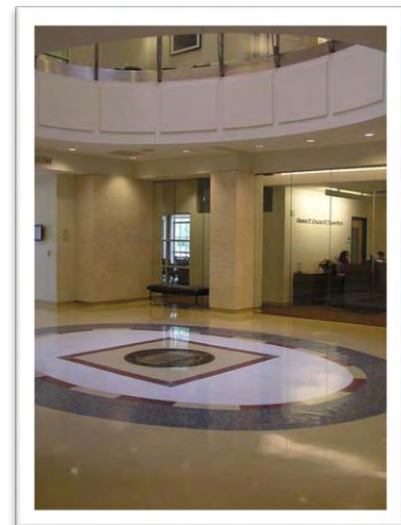


Image 1.2 Embrey Hall Lobby

located in the building provides plenty of natural light to filter throughout the building to facilitate an educational environment (See Image 1.2). For SMU, focusing on sustainable design and instituting LEED principles into their design standards parallels its teaching and design philosophy. Therefore, when the opportunity presented itself to research the integration of the LEED criteria into the design process through two new LEED buildings, this case study began.

For this study, the first case is an engineering building, Caruth Hall, and the second case is an education building, Simmons Hall. The engineering building was complete and operational May 2010. The educational building was complete and operational August 2010. Attending

Owner, Architect and Contractor (OAC) meetings and the LEED meetings for both Caruth and Simmons Halls gave this researcher access to the documentation necessary for this case study. Through observing the collaborative efforts of the design team involved; conducting interviews with each of the participants on the design teams; and conducting document reviews of drawings, program statements, photographs, meeting minutes, etc., the researcher compiled an abundant amount of information that was coded and analyzed to understand and evaluate the current practices for these two LEED buildings. Obtaining information, documenting experiences, and observing processes already instituted by the professionals involved on these two specific SMU projects, provides an understanding of how a LEED project can be approached more efficiently in the future clearer.

History of Southern Methodist University

Southern Methodist University (SMU) campus, founded in 1911, has an interesting history for a liberal educational institution. The founder, and first president, Dr. Robert S. Hyer, had a grand vision of how SMU would appear and provide an education. The university consists of colleges in the fine and performing arts, liberal arts, business, science, education, theology, and engineering. The philosophy and motto of SMU is “The truth will make you free” (Terry, 1993, p. 3). Dr. Hyer selected the colors of Harvard red and Yale blue as the official school colors, as well as Collegiate

Georgian Style of architecture similar to his alma mater, Emory University, in Atlanta, Georgia. Dr. Hyer believed there was no reason any

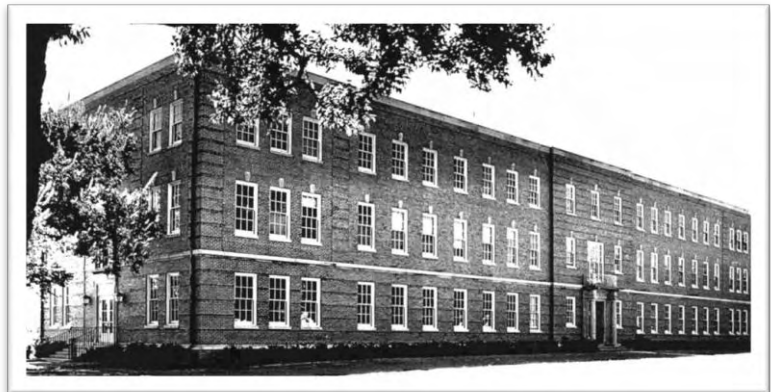


Image 1.3 Old Caruth Hall

building on campus could not endure 100 years. His master plan of the campus included an extensive boulevard that leads to the first building built on campus, Dallas Hall, and the boulevard was eventually lined with Live Oaks. As time progressed, additional buildings lined the boulevard. Nearly a century later, SMU is still expanding the various colleges and campus footprint. Over the last century, several buildings have been raised and rebuilt. The old Caruth Hall, Image 1.3, was raised to clear the site for the new Caruth Hall.

Caruth Hall

This building is the flagship building for the Bobby B. Lyle School of Engineering. The original Caruth Hall, built in 1938, consisted of 36,845 square feet of office, laboratories, and classrooms that housed the Engineering School (Maddox, 1995, p. 86). As the School of Engineering expanded, facilities were dispersed to a variety of other buildings across campus. In 2000, it was decided that the School of Engineering needed additional buildings to handle the expansion of space requirements. The Jerry J. Junkins building, dedicated to the Electrical Engineering Department and the J. Lindsay Embrey Engineering building, home to the Environmental, Mechanical, and Civil Engineering departments, were constructed to fit these expanding needs. Both buildings are three stories with approximately 50,000 gross square feet of classrooms, laboratories, and offices. From the present master plan, the new Caruth Hall



Image 1.4 Caruth Hall Front Entrance

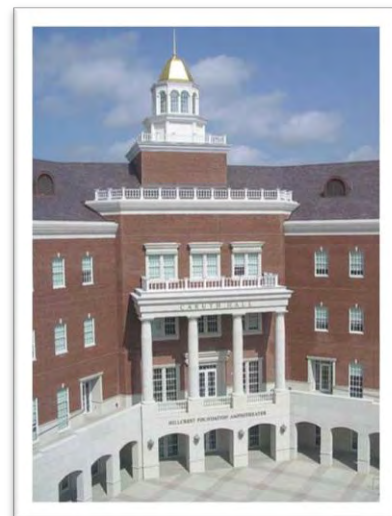


Image 1.5 Caruth Hall Back Entrance

(Images 1.4 and 1.5) is now a 65,000 square feet, four-story building, including a full basement that houses the Engineering Education departments which include science, math, and technology. The building includes the Lockheed Martin Skunk Works Laboratory, the first ever for any college campus, as well as the Hunt Innovation Laboratory, designed to encourage innovative global problem solving for today and the future. The Embrey and Caruth Hall buildings have both been awarded LEED Gold Certification.

Simmons Hall

For decades, the School of Education has been housed in various buildings all across campus. Now, thanks to gracious donors, a majority of those departments are in one building. This building is dedicated to the graduate degree programs that promote research and the practice of education and human

development. This three story 41,000 gross square feet building houses the expanding human development programs and includes a Locomotor Performance Laboratory for the department of Applied Physiology and



Image 1.6 Simmons Hall

Wellness Laboratory that allows the students a practical experience in applied physiology and wellness. The building contains offices, classrooms, seminar rooms, conference rooms, and a student-advising suite. Simmons Hall, Image 1.6, was designed to meet LEED Silver, but was submitted to LEED with the intention to achieve LEED Gold certification.

Purpose of Study

There is an abundance of information on how programming and the design process work in conjunction to each other; however, to date there is not enough information available

on how to collaboratively integrate the LEED requirements into these processes specifically in academic projects. Programming is typically conducted by an architect focused on gathering information to aid in the design to satisfy the owner's needs. Architects base their programming on owner's goals, scope, site requirements, the budget, and time constraints. If an owner requests the project to achieve LEED certification, this process must be initiated in the programming interviews. The architect must decide on how to implement these requirements. Questions that emerged at this time are; do they have to be both an architect and a LEED certified professional, or does the LEED professional become the programmer? Because everyone's role on a project is becoming more complex, how can all aspects of the design process be brought together to complete a project successfully? In order to address these additional questions, this case study of one LEED Gold certified building (Caruth) and one pending LEED certification (Simmons) on the SMU campus, focuses on how programming, the design process, and LEED can function together efficiently to construct multifaceted learning environments.

SMU has been developing a process in designing these educational buildings to LEED standards. It is required that all new construction buildings meet more stringent standards than those of typical commercial buildings, which usually have a lifespan of 40 to 50 years. Because SMU is a college campus, its buildings are designed and intended to last a minimum of 100 years. Therefore, the higher standards that SMU expects must be integrated with the LEED requirements. All new construction buildings on the SMU campus are being designed and built to LEED Silver, as a minimum. For this study to be useful, future practitioners, could learn and understand how designers, architects, and engineers can approach and/or use their problem-solving skills when implementing the LEED requirements into their design solutions for colleges and universities.

For example, in the Caruth building, thousands of feet of cable and wire were installed to meet the technological requirements for distant learning education program and for the required interconnectivity of the School of Engineering. Wireless connections for the Simmons building were installed so the students in the surrounding external areas can login to the inter/intra net. Lately students are not confined to a classroom environment. “Learning happens everywhere” has become the motto of the SMU community. Being able to conduct class or work remotely is becoming more the norm for such a mobile group of learners. The designer’s interviews for both buildings revealed pertinent information for designing an educational learning environment. As part of programming for both Caruth and Simmons, the user group committee defined and specified what technologies they needed for the classrooms and lecture rooms. A question emerges: Are these rooms, based upon the decisions made and the specified requirements from the user group, actually functioning as they were intended?

The results of this case study may contribute new ideas and suggest methods that may simplify the programming and design processes. Since there is a minimal amount of information on how to implement the LEED requirements except to have several LEED specialists involved early during the programming stage, it will be crucial for the programmer and the LEED professionals to work directly. The findings of this study reveal how significant a thorough knowledge of LEED criteria benefits the success of a project, and how the results can assist to enhance industry design standards.

Research Goals: Site and Methodology

A major goal of this qualitative research project was to select two buildings at different stages of the LEED process with two versions of the LEED criteria occurring simultaneously. To clarify, Caruth used the second version, or LEED 2.2 standards, while Simmons used the 3.0 version of LEED. The interest here was to learn about the different stages in the design process

and to observe and understand how the LEED program is improving its standards. Since the case study occurred in real time, it produced a variety of data through direct observation, open and semi-structured interviews, and document analyses of LEED records, drawings, field notes, etc. Exploration of interviews and understanding how the design teams used the implementation of the LEED standards into these projects has led to the findings and analysis.

Theoretical Context

In developing the contents of this case study the researcher created a conceptual theory map. Based upon the Concept Theory Map, Image 1.7, the main categories are Sustainable and Ecological Design, LEED, LEED Applied, Design process, Programming, Decision Making, Learning Environments, and Quality are represented and discussed within this study. Several factors

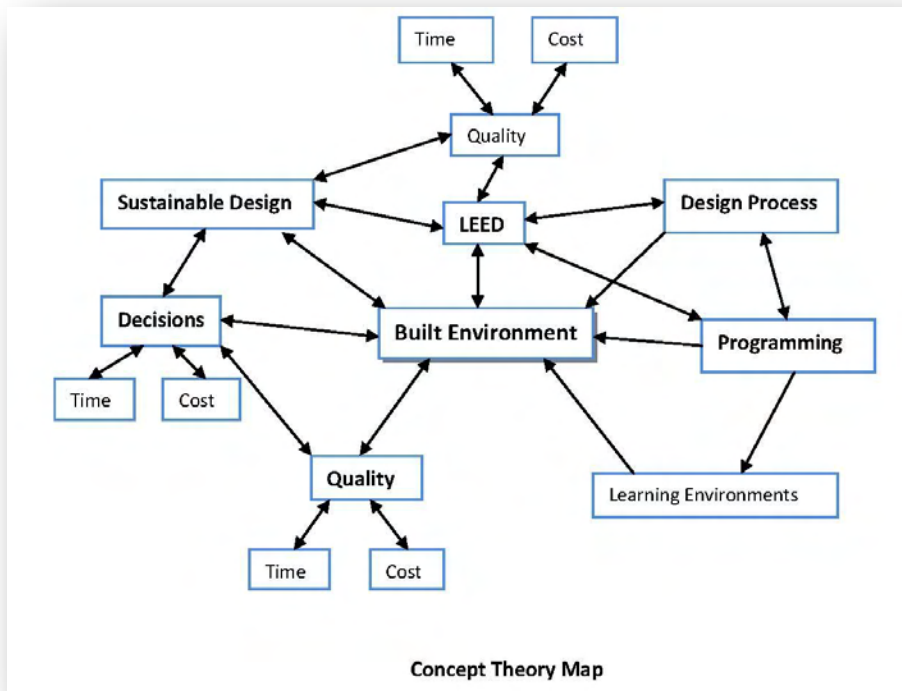


Image 1.7 Concept Theory Map

came into focus that helped to generate the research questions due to reflection on considering the following concepts applicable to all LEED projects:

- For the built environment, using the LEED criteria involves sustainable design that entails the variables of time and cost, which in turn, affects decisions and quality and vice-versa.
- Incorporating LEED and sustainable design into the programming and design process increases the quality of the building.
- For better programming through a clearer understanding of LEED and sustainable design, better learning environments are produced.
- Using the LEED criteria enhances the quality with minimal impact on time and cost due to LEED becoming a standard of design.

Through exploring the interrelationships of these concepts provided a deeper analysis of what has been accomplished, and what is presently occurring, is provided.

Research Questions

Having experienced various design projects, the researcher observed that a combination of collaboration and negotiation is required to allow projects to be completed on time and within budget. However, negotiation sometimes means that the design has to be re-evaluated, and can result in substitutions of materials, which in turn, can affect cost, time, and quality of the project. Substitutions must be analyzed and compared to the specifications, and sometimes full-scale models are generated to ensure quality and to maintain the design aesthetic. Even in the programming and the design process stages, unforeseen design problems, which must be modified to comply with the LEED requirements, can become apparent to the contractor. All the challenging components of each project considered here are designed to explore ways to facilitate better programming and design processes. The research questions for this investigation are:

- What are the current practices and considerations for two LEED certified buildings at SMU?
- How did seeking LEED certification change the interaction of programming, the design process, and the decision-making process?
- How did these decisions affect time, cost, and the quality of the built environment in an academic setting?

- What issues regarding LEED standards may be unique to university buildings?

Rationale for a Case Study

The focus of this investigation is explanatory because of the “how” and “why” questions about LEED and the other categories, which create a strong case study, “...because such questions deal with operational links needing to be traced over time, rather than mere frequencies or incidences” (Yin, 1994, p. 6). In addition, with this type of case study the how and why “...questions are being asked about a contemporary set of events over which the investigator has little or no control” (Yin, 1994, p. 6). Additionally, the role of the researcher as a direct observer for this case study spanned over 18 months, and her being able to follow the process of two LEED buildings being built provides strength to this case study. In addition, the use of a variety of data or evidence such as documents, interviews, and observations add to these strengths. The following components are necessary for a quality case study:

1. Explanatory case study with “how” and “why” questions
2. Variety of evidence: documents, interviews, and direct observation
3. Construct validity: besides multiple data collection, informant review of the study
4. Internal validity: establishing a causal relationship where by certain conditions are shown to lead to other conditions (causal relationships and effects)
5. Program Logic Model Analysis will be what entails both pattern matching and cross-case analysis
6. Explanation building as well as theory development (Yin, 1994, pp.102-118).

Since this case study involves two newly constructed LEED certified buildings on a university campus, both buildings are similar in use and design, but it is how these two buildings, including the use of the LEED criteria and current design practices, are what are of interest here. In addition, understanding how these two buildings coincide with the master plan vision and expectations of SMU is pertinent. To observe participants that had similar goals in mind for

designing and building sustainable buildings was enlightening. Because this is a qualitative case study there are some limitations.

Limitations

The opportunity to learn how an educational institution approaches its building needs was very informative. Since institutional buildings have a collective owner (including stakeholders), the goals of education and maintenance is a primary focus, while sustainability is an additional boon for SMU. These buildings not only have to function as intended, but be maintained economically for a minimum of 100 years. One limitation is the requirement for higher quality and efficient buildings, compared to the commercial industry. However, it may be possible for all SMU buildings to be designed and built to outlast the current disposable practices of the industry. In addition, awareness of the material and resource limitations worldwide, along with global warming, makes LEED a great catalyst for the green revolution. Given the site and the nature of these buildings, the findings may not be generalizable to non-academic buildings.

Definitions

BIM: Building Information Management is a software program used for site analysis and energy modeling.

Contractors: For this study, this term refers to the two construction companies that worked on Caruth and Simmons.

Designers/Design Team: For this study, these terms refer to the designers that worked on either Caruth or Simmons.

FF& E: Furniture, Fixtures, and Equipment are an abbreviation used in the design field.

Green revolution: designing and participating in being “green” and environmentally aware.

High Performance Building: is a sustainably designed building.

LEED: Leadership in Energy and Environmental Design was founded in 1993 by the United States Green Building Council. This rating system is voluntary and evaluates environmental performances of buildings based upon life cycle, and providing standards for green building design from design through operation.

Owner, Architect, & Contractor: Owner, Architect, and Contractor are meeting conducted by the parties listed and is part of the ongoing construction administration of a construction project through to completion.

Practices: the steps involved by the designers to solve the design problem

USGBC: United States Green Building Council was formed in 1993 due to the realization that there needed to be some type of system to define and measure “green buildings.”

VOC’s: Volatile Organic Compounds used in the manufacturing of paints, adhesives, etc.

VAV: Variable Air Volume is a box that regulates the outdoor airflow into interior spaces of a building. It is part of the HVAC systems.

Chapter 2

Review of Literature

This review presents the literature and its relevance to this study. The review covers the historical and theoretical contexts for this study. The contextual component of each category is addressed for its historical relevance. The categories that have shaped this case study are Sustainable and Ecological Design, LEED, Application of LEED, Design Process, Programming, Decision-Making, Learning Environments, and Quality.

Historical Context

Presently, we are witnessing changes in the way the built environment is designed and built with sustainable practices. Many of today's architects are realizing the flaws within the design process, and through the implementation of the LEED criteria are redefining the design standards. Ironically, architects realized these flaws as early as the 1970s due to the first energy crisis when the original design intent was based on the misconception about the abundance of energy and resources. "However, a world-wide oil embargo sparked a dramatic rise in the cost of oil and fuel, and caused architects to start thinking about new ways to design buildings" (Fullmer, 2007, p. 2).

In the 1980s with the discovery of the depleting ozone layer, many scientists, architects, and engineers discussed efficient ways in designing buildings that would enhance the quality of life and not destroy the natural environment. It is becoming clear that though the implementation of the LEED criteria, whether it was the 2.2 or the 3.0 versions, the current practices are elevating the design practice standards for the design industry. According to Fullmer, "In a nutshell, we believe the LEED rating system is credible. We plan to continue to

use it as a design standard” (2007, p. 4). It is common sense to move in a more positive and productive approach in designing more intelligently using sustainable practices. For practical purposes and research purposes, the focus is on understanding this current phenomenon occurring in the design industry.

The traditional linear way of programming and designing a building is flawed. Countless times the owner is not heard, or the designer completely dismisses the suggestions because the architect felt he knew best. The architect’s role is to help meet the owner’s needs, and not dictate their needs to them. The logical progression is to bring together everyone involved in the project at the beginning, including the owner, so a better design solution is achieved by incorporating the LEED criteria. In observing the present professionals involved with both SMU buildings, and understanding what they have learned, it may be that their current practices are more efficient.

For decades, with the realization that some energy sources might not be bountiful, other energy options were considered, i.e., passive solar. Unfortunately, at the time of the late 1970s it was cost prohibitive to develop and use solar power. With a greater realization about the effects of poorly designed buildings on the environment, many present designers are receptive to the concept of LEED and what its goals are, “Buildings have been a part of the problem, but by building green, you can have a measurable and immediate impact on the environment. That’s because we’re using less natural resources--we’re putting less of an imprint on the earth” (Fullmer, 2007, p. 3). Therefore, with the introduction and utilization of LEED, it makes sense to design high performance buildings in a more intelligent way and “...translates into being environmentally sensitive” (Fullmer, 2007, p. 3).

Through ecological design in the context of the built environment “seeks solutions that integrate human created structures with nature in a symbiotic manner that mimics the behavior

of natural systems, and that are harmless to humans and nonhumans in their production, use, and disposal” (Kibert, 2005, pp. 109-110). This is not a new concept. Buckminster Fuller was truly the forefather for laying down the groundwork for ecological and sustainable design. He pushed the technology of the materials of his time that were sustainable and economically used.

Several factors have become evident in the sense that designers did not have enough education, experience, or knowledge in sustainable practices to design efficient buildings. Second, the cost at the time was much more significant then compared with today due to deficiencies in manufacturing techniques and slow advancements in technology. Third, fear of change in the current practices and having to modify those practices was not feasible. But as more and more designers are implementing and using the LEED criteria, they are realizing how more efficient their processes are becoming. Presently, savvy owners have had the time to educate themselves about sustainability and the environment. With the market driving these changes, the implementation of LEED principles into the design process is great, whether the owner pursues LEED certification or not.

Presently, there are concerns the cost of LEED are a major impact the project, but once professionals are educated and completely versed in the LEED criteria, this cost will diminish and have a minimal impact on the project cost. With LEED practices becoming a standard, a more efficient use of time and costs will be the norm. “I think we can start making [green building practices] common place so it will help drive down costs. Once contractors become familiar with the process, the process ends up becoming more cost efficient” (Fullmer, 2007, p. 4). Being able to share these new ideas with other professionals and students is vital to the design industry of tomorrow.

Sustainable and Ecological Design

Within the last decade, sustainable design has finally come to fruition. Through the diligence of the United States Green Building Council (USGBC), standards for LEED are designed on the ideology of sustainability. It is not a new concept, but it seems to have taken an influential movement to implement, and due to the fact our natural resources are being depleted, “Nature is more than a bank of resources to draw on: it is the best model we have for all the design problems we face” (Van Der Ryn, 1996, p. 7). Once more professionals understand how important sustainable and ecological design is, the quicker the design process will change, “On the other hand, if we build a rich enough set of ecological concerns into the very epistemology of design, we may create a coherent response to the environment in crisis” (Van Der Ryn, 1996, p. 10). One way this concept is being developed is through smarter industrial design criteria, such as requiring packaging materials to be recyclable. Van Der Ryn cites an example in Germany, where companies have to take back their packing materials and reuse them or pay a steep tax. This moves design into a more sustainable direction as Van Der Ryn indicates, “Many of the same considerations that inform ecologically sound agriculture also inform the design of sound packaging systems, the design of sane energy systems, or the design of environmentally sensitive buildings” (1996, p. 11). Designers need to realize that all facets of design impact the natural environment as well as the built environment. Nature is becoming the current metaphor for environmental design, and not the machine.

For most of the 20th century, architecture used the metaphor of the machine for its design inspiration, “At its worst the metaphor of the machine allows us to see nature as passive and malleable resources, ready to be used and refashioned into useful products (Van Der Ryn, 1996, p. 11). By using nature as a model, and not the machine, “We have used design cleverly in the service of narrowly defined human interests but have neglected a relationship with our

fellow creatures. Such myopic design cannot fail to degrade the living world, and, by extension, our own health” (Van Der Ryn, 1996, p. 9). Van Der Ryn is correct that this narrow mindedness cannot continue. These points seem more relevant and prevalent with the adaptation of LEED, and the simple concept that designers, as problem solvers, are trying to reflect their concerns for the future.

It is our human responsibility and good stewardship to work and design with nature, not against it, “A long term approach to building a sustainable world is to redesign the details of the products, buildings, and landscapes around us. Such redesign-attending carefully to scale, community, self-reliance, traditional knowledge, and the wisdom of natures’ own design requires patience and humility” (Van Der Ryn, 1996, p. 7). It is not necessary to reinvent the wheel, but to implement what is learned about ecological and sustainable design into everything designed from packaging to the built environment.

Sustainable design is essential for the future of our planet and its inhabitants. The Bruntland Report of 1987 defines sustainable development as “...meeting the needs of the present without compromising the ability of future generations to meet their needs” (Kibert, 2005, p. 33). Sustainability is not a new concept, and to expand upon this definition, sustainability “advocates that the environment and quality of human life are as important as economic performance, and suggests that human, natural, and economic systems are interdependent” (Kibert, 2005, p. 33). With the implementation of LEED standards, the world of architecture and construction has evolved and changed for the betterment of the planet. Ecological design delves deeper into how natural systems function, and LEED has incorporated or simulated some of these natural processes within its design criteria.

In fully exploring the concept of sustainability and ecological design theory, a better understanding of these components, and how professionals incorporate the LEED standards is

necessary. Ecological design is not a “style.” It is a type of partnership with nature that is not specific to a particular design profession. “Ecological design is simply the effective adaptation to integration with nature’s processes” (Van Der Ryn, 1996, p. 18). LEED is implementing or mimicking nature’s systems in their building requirements, “The integration implies that the design respects species' diversity, minimizes resource depletion, preserves nutrient and water cycles, maintains habitat quality, and attends to all other preconditions of human ecosystem health” (Van Der Ryn, 1996, p. 18). LEED parallels this with having six sections of criteria to design: Site Systems, Water Efficiency, Energy and Atmosphere, Material and Resources, Indoor Environment Quality, and Innovation and Design Process: and for the 3.0 version, the addition of Regional Priority points. It will be necessary to become ecological designers, so designers can be the catalysts in the progress of the cultural process to facilitate sustainability (Van Der Ryn, 1996, p. 25). It would take a public consensus to incorporate sustainable design into the built environment. “The goal is to calibrate human behavior with ecology, which requires a public that understands ecological responsibility and limits” (Orr, 2002, p. 31). Given academia’s move toward teaching the necessity of sustainability, it seems appropriate for universities to build with LEED design.

LEED and SMU

Shortly after the US Building Green Council was formed in 1993, they realized that the building industry needed a rating system for sustainable buildings (USGBC, 2000, p. 12). Research began on existing green buildings metrics. These metrics are based on the mission of LEED. “LEED encourages and accelerates global adoption of sustainable green building and development practices through the creation and implementation of universally understood and accepted standards, tools and performance criteria” (USGBC LEED, 2006, p. 3). The committee, which was composed of architects, environmentalists, and industry representatives focused on

devising a rating system that could be followed easily. The LEED Building Rating System Version 2.0 was released in March 2000 (USGBC, 2000, p. 13). Over time LEED has matured and evolved and will continue to do so in order to adapt to the needs of the designers and architects. For this case study, the two buildings, Caruth and Simmons, are considered New Construction 2.2 and 3.0, respectfully.

Once the certification such as Silver, Gold, or Platinum is decided, there is a list of prerequisites that have to be met in order to pursue the specific type of certification. There also has to be a LEED certified professional assigned to the project and he/she registers the project and assigns access to the website so that information is collaboratively uploaded by the professionals on the design team. Each discipline has its LEED person enter the information and credentials into the LEED system so the points can be documented and followed. As information is being submitted to USGBC by the designers, the people at USGBC review the information and have a timeline of three weeks to review the information being submitted. The documentation includes written explanation, drawings, specifications, authorized letters, and photos. LEED does everything online so that all the information, resources, and support are all in one centralized location (USGBC, 2000, p. 15). The project team also submits Credit Interpretation Requests or CIR's, in order to obtain credit for innovation or specific information about the project. The procedures for CIR's are to present the case briefly and succinctly and if there is a conflict, it is advised that the design team provide viable solutions so the USGBC can review and respond to the credit in question (USGBC, 2000, p. 15).

There are fees involved in registering a LEED projects, and the cost is based on the amount of square feet, the percentage of occupancy, and if the client is a USGBC member. For SMU, who are USGBC members, the cost to have a project reviewed involves the combination of design and construction equals out to \$.45 per square foot (Green Building Certification

Institute, 2011, ¶ 1). Project scope must include 100% of the total floor area. Buildings must be in compliance with Federal, State, and Local environmental laws and regulations and LEED certification can be revoked any time a violation or a noncompliance is noted.

Once a building is granted certification, it can file for recertification once every five years under the Existing Building status. In order to register for recertification, the project is registered separately from the initial certification. Additional fees are associated with recertification as well (USGBC, 2000, p. 17).

Through the exploration of this study and relevant literature on sustainability, ecology, and the LEED standards, more information was available to expedite the present processes involved in designing the SMU LEED buildings. A goal of this study is to learn how the LEED standards can be integrated into the programming and design process phases. The variety of professionals who are working on LEED projects have the ability to streamline the design process for designing high performance buildings. Professionals and educators can cull through the information in order to integrate LEED into their methodologies of teaching and designing. Overall, learning about how the various experts worked by sharing their ideologies and their understanding of LEED, has yielded noteworthy data concerning LEED on university campuses.

In the beginning, with all the general discussion about designing LEED and building green, it appeared to be a trend or a fad. On the contrary, because LEED has been around since its inception in 2000, many professionals are participating in wanting to fund, design, and build according to LEED. Several books, seminars, and articles revealed how sustainable design is impacting the world. In addition, a more in depth knowledge about the origins of LEED was obtained from *Sustainable Construction* by Charles Kibert, in which the process of sustainable construction and how LEED unites sustainable concepts is explored. He sums it up well, "This book is meant to enhance the collaboration espoused by the green building movement by

providing a reasonably detailed overview of the entire process so that the participants will be able to learn about the role of all the actors on the projects” (Kibert, 2005, p. xii). In addition, the text explores the ideology of ecological design, ecological footprint, ecological rucksack, eco-efficiency, construction techniques, etc. It is clear how sustainable and ecological design interrelates, and how they correlate efficiently without leaving a giant carbon footprint.

As this study evolved, it became clear how the various components of information are intertwined and how it all works harmoniously. Sustainable design is not only a philosophy; it is a responsibility. It is common sense that designers should be designing with nature and not destroying it. Lewis Mumford was correct in his views that cities should be designed to integrate and accommodate how people use cities, yet coincide with nature (Mehrhoff, 1999, p. 95). It is vital to see how each component of a university functions, and then how it is the sum of its parts. We should be designing university buildings in a collaborative effort, so there is harmony and balance within the built environment that it is synchronous, not asynchronous, with nature. To understand buildings as living organisms and not static structures changes the attitude towards designing more sustainably.

Another interesting concept about sustainability is that it is being addressed more within the curricula of the colleges and universities to educate and increase the awareness for future generations. In the book *Sustainability on Campus*, it is stressed, “Sustainability in this instance is not an end point, not a resting place, but a process” (Bartlett, 2004, p. 7). This philosophy is not just rooted in ecology, but throughout the varied sciences such as biology, chemistry, environmental ecology, etc., and how it affects people’s daily lives. How can designers minimize the carbon footprint and leave the world a better place? The various case studies in this book express the responsibility for environmental stewardship and how to implement these ideals into everyone’s lifestyle, let alone on college campuses. For example, at

Penn State a group of biology students set out to analyze how to cut the ecological impact of the Mueller building in half while creating healthier working conditions for all Mueller occupants (Barlett, 2004, p. 42). “So students began by considering all the inputs to the building: electricity, steam, paper, computers, printers, toners, furniture, etc., and determined 1) Mueller’s annual consumption for that item, 2) the environmental impacts of this consumption, and 3) alternatives that would significantly reduce ecological impacts” (Barlett, 2004, p. 42). From this research, the students presented the findings and the professors continued the research to develop a document that is the sustainability blueprint for the Mueller building. From that study, they are able to do the same for each building on campus. For professionals, there is a need is to learn from the current processes in order to expand the information and implement new knowledge into the design standards.

There have been case studies on LEED use on campuses. One case study, *Influence of Project delivery Methods on Achieving Sustainable High Performance Buildings* conducted by Sinem Korkmaz and Lipika Swarup at Michigan State University through the Charles Pankow Foundation explores 12 universities across the country focused on project delivery and building performance based on sustainable design. Korkmaz’s 2010 study involved LEED and project delivery methods used for designing and building of high efficiency education buildings, in which it was discovered that early involvement of all the participants produced better outcomes. “Early involvement of participants, level and methods of communication, and compatibility within project teams, overall known as the characteristics of integrative design, would result in better outcomes” (Korkmaz & Swarup, 2010, p. 1). Additionally, the case studies revealed that through multidisciplinary integration during the design phase that the schedule (time), cost, and quality were analyzed. As for the delivery method for sustainable buildings, Korkmaz discussed the three delivery methods: Design, Bid, and Build (DBB), Design Build (DB), and Construction

Management at Risk (CMR). Design, Bid, and Build is considered the traditional process that is utilized for most construction projects throughout the United States. Design Build is more of a single agreement between the owner and a single entity to perform both design and construction under a single design build contract. As for Construction Management at Risk, the owner contracts with a design company to provide facility design and the owner contracts separately with a contractor. For this method, the contractor has a significant amount of input into the design process and guarantees a maximum construction price (Korkmaz & Swarup, 2010, p. 3). For Caruth the project delivery method was CMR, which was the first of this type of delivery method for SMU. Typically, the method of delivery for previous projects at SMU was Design, Bid, and Build. It is believe that newly utilizing CMR, with the effects of weather, affected the schedule causing a delay in completing the building by six months. For Simmons, utilizing LEED, there was more time initially to design the facility, therefore, obtaining a more accurate construction budget and timeline due to using the traditional method of Design, Bid, and Build. There were several other components of Korkmaz's study that involved levels of integration in the design process, project performance and construction completion, levels of sustainability, high performance, quality and post occupancy evaluation with more of a focus on sustainable design than LEED. The concept that there needs to be more multidisciplinary integration during the programming of design and construction eventually results in reducing delays, costs and rework on projects (Korkmaz & Swarup, 2010, p. 3).

Presently, the LEED standards do not discuss how to implement the LEED criteria into the design process, except to express that all involved need to be committed early and work collaboratively. This is very challenging as it changes the way projects are orchestrated. First, a concept is developed by the architect, which supports a linear design process. Now LEED requires the contractor, the architect, and the engineers work together simultaneously to

develop the design concept. This is logical as it lets everyone bring his or her knowledge and expertise to the forefront, so the design time is more productive. The contractors can bring their experiences with materials; engineers can share their expertise about building techniques; and architects can discuss various wall systems. This study, through interviews and observations on how these professionals have incorporated LEED into their processes has clarified how LEED buildings come to fruition. Through further exploration of ecological design, a clearer understanding of sustainability and the overall representation becomes evident. Learning more about the energy model and the life-cycle costs will be beneficial in discovering gaps in LEED and in the energy model. In the 3.0 version of LEED, more points are offered for sustainable sites, optimizing energy performance, water efficiency, and four additional points for regional priority points.

Points are added for site selection and how the building should harmonize with the community both ecologically and sustainably. Interestingly, this concept has been around for a very long time. Lewis Mumford expanded his views based upon Scottish planner Sir Patrick Geddes, whose focus was bioregionalism by adding technology to the mix. Mumford coined the phrase, *biotechnic civilization*, in which the regional planning would balance the demands of technology, "Such a planning approach would take into account natural systems such as open spaces and human needs for settlement patterns on a human scale, very similar to the contemporary pleas of the New Urbanists to use the prototype of the village in designing new communities" (Mehrhoff, 1999, p. 95). In parallel to developing patterns in community design, Mumford discussed the benefit of not building haphazardly, wasting the land and valuable resources, but to plan accordingly with the ecology of nature, since everything is interdependent.

Another component that seems relevant in understanding LEED is eco-efficiency. The World Business Council on Sustainable Development (WBCSD) considers the term *eco-efficiency* “to describe the delivery of competitively priced goods and services that satisfy human needs and enhance quality of life, while progressively reducing the ecological impacts and resource intensity throughout the products’ life cycles, to a level commensurate with the Earth’s estimated carrying capacity” (Kibert, 2005, p. 41). It is a recommendation of WBCSD to implement the seven elements of eco-efficiency into the design:

1. Reducing the material requirements of goods and services
2. Reducing the energy intensity of goods and services
3. Reducing toxic dispersion
4. Enhancing material recyclability
5. Maximizing the sustainable use of renewable resources
6. Extending product durability
7. Increasing the service intensity of goods and services (Kibert, 2005, p. 42).

This list of recommendations stresses the seriousness of sustainable development, and many corporations and manufactures are taking responsibility in creating eco-friendly products to support a better built environment. Increasing the life cycle of products and making them sustainable will reinforce the concept of “cradle to cradle” which mimics nature’s cyclical systems. William McDonough takes this ideology to the next level by explaining the concept of eco-effectiveness that “...means working on the right things-on the right products and services and systems-instead of making the wrong things less bad. Once you are doing the right things, then doing them “right,” with the help of efficiency among other tools, makes perfect sense” (McDonough, 2002, p. 76). As it is in nature, all systems work together as such, and so should the designing and the construction of the built environment. The universal goal should be to design ecologically and sustainably for all types of manufacturing and construction.

Application of LEED

The construction world is learning to build sustainably, but is still relying heavily on the architects and engineers for the design requirements for building a project. Interestingly, since the mid 1920's SMU buildings have implemented changes through technological advances over the decades to decrease energy use and enhance water conservation. There is an initial cost to include underground water cisterns for gray water storage; and to utilize the site placement for the structure so that daylighting is more effective, in turn, the building is more energy efficient. Facilities have installed several sets of pipes underground to route the various types of water, such as gray water, black water, and domestic water. The gray water is filtered, stored, and used for flushing toilets, while black water is routed directly to the sewer lines. The utilization of grey water for flushing purposes conserves domestic water for human consumption. As a consequence of this, the system compensates itself in the sense of lower utility and operating costs (USGBC, 2006, p. 110).

Subcontractors have to provide documentation about the products they use so they match the specifications that LEED requires (USGBC, 2006, p. 255). For example, if the project specifies a wood veneer for millwork, the subcontractors have to show proof that the wood is certified by the Sustainable Forestry Initiative (SFI) to prove they are using a renewable product (Kibert, 2005, pp. 292-293). So far, the same construction materials are being used such as steel, brick, stone, concrete, cast stone, wood, etc., but are used more efficiently by limiting waste through recycling, reusing, and reduction, which is in line with the eco-efficiency concept. Since each building project is unique, the construction and design methods are improving. By having the opportunity to work with two large construction companies, the architects, and engineers on these two LEED projects facilitated a better understanding of their collaborative efforts. Gleaning from this plethora of information, strategies and ideologies have emerged.

Sharing this information with other professionals and educators can be beneficial in advancing the present design and programming practices.

The concept and practices of LEED are beneficial to the building and design process. The people involved with these types of projects learn to work more collaboratively and simultaneously, although this can be challenging. Time lines seem to be tighter and people need information more quickly in order to work simultaneously to complete the design. Traditionally, to work with the architects, structural engineers, and MEP engineers, the design process was a linear process because their steps were asynchronous. Now LEED requires a more synchronous approach. Some of the design of a building is still a linear process. The architect develops the concept for the building, followed by the structural engineer analyzing the design for structural compatibility. Since many architects are trained to design alone, contrary to collaboratively, they have to adapt, as do engineers, for everyone else on the project to work more synchronously. Judith Blau explored the way architects think and work, "Others emphasize the individualistic character of creativity; design involves a personal expression; architects can be very independent in how they develop their ideas" (1984, p. 46). Now these professionals need to work more succinctly, which makes sense to limit time lost in the conceptual and schematic phases of design, "Collaboration among all these players marks high performance green building as a distinct delivery system, and is essential to make optimal use of the site and landscape" (Kibert, 2005, p. 139). Efficiency in all facets of the design process is necessary to save time and money not only for the owner, but for everyone working on the project.

Design Process

Much of the information about creating design theory has not come from just the practice of architecture, but from the behavioral sciences. In his book, *Creating Design Theory*, Lang talks both about "theories and models that enhance understanding of design process and

the relationships between people and the physical environment” (1987, p. 24). Theories help designers to become proficient at problem solving, especially through the experience of testing their solutions. Interestingly, “Empirical facts in themselves do not guide practice; theory can. Research needs to focus on theory building” (Lang, 1987, p. 22). Since each project is different, designers do learn by trial and error, and realize that no solution is perfect; therefore, evaluations are important to the design process as well. The design process is a progression, and not necessarily a linear task. The creative process seems to go back and forth until the problem is completely understood, and a viable solution is realized. Zeisel calls this the *spiral metaphor* because designers do backtrack at certain times as they work on a design solution (2006, p. 29). Through further exploration of the design process, it is essential to understand how it integrates itself into the LEED design standards and vice-versa.

Interestingly, there are various steps defined for the design process. Lang defines the design process for environmental design as Intelligence, Design, Choice, Implementation, and Post occupancy evaluation (1987, p. 45). He then states that most professionals prefer to call these steps as Programming, Design, Evaluation and discussion, Construction, and Post occupancy evaluation (1987, p. 45). However, William Pena’s method is more prevalent because it is what is taught and practiced, except for post occupancy evaluations, which are considered optional. He defines his methodology as “Establishing goals; Collecting and analyzing facts; Uncovering and testing concepts; Determining needs; and Stating the problem” (Pena, 2001, p. 24). Fortunately, LEED does require post occupancy evaluations in the sense of thermal comfort as part of the certification based on the requirements of the enhanced commissioning report (USGBC, 2005, p. 370). However, more feedback about a building’s performance needs attention. Too often projects are built by repeating the same processes over and over again with the design team not realizing the inefficiencies. Bill Reed (2009), a

founding member of the USGBC and LEED, and co-author of *The Integrative Design Guide to Green Building*, suggests that post occupancy evaluations and questionnaires need to be administered by the design team to assess if a building meets its intended design and use. This requires time and resources in which many firms do not want to invest in order to implement these surveys into their processes because they want to advance to the next project. Feedback and constructive criticism would be beneficial to all design firms so improvements can be made in their services, “To create better buildings that achieve a far greater level of performance, the building industry needs to create additional avenues of feedback in order to learn and evolve” (Reed, 2009, p. 313).

A perspective about what the design process entails states that, “Rational models provide a foundation for thinking about the design process. New ideas that add to our understanding of the process have emerged. This is why having explicit positive theory in architecture is important; concepts can be evaluated and improved” (Lang, 1987, p. 43). This is applicable for the purpose of this case study. Another model of the design process involves Analysis, Synthesis, Prediction, Evaluation, and Decisions in which these steps are conducted intuitively. It is very difficult to break down all the cognitive steps within the design process (Lang, 1987, p. 45). The design process is also viewed by some as intuitive, indescribable, and a natural process that occurs in phases (Lang, 1987, p. 37). All designers work differently on how they solve design problems, “designing involves generating ideas and putting components of these together to form a whole” (Lang, 1987, p. 48). This brings an even deeper analysis of problem solving, “The goal of any intelligence activity in design is to identify and understand the problems being addressed.” This is where many designers break down the problem through synectics “...like brain storming procedures as a whole, helps designers probe their subconscious. Synectics makes particular use of analogies, metaphors, and similes to liberate

their minds from traditional ways of thinking” (Lang, 1987, p. 55). With Lang’s concepts and using this case study, the goal was to expand on these theories and ideas or to improve the model of the design process unique to universities, and possibly other projects.

Historically, the industrial models used for the design process caused design to fall into a trap, even for the masters of the modern movement, because they had too narrow a definition of function. They worked through solutions internally and intuitively without much external validity (Lang, 1987, p. 43). Because of this process, many of the buildings were not designed to function as efficiently as they could have, which brings up the issue about programming. Programming, as Pena defines it “A process leading to the statement of an architectural problem and the requirements to be met in offering a solution” (2001, p. 14). Programming is considered an additional service, or is conducted by a consulting firm. It would make more sense if all the designers participated in the programming process. Fortunately, LEED is requiring that the design team congregate as soon as possible to discuss the design requirements of the building as well as what LEED requires of the building itself based on sustainable design.

Programming

Historically, programming is done by the architect, but for SMU, an external consultant was utilized for the functional programming of the buildings based upon use and occupancy. From there, it was turned over to the architects, MEP engineers, civil engineers, and landscape architects to commence with the conceptual concept phase. Understanding initially that SMU uses the Collegiate Georgian style architecture keeps the exterior somewhat simplified, but the use of the LEED criteria for the interiors was more challenging.

Incorporating the LEED criteria early, for both the Caruth and Simmons buildings, user groups were formed to aid in additional programming to make sure all the goals for the

buildings were clearly defined. With SMU being a very active owner, these meetings continued until there was a consensus of the goals, and a preliminary design was accepted. This is part of the programming process where “Programming as iterative process integrates programming with design into repetitive loops of program-design-evaluation-feedback, which occur throughout the design process” (Kumlin, 1995, p. 7). The use of three dimensional drawings and perspectives conveys the aesthetic qualities of the interior space, but until the space is tangible, some people do not always comprehend the full impact of the design concept. Therefore, “Making the most out of workshops, format meetings, group size-the number of persons in a group affects both the distribution and the quality of the interaction –small groups are better (Kumlin, 1995, p. 91).

Programming should not be the responsibility of one professional, but should be assigned to the whole team and user groups, especially for determining the function and occupancy. As Pena points out, “Programming requires team effort. More and more people are participating besides owner/architect” (Pena, 2001, p. 60). Again, collaboration is being elevated to another level that requires more time by front-loading the conceptual and schematic design phases. Interestingly, Reed (2009) has redefined this phase as the *Discovery Phase*, encompassing research and workshops to formulate the conceptual design. His philosophy is to be completely finished with the design development phase, which reduces the time spent on the construction documents. More time is utilized up front with less time required on the back end of the design process. This also facilitates better decision making, “In front loading the design concept phase in which major decisions are made by the owner makes for a better design solution and is less costly.” (Reed, 2009, p. 103).

Decision Making

There may be two types of decision processes occurring. One set of decisions being made is by the designers, and the second set of decisions is made by the owner. Each has their own thought processes and influences, “For the designer, forming your general ideas into specific requirements is the pre-design process of programming--the most important decisions you will make” (Box, 2007, p. 59). It has become increasingly clear how programming, the design process, and the decision making processes are all interconnected. For the designers to make intelligent decisions, a clear understanding of theory and history gives them an intellectual basis for design (Box, 2007, p. 157). In the traditional design process, “Good programming is characterized by timely and sound decision making by the owner-not the programmer” (Pena, 2001, p. 64). If the owner does not conduct timely decisions, then it postpones the design solution. Therefore, if utilizing the proper design tool, such as LEED, in a way that integrates their use into the design process from the beginning, then improved informed decisions are plausible (Reed, 2009, p. 52). Diagram

2.1 illustrates the interconnectedness of programming, the design process, and the decision making process.

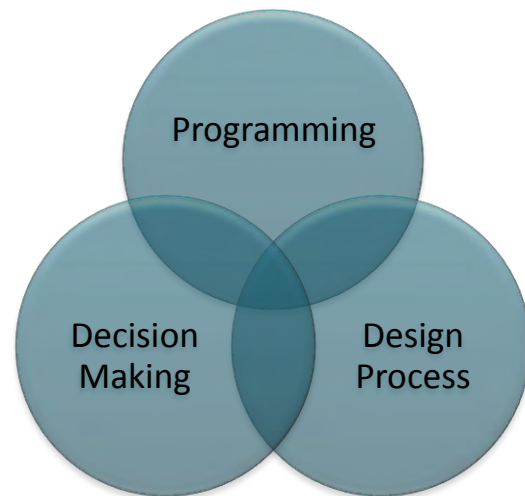


Diagram 2.1 Decision Process

This case study is about two LEED buildings on a college campus in which the owner’s perspective was, “The principle function of the planning and decision making in higher education is to enhance the environment for student development” (Baird, 1980, p. 70). The decisions made by the owner were conducted collectively based upon the board, stakeholders, end users, and the students.

These buildings have to facilitate education through proper programming and design to accommodate the variety of learners and the use of technology as well, "...manipulating certain aspects of the learning environment structuring the physical environment (for example, design and location of classrooms, buildings and athletic fields), or establishing certain rules and regulations" (Baird, 1980, p. 72). In essence, there were two major groups involved in the decision making process, designers and owners, so by working more collaboratively these decisions can be made together more efficiently, "Utilizing the right tools at the right time to design more efficiently as a whole (Reed, 2009, p. 52).

Learning Environments

Obviously, the integration of technology into the learning environment is imperative. The Generation Y, or "Net Geners", as Tapscott (2009) refers to them, uses technology as an extension of themselves. They are the first generation to be completely immersed in digital media, and expect it, as well as demand it. This case study has shown how classrooms are changing based upon technology, and how teaching and delivery methods are more diverse. Historically, the initial educational application was based on the industrial age type of education. It is clear today that education cannot be a *one-size-fits-all* solution as it was perceived and executed in the last century (Tapscott, 2009, p. 123). The world is constantly changing, and education has to coincide with technology and enter the information age. "Arrangement of environments is perhaps the most powerful technique we have for influencing human behavior. From one point of view, every institution in our society sets up conditions that with hope will maximize certain types of behavior and certain directions of personal growth" (Strange & Banning, 2001, p. 4). Both ideologies are intended to facilitate learning, but external factors are forcing or encouraging change. A variety of universities across the United States are redesigning the classroom environment because the focus is now on the students and how they learn,

“Instead of focusing on the teacher, the educational system should focus on the student”
(Tapscott, 2009, p. 123).

Environments on college and university campuses are designed to achieve specific goals, explicit or implied. There are also several key components required for human environments that serve to shape behaviors. Below is a list to consider when designing for the built environment:

1. Physical condition, design, and layout
2. Characteristics of the people who inhabit them
3. Organizational structures related to purposes and goals
4. Inhabitants collective perception or constructors of the context and culture of the setting (Strange, 2001, p. 5).

These components are necessary in designing learning environments in addition to the required technology. Instead of lecturing, teachers should interact with students and help them to discover for themselves. Instead of delivering a *one-size-fits-all* form of education, schools should customize the education for each student’s individual way of learning. In addition, schools should encourage collaboration and not isolate the students (Tapscott, 2009, p. 123).

“We never educate directly, but indirectly by means of the environment. Whether we permit chance environments to do the work, or whether we design environments for the purpose makes a great difference.” This quote from Dewey about the educational environment back in the 1930s is still applicable today. He had the foresight to realize that the built environment should facilitate knowledge for all types of learning styles (Strange & Banning, 2001, p. 2). “As dynamic institutions, colleges must be responsive to societal conditions, reflecting changes in programs and curricula in order to attract a sufficient student enrollment base” (Strange & Banning, 2001, p. 77) In order for colleges and universities to recruit and retain students, they have to understand Generation Y, technology, and the generations and innovations that follow.

When observing in this case study, originally, it did not seem there was enough programming conducted for the classrooms requirements until the goals were clarified. Just simply requesting standard audio visual equipment was not enough; clarification about how the instructors were utilizing the spaces was required to meet the design goals. The classrooms for both buildings were to be multi-functional, since SMU conducts several functions simultaneously. Therefore, flexibility was important for the majority of these spaces. The use of moveable furniture was crucial to accommodate the needs and use of the space, as well as the teaching style or activity for that class. In providing quality learning environments, and understanding the present technology and how future generations will be using technology, became crucial to the space planning of these areas.

Quality

With these two buildings, as with any LEED buildings, the goal was to enhance the quality of life within the building. Less sick days and more productivity, are the underlying economic goals for functional buildings, “We want to grow education and not ignorance, health and not sickness, prosperity and not destitution, clean water not poisoned water. We wish to improve the quality of life” (McDonough, 2002, p. 78). As for the interiors, LEED focuses on Indoor Air Quality and hones in on the ventilation systems and materials used for the built environment. Meeting stringent low VOC’s (volatile organic compounds), and keeping duct work clean of debris, as well as the interiors, is vital to the quality of the air circulation throughout the buildings. In addition to improving the quality of life and the overall quality of the building, the construction and its efficiency were vital to the success of the building.

Quality of the building goes beyond just aesthetics; it is the construction means and methods and the level of expectation that the owner has, “Overall environmental satisfaction is also dependent on the individual’s perception and assessment of several specific attributes of

the physical environment” (Marans, 1981, p. 24). Albeit, construction techniques have not changed much in 100 years or so for SMU, the preparation and disposal of the materials have in the sense of recycling and reusing building materials instead of filling up landfills. Quality has to do with the manufacturers addressing the global issues of limited resources. Fewer toxins in the finishes are beneficial to the air quality, and acknowledging that the majority of finishes can be reused or recycled, is beneficial. There is concern about the finishes not being as durable as previously specified finishes, and there are quality factors based on materials, systems and construction, function and performance, and spatial qualities as well (Pena, 2001, p. 124). Time will reveal the durability and the efficiencies of the new materials and finishes being used presently in these LEED buildings.

As Pena mentioned, “Assign a reasonable efficiency for a building that would contribute to its expected quality,” and depending upon what systems this is applied to, from mechanical to finishes, it is relevant (Pena, 2001, p. 125). Improved mechanical efficiencies in the building contribute to lower energy and water consumption that improves the quality of the environment by not draining natural resources. Of course, commissioning is crucial to the actual performance of the building, “The integrative design and commissioning process provides a means for a beginning to fill the quality control gap and for bridging the disconnect between design and construction professionals” (Reed, 2009, p. 311). Commissioning enforces the specifications and installations of the mechanical systems in these buildings to make sure they are operating efficiently, which in turn, increases the energy and water efficiency for the buildings. Despite there being several facets to the construction of a building, quality is always a concern from design through to the use of the actual building.

Summary

In review, the exploration of sustainable and ecological design, LEED, the design process, programming, decision-making, learning environments and quality illuminates how designers should work collectively in order to produce a better built environment for universities. The variety of evidence that is prevalent redefines the design process for designers to make better informed decisions based upon history, theory, and experience. By using nature as a model, and acknowledging that LEED criteria parallels natural systems, the designers learned to implement these strategies, making the design process whole and cyclical. Observing the synthesis of how all of this was done collectively, made designing the built environment more rewarding. Understanding what occurred over time in designing and constructing the buildings, and with the integration of LEED into the design process realized through this case study at SMU adds to the body of knowledge of LEED projects.

Chapter 3

Methods

The purpose of this study is to analyze how incorporating LEED into the design process affected the way buildings were designed and built on a university campus. Both buildings were at various stages of construction using two versions of LEED. For Caruth, LEED 2.2 standard was used, while for Simmons, LEED 3.0 was used. A variety of data was produced through direct observation, open and semi-structured interviews, document review of LEED records, drawings, field notes, and memos. Additionally, through interviews a clearer understanding of how the design teams used and implemented the LEED standards into the design standards for both projects has been revealed through the analysis of the findings. The role of the researcher was to collect data in order to answer the research questions about the current practices being used for two LEED certified buildings at SMU: How did LEED change the interaction of programming, the design process, and decision-making; and how did decisions affect time, cost, and quality of the buildings? Therefore, current practices were observed in operation that may help to bridge the gaps within the traditional design process. With a clearer understanding of the LEED criteria and integrating these guidelines into the current practices as design standards should help to elevate problem-solving abilities. Overall, with a modified design process, the design/build experience will efficiently save time and money with assured quality.

Site Selection: Southern Methodist University

Due to a well established relationship with Southern Methodist University's Planning, Design, and Construction (PDC) office on the Dallas campus, the opportunity to study two of

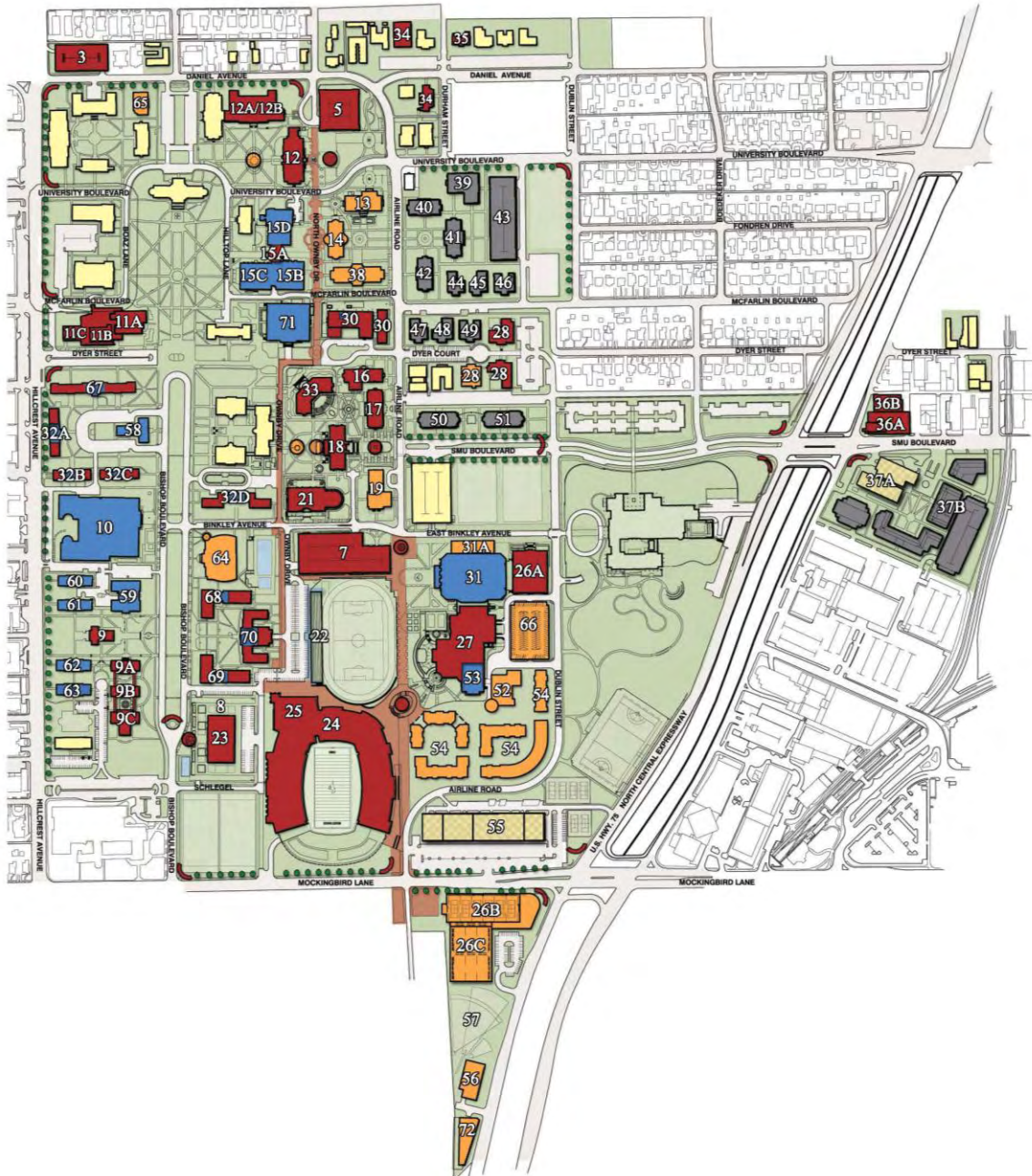


Illustration 3.1 SMU Campus Map

their current LEED projects occurred. A letter was written to the president of SMU requesting permission to study these LEED buildings, in which SMU could at any time, review the research being conducted. Through permission of the president of SMU and the Executive Director of PDC, the request was granted to research and directly observe these projects. The campus of SMU is located in Dallas, Texas and is six miles north of downtown Dallas. The researcher visited the SMU campus over a period of 18 months. The campus map, Illustration 3.1, shows the location of both Caruth Hall (Number 33) and Simmons Hall (Number 13) on SMU's campus.

Grounded Theory for Case Study

Grounded theory is the foundation for this comparative analysis of two LEED buildings in order to understand how LEED is redefining the design process. "The aims of grounded theory analysis are to develop inductive theory which is closely derived from the data rather than deductive theory which is supported by hypothesis testing" (Coyle, 2007, p. 7). Strauss and Corbin define grounded theory as "theory that was derived from data, systematically gathered, and analyzed through the research process" (Strauss & Corbin, 1998, p. 12). In using grounded theory, the concept that *theory is process* is a deductive method to develop a hypothesis. Based on founders Glaser and Strauss, theoretical sampling is done where the researcher collects data, codes, and analyzes the data to develop an emerging theory (Curry, 2003, p. 1). Grounded theory is applicable to this type of case study because grounded theories offer insight, enhance understanding, and provide a meaningful guide to action due to the gathered data (Strauss & Corbin, 1998, p. 12).

Through purposeful sampling and having direct access to the site and contact with the design team, selecting the interviewees benefitted the study because of grounded theory in which "...theory is inductively developed during a study...and in constant interaction with the data from that study" (Maxwell, 1996, p. 33). Through the grounded theory process, qualitative

evaluation draws on both critical and creative thinking (Patton, 1995, p. 434). Additionally, this study allowed the researcher to aptly name categories, ask stimulating questions, make comparisons, and extract an innovative realistic scheme from masses of unorganized raw data (Strauss & Corbin, 1998, p. 13). Grounded theory suggests purposeful sampling, a variety of data collection, analysis through coding, and deeper scrutiny through cross-case analysis in order to answer the research questions and generate plausible theory or theories. The collection of raw data, which is then coded, is the first step in developing prospective theory.

Direct Observation: Site

Depending on the occasion or meeting, the researcher visited SMU as little as once a week up to three times a week. The researcher's role on campus was as a visiting student that reported to the Executive Director of the Planning, Design, and Construction department. Temporary space was awarded to the researcher with computer access to conduct research and become familiarized with SMU's protocols. This integration into the SMU culture facilitated direct observation of the design team, the project managers, and facilities personnel's interaction within the SMU environment. Direct observations ranged from formal to informal data collection of "Observational evidence is often useful in providing additional information about the category being studied" (Yin, 1994, p. 87).

Direct observations occurred in the actual environment of the Owner, Architect, & Contractor and LEED meetings, and while attending site visits for both Caruth and Simmons. The observer recorded behavior patterns including actions, conversations, and descriptions of the locale and the people being observed. Furthermore, this method "is a device to circumvent some of the contaminants of studies employing an 'outside' observer" (Webb, 2000, p. 115). There were benefits of being able to observe directly within the meetings by establishing a rapport with the participants. It created an opportunistic sampling of designers to interview. As

a direct observer, the researcher joined the Owner, Architect, & Contractor meetings, which were scheduled for two hours each week, 1:30pm to 3:30pm on Wednesdays for Caruth, that started August 5, 2009, and continuing until March 31, 2010. LEED meetings were scheduled monthly for one hour throughout the duration of the project based on everyone's availability. Final documentation was submitted to LEED in June 2010 for Caruth.

For Simmons, the Owner, Architect, & Contractor and LEED meetings began on August 12, 2009, were scheduled weekly for one hour from 10:00am to 11:00am on Wednesdays. The Owner, Architect, & Contractor meetings for Simmons continued until August 4, 2010 while the LEED meetings continued until October 27, 2010. In November 2010, Caruth was awarded LEED Gold, while Simmons is awaiting acknowledgment to obtain LEED Gold status. In these meetings, the researcher made notations about issues and concerns of the participants for each of the projects. The data collection was conducted simultaneously with other methods such as document reviews and meeting notes. By attending Owner, Architect, & Contractor meetings, LEED meetings, and periodic field tours for both buildings, continued observation was beneficial to the study to clarify the processes involved with each building.

Participants: Sample

In attending the Owner, Architect, & Contractor and LEED meetings for each of these buildings, purposeful sampling generated a list of participants to interview who had explicit knowledge of these projects. Since this study used grounded theory methodology, purposeful sampling was done selecting the most knowledgeable professionals involved in the design process. "Selecting those times, settings, and individuals that can provide you with the information that you need in order to answer your research questions is the most important consideration in qualitative sampling decisions" (Maxwell, 1996, p. 70). There were 23 people

interviewed for Caruth and Simmons. The original allotment of time was 30 minutes for each interview; however, most interviews were 60 minutes or longer.

The actual participants in this study included the senior project managers for SMU, the architects and sub-consultants, the general contractor, the LEED Project Administrator, facilities personnel, an end user, and the commissioning agent, who worked on each of these projects. Below, Table 3.1, lists the participants by name with their titles (their names were changed to protect their identity) that were interviewed. Of the 23 participants interviewed, 10 were LEED Accredited Professionals or LEED AP, and are highlighted in green. This illustrated who was certified as a LEED Accredited Professional with the ability to perform sustainable-designed projects per the USGBC. This opportunity allowed the researcher to take field notes and observation notes that were used in the data analysis. In addition, the researcher had the ability to observe the collaborative efforts inherent to each project. An example of collaboration noted was that SMU worked directly with the landscape architect for Caruth to develop an organic garden to obtain an Innovation in Design Credit 1.4 (ID1.4). Through initial document review and observation, interview guides were developed and administered to the participants.

Table 3.1: List of Interviewees	
Participant	Title
Alan	Senior Architect (Both)
Clayton	Architect/ LEED AP LEED Consultant (Both)
Leslie	Director of Interior Designer (Both)
William	Director of Construction Administration & Quality Control (Both)
Cheryl	Senior Project Manager, SMU (Simmons)
Glen	Senior Project Manager, SMU (Caruth)
Kyle	Director of Landscape Management, SMU (Both)
Tina	Project Resource Coordinator, SMU (Both)
Lou	MEP Engineer, SMU (Both)
Jack	Executive Director, Facilities Management, LEED AP (Both)
Sue	Assistant Dean of Finance & Operations, End User(Simmons)
Mark	Senior Vice President, Civil Engineer, LEED AP (Both)
Neal	Landscape Architect, President (Simmons)
Lynn	Landscape Architect, Senior Associate, LEED AP (Caruth)
Charles	Project Manager, Construction, LEED AP (Caruth)
Steve	Senior Project Manager, Campos Engineering (Caruth)
Ray	Project Manager, Construction, LEED AP (Simmons)
Brian	Assistant Project Manager, Construction, LEED AP (Simmons)
John	Project Superintendent (Simmons)

Andrew	Project Manager/Construction Manager, LEED AP (Caruth)
James	Assistant Project Manager, Construction, LEED AP (Caruth)
Edward	Associate Project Manager, Structural Engineer (Both)
Dave	Vice President, Senior Project Manager, MEP Engineer, LEED AP (Both)

Interviews

Preliminary research of varied topics that related to the study was explored in preparation for conducting the interviews. This occurred simultaneously as direct observation occurred over the 18 months through site visitations. Once the projects were completed and a pre-analysis of the memos, quality control reports, and meeting notes occurred, the interview questions were generated based on the participant's expertise. Then these interviews were conducted after the projects were built. This was deliberate because the researcher wanted to be prepared before conducting the interviews since it would have been difficult to schedule more than one interview with each participant.

In conducting interviews for qualitative studies, several variables are important for the participants. The main concern was explaining the purpose of the study to the participants. Elements such as risk assessment, confidentiality, informed consent, data access and ownership were considered as Michael Patton stated (2002, pp. 408-409). The intentions and benefits of the study were clarified when the researcher was introduced to the design team. It was explained to the participants how the results of this study can help designers use the information to aid them in designing LEED buildings and that it can assist educators in updating existing curricula. Complete confidentiality was honored and respected for each of the interviewees. Each respondent reviewed, signed, and retained a copy of the informed consent document. This document explained what the study was about and that he or she could withdraw at any time without repercussions. A copy of the Institutional Review Board (IRB) consent form used for this study is located in Appendix A. In addition to this case study, SMU

was looking for a summative evaluation of their current processes being observed to determine their program's effectiveness.

In the conducting of semi-structured interviews for this type of case study, interviewing "...fosters eliciting each participant's interpretation of his or her experience. The interviewer seeks to understand the category and the interview participant have the relevant experiences to shed light on it" (Charmaz, 2006, p. 25). There was no summarization, paraphrasing, or correction of bad grammar that could affect or contaminate the data. Clarification about meaning, tone, and answers was done but the respondent was not lead in any case. Even though note taking is encouraged during interviews, minimal notes were taken since all interviews were digitally recorded. For the scheduling of the interviews, some took place at SMU in either a private office or a conference room. The goal was to interview the participant in their own environment, and this did occur for 17 of the 23 participants. Three of the participants felt comfortable being interviewed at SMU. One interview was conducted over the phone. Two of the interviews were conducted over a lunchtime meeting to accommodate their schedules. The remaining 17 were interviewed at their place of business either in their office or in a conference room. The interviews were an active process and required time to organize and conduct, but the time required to document the details and analyze all the information was considerable. The interviewing of 23 participants spanned over 10 weeks in order to accommodate their schedules.

A spreadsheet titled ***Interview Schedule and Timeline*** is located in Appendix B that lists the person, date, time, and duration of the recorded interview. This allowed time to reflect on the interviews for direction, acknowledge missing information, send thank you notes, and to verify if the data being obtained was beneficial in answering the research questions. Despite the time involved and being aware of biases on both sides, interviewing with the proper preparation

yielded detailed information required for this case study. Once the interviews were completed, it was prudent to take time to review the interviews so there were no doubts or additional questions needing to be answered. However, one question was not completely answered and was discovered during the transcription of one of the interviews, so a second interview was scheduled to obtain the missing information.

Interview Guide

Through further investigation and familiarity with the projects, a list of questions and issues to explore in the interview process was developed. Maxwell notes, “Your research questions formulate what you want to understand; your interview questions are what you ask people in order to gain that understanding” (Maxwell, 1996, p. 74). A combination of informal conversational interviews included open and semi-structured questions as they pertained to each building. The interview guides were developed from direct observation, meeting notes, and from quality reports issued by SMU. Three sets of questions were developed and used depending upon the interviewee’s expertise. In other words, design questions were not asked of the general contractor, just like questions about waste management was not asked of the architect. Below, is an excerpt of the interview questions written and utilized for the architects and designers.

Interview Questions Part 1: Focusing on design process and programming

1. Is the concept of sustainable design appealing to you and do you feel it should be implemented into all architecture?
2. Based upon what was learned in designing and building Embrey, what were the considerations and/or similarities for the Caruth building?

Interview Questions Part 2: Focusing on decision-making

1. User groups were defined early to help with the programming for both buildings. Was a particular sub-group such as the faculty, more or less helpful in discussing the design outcomes for the classrooms and labs to facilitate a learning environment?

2. Besides the budget and scope for each building, for the end-users, how much of their influence affects the decision making process for the design outcomes?

Interview Questions Part 3: Focusing on time, cost, and quality

1. In an observation by the Dean, he mentioned that you cannot literally “see” that the Embrey building is sustainable. Do you think the quality of the design and the finish-out helps the building to blend in with traditional architecture?

2. SMU uses Georgian Architecture with Greek, Roman, and 18th Century influences; have these requirements made using the LEED criteria challenging for the design solutions, if so, how?

The three different interview guides administered are located in Appendix C. Additional questions stemmed from the interviews that revealed more information and concepts used to answer the research questions. In addition to these questions, knowledge based questions were included in the interview guides so participants could demonstrate their experience and knowledge about these LEED projects.

Information Organization

After creating the interview guides and conducting the interviews, the initial open coding analysis was done during the transcribing of interviews, coding memos, observation notes, and meeting notes, and a list of frequent words was kept and organized based upon each of the informants. From this list of frequently used words, a matrix was developed for each research question. Each research question was assigned a specific color that included additional colors relating to patterns and themes discovered in the open coding process. To manage the amount of information obtained and being reviewed, especially for the transcribed interviews, notes were made in the margins of key words and concepts as well as the time of the participant’s comments in case they needed to be audibly reviewed again. When filling in the matrices, the information was color-coded and pages numbered from the transcription documents were noted as well. These minor steps saved time in locating quotes, terms, and concepts for the Findings, and Analysis and Interpretation chapters.

Document Review

An additional data collection method for this study was through document review. Even though documents are considered secondary data originated from another source such as articles or books, it was still viable information (Livesey, 2010, p. 1). For this line of inquiry, the documents collected were LEED certification documents, meeting minutes, quality field reports, articles, publications, Southern Methodist University (SMU) standards, observation notes, transcribed interviews, and memos for both LEED buildings. This provided a great combination of primary and secondary data obtained. The only downfall to obtaining documents from other sources is that this information is not considered first-hand information, although by being a direct observer in attendance of meetings, ground visits, etc.; observation field memos were generated and reviewed as part of creating the interview guides. These documents were coded as part of the open coding process as they were reviewed and analyzed to search for clues and voids within the data. In addition, some of these documents were supportive to “provide the evaluator with information about things that cannot be observed” (Patton, 2005, p. 293). Many of these documents are considered private, and therefore, confidentiality was important, especially with interviews. For observation, permission was not necessary, but it was better to inform the design team about the intentions, of the direct observer.

Despite being able to observe first-hand and being cognizant of the activities taking place, there could be some concern about this type of data collection due to bias. No matter how well integrated an observer becomes there is an element of potential bias to the production of the critical data. The bias may be a selective one to jeopardize internal validity, or perhaps more plausibly; it may cripple the ability of social scientists to generalize their findings very far beyond his sample (Webb, 2000, pp. 114-115). Any biases, whether the researcher’s or

someone else's, were documented and attempted to be addressed so that the validity and credibility of this study were not jeopardized.

The only other disadvantage is the time involved in being a direct observer. Therefore, letting this study evolve over 18 months was within reason. Another concern was that “the researcher has to rely on their memory and personal discipline to write down or expand your observations as soon and as completely as possible” (California State University, 2008, p. 15). This is why it is important to write memos and any pertinent information as it unfolds so nothing is disregarded. This was accomplished after specific situations occurred and the information was recorded in the form of a memo to be reviewed later. There is a difference in reporting or describing what is observed versus interpretation. Since this was inherently a subjective exercise, one had to filter out personal bias, which takes practice (California State University, 2008, p. 15). Overall, by using interviews, documents, and observations these methods of data collecting ensures the reliability of the data collection.

Data Coding and Analysis Processes

Coding Process

As part of the grounded theory methodology and due to the extensive amount of information obtained, a three-stage coding paradigm was used to organize and

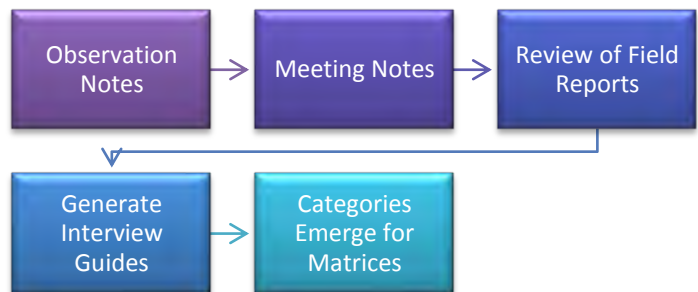


Illustration 3.2 Coding Process

analyze the data. The three stages of coding were open coding, axial coding, and selective coding were used to reveal an in depth detailed consideration of “the wide range of conditions and consequences related to the phenomenon under study” (Strauss & Corbin, 1990, p. 158). Open coding assisted in developing the matrices used for each research question in order to

discover categories. Illustration 3.2 shows the process for developing the matrices as they related to each research question. For example, for research Question 1, “What are the current practices and considerations for two LEED certified buildings at SMU?” the categories of Criticisms and Attributes stemmed from the interview guide asking the participant if they had any criticisms or attributes about utilizing the LEED criteria since, for example, cost was a constant criticism. Below (Table 3.2) is an example of the matrix for research Question 1 used for the open coding process. Relevant information from the line-by-line coding process of the interviews was placed below each of the categories.

Table 3.2 Matrix Example					
Data from Interviews to answer research Question #1: What are the current practices and considerations for two LEED certified buildings?					
Who Said It	Current Practices	Criticisms	Attributes	Recommendations	Other

Once the categories were established, subcategories emerged through axial coding by literally drawing up a variety of conceptual sketches based on the information reviewed from interviews, meeting notes, and observation notes. These types of diagrams were generated for the research questions. The axial coding stage illustrates the developing causal relationships between the categories and subcategories revealed from open coding. In order to discover core categories, selective coding was done based on the frequency of the themes and patterns within the matrices. For example, the theme *documentation* shows up repeatedly based on interviews and field notes under the categories of Criticism and Time. This process was repeated for each of the research questions.

Data Relationships

The axial coding stage of the data was arranged in new ways to identify the causal relationships between the categories and the subcategories. The goal here was to make explicit connections between the categories and the subcategories with an explanation and

understanding of the relationships. From the axial coding process, analytic memos were written for each category to develop subcategories relevant to the research questions. This process included literal sketches similar to cognitive maps to illustrate the causal relationships. This process was completed for each research question. Once the axial coding was completed, the next stage of selective coding began.

Through selective coding, core categories were revealed in order to generate and link concepts. As part of the grounded theory process, selective coding makes sure the core categories and data are saturated and exhausted from all document analysis in order to develop probable theory. Each category is sufficiently developed in terms of properties and dimensions to demonstrate its range of variability as a concept as it related to LEED (Strauss & Corbin, 1998, p. 158). This process was done for each research question.

Cross-Case Analysis

This case study analyzes two buildings using two different versions of LEED, to answer the four major research questions, created the opportunity for cross-case analysis. By using cross-case analysis, “means grouping together answers from different people to common questions, or analyzing different perspectives on central issues” (Patton, 2002, p. 440). Actually, both techniques were done so that the answers are not just grouped together, but that the perspectives of the participants were acknowledged. These methods will enhance the generalizability and deepen the understanding and explanation of the findings. Through cross-case analysis, the data is examined to find similarities and differences between the categories and the subcategories. Additionally, the researcher examined the interrelationships within each case, or for this study, each building, and for each research question (Kohn, 1997, p. 5). Using the cross-case analysis method to analyze the data gives the case study validity and reliability by

exploring the interrelationships in order to find the core categories and generate plausible theory or theories.

Validity

There are four ways to test the validity of this case study by acknowledging Construct Validity, Internal Validity, External Validity, and Reliability. For construct validity, the use of multiple sources of evidence and method triangulation for this case study used document reviews, interviews, and quality reports. For internal validity, identifying patterns and themes within the data to develop explanation building through program logic models. Since this study follows the chronological sequence of the construction for Caruth and Simmons, using program logic models in which key cause-effect patterns between independent and dependent variables present themselves through analysis (Yin, 1994, p. 118). For external validity, defining the context to which the study's findings can be generalized such as implementing sustainable practices into a designer's design philosophy based on the outcome of utilizing LEED procedures.

As for reliability, documenting the procedures followed in conducting this case study helped with the documentation so that this study could be replicated (Yin, 2009, p. 45). In developing a case study database based on the data collected helps with secondary analysis independent of any initial report (Yin, 1994, p. 95). Having the database accessible helps with the reliability of case study through document retrieval. The data were divided into categories such as SMU Quality Field Reports with quality issues listed in a matrix form, interview guides and the transcribed interviews with reference to the audio files are kept together, LEED meeting minutes, Owner, Architect, & Contractor meeting minutes, drawings, images, etc. Research Questions matrices include data from interviews, meeting notes, observation notes, articles about LEED, Design Process, Programming, and Decision Making, Costs, and Quality (Yin, 1994, pp. 94-98). Additionally, creating a cross-reference of information via the actual documents and

the matrices along with different evaluators or investigator triangulation as well as with method triangulation (Yin 1994, p. 92).

Method Triangulation

Triangulation is a method to check and establish construct validity (University of Florida, 2002, p. 1). In using "...different data sources of information by examining evidence from the sources and using it to build coherent justifications and themes," is what this case study is about (Creswell, 2003, p. 196). In learning more about the current design practices for LEED buildings on a college campus, possible alternative processes can emerge. It is understood that implementing LEED into the programming and the design process, is primary in understanding how the time, cost, and quality impacts these types of structures. For this study, the focus was on *method triangulation* because through the inclusion of each method being utilized such as interviews, documents, and observation, the findings from all of these methods will draw the similar conclusions, establishing validity (University of Florida, 2002, p. 2). Validity in qualitative research relates to whether the findings of your study are *true* and *certain*. *True*, meaning the accuracy in reflecting the real situation, and, *certain*, in the sense of your findings being backed by evidence (University of Florida, 2002, p. 1).

A few techniques to validate the findings were to conduct member checking, clarifying biases, and notating anything negative or contradictory (Creswell, 2003, p. 196). Member checking is taking the final report or specific descriptions back to the participants to determine if the participants feel it is accurate. This was accomplished numerous times through the analysis and questions generated from reviewing the quality control reports completed by SMU to verify and clarify meaning of the language or terms being used. In clarifying bias, the researcher brought to the study self-reflection that facilitates an honest narrative for the readers. As for negative or discrepant information that shows up contrary to the different perspectives that do

not coalesce, discussing this brings credibility of the account to the reader (Creswell, 2003, p. 196). These are all viable techniques to ensure validity. Using the method of triangulation helped to ensure the information of several findings for this case study will reveal similar information about programming, the design process, and how decisions affects time, cost, and quality of these LEED buildings.

External Validity

The only limitations explored were external validity, non-comparison case study, bias, and inferences in which steps were taken to minimize these types of limitations. For external validity, the findings might not be generalizable as a whole, but perhaps designers can acquire information from this case study that can benefit them with their design processes for universities. It has been an enlightening experience for the researcher to observe the inter-workings of everyone's involvement on each of these projects. Analytical generalizability helped with the external validity as well. "In analytical generalization, the investigator is striving to generalize particular set of results to some broader theory" (Yin, 1994, p. 36). For this case study, the integrated design process due to LEED is not confined to a university setting. In addition, reliability can be established by a researcher following the exact procedures described so that a second investigation would arrive at similar findings. This was achieved, in part by analyzing both the Caruth and Simmons buildings because of using two versions of LEED. Both projects were trying to achieve LEED Gold, for Caruth it was achieved as of November 12, 2010, and Simmons was still awaiting a response, but each had accomplished this a little differently. "The goal of reliability is to minimize the errors and biases in a study," (Yin, 1994, p. 36), so thoroughly documenting the procedures can help the study to be repeated, and it minimizes people's suspicions. Biases and inferences always come into play for case studies and the biases will have to be made known. For an investigator, inference has to be clarified or cross-

referenced based on the gathered evidence. One last limitation is that this is not a comparative case study.

This type of case study is a *non-comparative study* in the sense of a traditional building versus a LEED building. However, the differences between the two versions of LEED used as well as the criticisms that LEED has encountered are discussed. As mentioned before about the case study having levels, Yin uses the term *embedded units*. This concept is more accommodating to this case study because there is a deeper level of cause and effect along with the *how* and *why* of the research questions. By having embedded units, there is information revealed or discovered that can help designers and the owner in how they construct their design programming processes.

The limitations can be overcome based upon how the case study is designed. Through careful planning and taking advantage of every opportunity gives more exposure to information, the stronger the case study. Additionally, following the case study protocol that Yin outlines in which the researcher is reminded of what the case study is about, and second, preparation of the protocol forces the researcher to anticipate problems including how reports might be completed (1994, p. 65). Thorough documentation of what was completed is necessary for the reliability of the study, therefore, a different researcher can conduct or reconstruct this case study. The strengths still outweigh the limitations, but again, careful documentation has helped to curb the limitations. Since this is an explanatory case study with strengths through the variety of evidence being gathered, and by using grounded theory and cross-case analysis methodology of the information, this will assist with theory building and bringing pertinent information to the forefront.

Reliability

To enhance the reliability of this case study several factors were considered such as using multiple sources of data, creating a case study database, and maintaining a chain of evidence. For evidence, as Yin discusses there are six types: documentation, archival records, interviews, direct observation, participant observation, and physical artifacts (p. 80, 1994). For this case study, documentation, interviews, and direct observation were conducted.

Documentation included LEED documentation, meeting minutes, quality reports, observation notes, and relevant literature through articles and books. For interviews, selected participants were interviewed that had specific knowledge of each project with questions based on observation, meeting notes, and quality reports. As for direct observation, events were covered in real time within the context of the study. Additionally, documents helped with spellings, titles, organizations, etc., that were involved with both Caruth and Simmons. In addition, documents helped to corroborate information and even revealed anything contradictory. Last, inferences by the researcher were made to illicit additional questions and research. Documents provided a great source of information for the phenomena being studied (Yin, 1994, pp. 79-80).

Interviews conducted as open-ended revealed the informant's opinions about events in which they participated. Additionally, the informant provided the researcher with insights into matters and suggested other resources to corroborate evidence as well (Yin, 1994, p. 84). Having interviewed 23 people helped the researcher not to solely rely on just a handful of informants. Interviews for this case study provided the most evidence because the information was reported through the eyes of the informant that provided insight into the situation or phenomena being studied (Yin, 1994, p. 85).

As for direct observation, having a specific case study site created the opportunity for direct observation that provided another form of evidence adding to the reliability of this case study. Both formal and informal observations occurred by being on site, in meetings, building tours, and in interviews (Yin, 1994, pp. 86-87).

Understanding the four ways to test validity through construct, internal, external, and reliability a case study protocol was developed to ensure how this study was orchestrated and conducted. By creating a chain of evidence such as documenting the time and place for each interview reveals the actual circumstances as it occurred. The actual procedures documented in the case study protocol illustrate the link between the information and the research questions (See Appendix D, Case Study Protocol) (Yin, 1994, p. 99).

Validity Threat

There are four possible types of validity threat to harm this type of case study. Based on how Maxwell defines each category: Description, Interpretation, Theory, and Generalization, each of these are addressed. As for description, not relying on a simple description of what was observed or heard because there can be inaccuracies and incompleteness within the data (Maxwell, 1996, p. 89). Not solely relying on what was observed or heard, and after reviewing meeting notes from the Owner, Architect, & Contractor and LEED meetings, interview questions were developed, and the interviews were conducted, recorded, and transcribed. Any questions or missing information revealed during analysis was notated and dealt with immediately in regards to interpreting the information.

Maxwell defines “interpretation” as imposing one’s meaning or leading the interviewee (Maxwell, 1996, p. 89). The various design disciplines have their own vocabulary, so clarifying the meaning and use of specific words or concepts was completed during the interviews. Similar steps were taken during meetings and with reviews of written documents such as the

field reports, so the researcher was clear about what was discussed. Fortunately, for this industry, plausible alternatives to what was discussed are not vague but specific. Again, any clarification of meaning was done openly so that both parties understood the context of the discussions and interviews.

In conducting the transcribing of the interviews, as well as the meeting notes, any discrepant data was notated and addressed to minimize theoretical validity. Maxwell defines it as "...not collecting or paying attention to the discrepant data, or not considering alternative explanations or understandings of the phenomena you are studying" (Maxwell, 1996, p. 90). There were discrepancies that occurred in the design process and the programming based upon a few of the individual's perspectives. For example, not understanding the intent of a punch list is not for items that were omitted from the scope of the project, but for items in the scope of the project that are incomplete or unacceptable. Naturally, the project managers for these buildings made sure all the end users needs were met based upon budget allocations and the scope of the project. Through this stage, developing theory can evolve in the generalization of the information obtained in this study.

Maxwell's fourth issue about validity threat is generalization. He defines it as, "Internal generalizability refers to the generalizability of a conclusion *within* the setting or group studied, whereas external generalizability refers to its generalizability *beyond* that setting or group" (1996, p. 97). Since this is a comparative case study within the confines of a university with a focus on LEED, some practices can be universally applied to any type of design project. Many of the practices currently being used are becoming standards, and can reshape how designers manage the programming and design process phases of a project. However, through this case study it has been interesting to learn how the processes and procedures work internally from a university perspective. Plenty of forethought and planning is involved compared to the

commercial side of the industry. The acknowledgement of external validity and the limitations of this study on a university campus have been considered for the generalizability of this study.

Bias

For a qualitative study, there are two types of bias that exist: Researcher Bias and Reactivity. Understanding the types of bias is to ensure the validity for the qualitative conclusions in which all aspects of validity are being acknowledged. Maxwell defines researcher bias as being aware of the researcher's theories, preconceptions, or values that can interfere with the conclusions of the study (Maxwell, 1996, pp. 90-91). Additionally, Patton's concept of "empathic neutrality" is applicable for this type of case study because the researcher has to be fair in the analysis and representation of the data gathered in order to generate plausible theory or theories for practitioners to use (Patton, 1995, p. 50). Patton clarifies that empathic neutrality "Suggests that there is a middle ground between becoming too involved, which can cloud judgment, and remaining too distant, which can reduce understanding" (p. 50, 1995). Overall, being cognizant of these types of bias as conclusions and as theories evolve, it is imperative to the analysis of the study's findings and the generalization of information. As for reactivity bias, it is to realize and understand that the influence of the researcher cannot be fully eliminated, but to use it in a productive way (Maxwell, 1996, p. 91).

It is clear that no matter which type of research is being conducted, the fact that the researcher is present in the situation is somehow influencing what the informant says, especially in interviews (Maxwell, 1996, p. 91). Fortunately, for this situation and being on campus for over a year, and having developed a rapport with all the participants through the project as well as through external associations, the researcher's presence did not seem to affect or influence the participants to any great degree, therefore reducing the issue of reactivity bias. If anything, they were more open about what was discussed about the projects. Another benefit to this

study was the researcher's professional association with the industry as an interior designer and not as a complete stranger to the design world.

Addressing method triangulation, validity threat, external validity, and bias for this type of qualitative case study clarifies any issues that could affect the validity of how this study has been conducted. Being aware of these types of validity threats, and being aware of how they can hinder the research process, is vital to the success of this type of study, and care has been taken to minimize these researcher errors.

Summary

In working on a summation of the methodology for this case study, a dialog about the scope of this case study occurred with several people at SMU. Permission was granted in a letter by the SMU Executive Director of Planning, Design, & Construction on behalf of the President of SMU. Once permission was granted, the researcher was added to the invitations of all Owner, Architect, & Contractor and LEED meetings for both Caruth and Simmons. Through the introduction of the researcher, the scope and purpose of the study was revealed, and then again prefacing the interviews. By attending the meetings, the researcher was included in site visits, extracurricular events, and the dedications for both Caruth and Simmons. In addition, the researcher had access to drawings, documents, photos, and field reports as they related to each project. Additional direct observation notes in the form of memos were written as well as notes taken during the Owner, Architect, & Contractor and LEED meetings for both buildings. The researcher was permitted to take pictures of the buildings in various stages of completion, and made field notes about progress, issues, and concerns as they related to the projects. By being in attendance to these variety of opportunities, a rapport with the design team was established which benefited the sampling process. Through review of meeting notes, memos, and field reports the interview guides were generated in conjunction with the research questions. The

interview guides were used to facilitate a dialog with the designers to obtain the information needed to conduct this study and answer the research questions.

Through emails and phone calls, interviews were scheduled based upon the participant's schedule. The interview questions were administered as they related to that participant's role within the project. The interviews were recorded and then transcribed. Meeting notes and memos, in addition to the transcribed interviews, were then ready for the coding process. The grounded theory method of data analysis was used to set up a three step paradigm of open, axial, and selective coding. Through the grounded theory process, possible theory or theories about utilizing LEED in university building can be generated from seeking answers to the research questions. Through the open coding, a matrix for each research question was established to reveal categories and subcategories. In conducting the line-by-line open coding process, colors were assigned to the specific categories as it related to the data. For example, *Criticisms* was the category, and *documentation* was the subcategory and was highlighted in orange. Once all the open coding was completed, axial coding commenced through review and literal sketching to start the discovery process to reveal causal relationships and themes within the data. Then through selective coding, an analytical process of the causal relationships continued until the researcher realized saturation of the information as it related to the research questions. A cross-case analysis was done to discover the core categories and the causal relationships in which the findings are discussed as they relate to the themes and categories discovered. Then plausible theories were generated based on the interrelationships of the variables. In addition to the steps taken to conduct this case study, specific components of validity and reliability were considered and discussed.

Chapter 4

Findings

As part of the grounded theory methodology, the findings resulted from utilizing the three-stage paradigm of the coding process: open coding, axial coding, and selective coding. The initial analysis of the data through open coding is the analytic process through which concepts are identified and their properties and dimensions are discovered in the data (Strauss & Corbin, 1998, p. 101). The findings are based on three main categories: LEED, Design, and Decision Making and the variables within those categories. The information based on those concepts was organized into spreadsheets, or matrices, for further analysis of the variables of each category as it related to the research. Once the open coding was completed the second level of the coding process, or axial coding, was completed that involved line-by-line analysis, which in turn, helped to generate additional categories and subcategories. Additionally, within the axial coding process for each category, several diagrams were drawn to discover relationships between the categories and subcategories. For the selective coding process, the goal was to integrate and refine the categories as they related to the study, since this study's focus is LEED and the design process. All the categories and their components are a significant part of the grounded theory process because through analysis, theory or theories can evolve from the data. For each key category, axial coding and selective coding are briefly discussed and illustrated for clarity.

Axial Coding based on LEED

Through the analysis of the category of LEED, it became evident how much LEED influences the design process. Through the development of a major category, the goal is to sort, synthesize, and organize a large amount of data for the next stage of selective coding (Charmaz,

2006, p. 60). For LEED, dealing with the current practices and considerations for two LEED buildings at SMU, the categories and subcategories were simplified to aid in discovering the actual core category. Illustration 4.1 shows the axial coding for LEED including each category

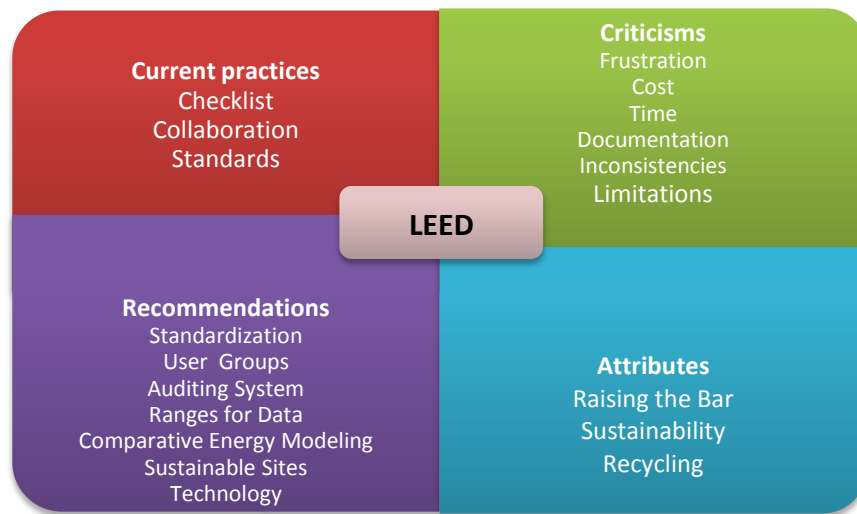


Illustration 4.1: Axial Coding based on LEED

and the tentative subcategories. The illustration lists Current Practices, Criticisms, Recommendations, and Attributes as the primary categories.

Selective Coding based on LEED

Through the selective coding process of analyzing the data, specific categories were revealed about both buildings despite several components becoming commonplace or integrated from the experiences of Caruth, which were utilized for the Simmons project by the designers. For the designers, specific elements from the LEED process were implemented into their design standards. These *standards* included collaboration, simultaneous design, spending more time in the design concept phase, generating standard specifications, and understanding specific LEED points that are now SMU standards. Logically, the owners wanted the best value obtainable, which required the owner to be more involved and contribute greater knowledge than that of a typical project. This mirrors what LEED is trying to accomplish through their

design criteria for LEED certified buildings. However, by understanding that LEED is an ever-evolving system, it became evident based upon everyone’s experiences in the designing and building of both Caruth and Simmons that the refined categories are Criticisms, Attributes, and Recommendations, see Table 4.1 below.

Criticisms	Attributes	Recommendations
<ul style="list-style-type: none"> • Documentation • Inconsistencies • Limitations 	<ul style="list-style-type: none"> • Collaboration • Innovation 	<ul style="list-style-type: none"> • Standardization • Gathering Data • Technology

Table 4.1: Categories and Subcategory based on LEED

Findings based on LEED

Criticisms: Documentation

Under criticism, the categories of documentation, inconsistencies, and limitations became prominent reoccurring variables within the data. The documentation portion itself was very time consuming, and was an additional cost to the project due to the required narratives, drawings, specifications, etc. Fortunately, the documentation was done digitally, aiding in making it a paperless system. For several points, the documentation was redundant. For example, sustainable sites and landscaping share a lot of the same documentation and drawings and have to be submitted in multiple areas to obtain the corresponding points. Since both buildings are similar, submitting the same documentation for a point does not mean the point will be awarded. For example Mark, the civil engineer, stated:

Problem with LEED, like we saw with Caruth and Simmons, is depending upon the reviewer, once you get into it and things you might submit on one building will work, but you submit it on another building and they say no, this doesn’t meet our requirements because someone is looking at it in a different light. So the standards aren’t consistent from project to project (p. 17, 2010).

Additionally, it takes time to handle the administrative tasks of the documentation. The designers and contractors felt the documentation process could be streamlined more to save time as James, the assistant project manager of construction for Caruth stated, “It needs to be a bit more standardized, so there is one certain way to do everything and to be up front about it, and it’s not really like that. There’s different interpretations’ going on through the checklist” (p. 14-15, 2010). More time was required for the submittal process of the materials that were actually used for Caruth for which the contractors developed their own data sheets.

For the MEP, civil, and landscaping except for the submittals, all the documentation was electronic. The architect still preferred physical copies and actual samples opposed to digital images and electronic files, “We [contractors] wanted to be all paperless, but the architect didn’t want it” (Andrew, 2010 p. 9). As for the project managers for SMU, with everything being electronic, it cut down on how much they had to physically store, “You can look at my office here and I have 15 boxes in here. There would have been 30 had we not gone paperless, and I think that makes a difference in the cost” (Cheryl, 2010, p. 21). For the commissioning agent and architect, notebooks are still generated for reference, but are available electronically. In addition, LEED has reduced the number of pages for the criteria lists from four pages to one page for the 2.2 version versus the 3.0 version, respectively. (See Appendix E for LEED Project Checklists). Interestingly, in the initiation of LEED the documentation was hard copies before they were able to create the websites for filing and documenting the LEED process for building projects. Leslie, the interior designer stated, “They used to do it as three notebooks before going online” (p. 4, 2010).

Additionally, there was frustration using the USGBC website for the 3.0 version of LEED. Due to criteria changes from version 2.2 to 3.0, and creating a new website for the 3.0 version for LEED buildings, there were glitches within the data links, with saving, and with document

uploading. The project manager for SMU Cheryl stated “...they were actually in there working on it and I think a couple of times it erased everything they input, and they had to go back and resubmit it all” (p. 1, 2010). Several designers, including the architect, had to input the data more than once since the site had saving discrepancies, “Criticism is it’s difficult to access their sites and register things for points, not very user friendly” (Alan, 2010, p. 2). Other frustrations involved the time it took to gather the necessary information for the LEED requirements.

Inconsistencies

For the feedback and responses from LEED on the documentation requirements, their answers were inconsistent despite the same requirements for some of the points. For example, for the LEED point Sustainable Sites Credit 4.2 (SSC4.2), Alternative Transportation-Bicycle Storage and Changing Rooms, the architect had to explain twice where the changing rooms were in relation to the building, since they were being shared with an adjacent engineering building. The issue was they submitted the same information on a previous building thinking it was clear where these changing rooms were located and that it complied with the current LEED criteria. Despite drawings and written narration, the architect had to resubmit the information. The point was granted, but it took extra time to clarify what was apparently not clear. “Different people, and you get different results, so there’s not a lot of consistency right now with the review comments and it’s making for a lot of extra time and work” (Clayton, 2010, p. 10). Many designers spent additional time explaining the design specification for a specific point before their documentation was finally accepted. Despite the inconsistencies, the designers felt that some of the points caused them to be limiting in their design solutions.

Limitations

For both Caruth and Simmons, the designers felt they were limited in the design and use of materials especially for the landscaping. The LEED site boundary requirements are to use

native and adaptive plants, and for North Texas, this is limiting. “From the landscaper’s perspective it does, and that it limits our use of plants we can use” (Lynn, 2010, p. 8). SMU agrees that plant selection can be limiting, “I think sometimes our landscaping has difficulty, not difficulty, but they rather do different types of plants, and they have to be native, and LEED is a little bit restrictive” (Cheryl, 2010, p. 2). Despite being limited in plant selection, the SMU campus does display a variety of trees and plants.

Besides the landscaping limitations, another set of criteria dealing with daylighting was restrictive. For example, the daylighting criterion, which is hard to achieve with Collegiate Georgian architecture, was not achievable despite the use of a sizable light column incorporated into the design of both buildings. Perhaps creating a “range” for the daylighting points would be a better approach, since they missed this point for both buildings. For Simmons this point was missed by .73%. It was stated by Clayton that “...their reviews of daylighting have gotten a bit stiffer and we still have it down [on the checklist], but don’t think we will [obtain the credit]” (p. 4, 2010). Despite the criticism of LEED being limiting, the designers still felt they could be innovative through their collaborative efforts in their design solutions for both buildings.

Attributes: Collaboration

The term *collaboration* was used throughout the meetings and interviews. Many of the designers were glad to be a part of the project earlier than in the traditional practice of entering at staggered stages within the design process. They felt they had a better understanding of what the owner’s goals were as well as an understanding of everyone’s role on the project. “It’s also part of the process because it helps me and the other professionals to understand each person’s scope on the team. It helps to understand the project better and feel more related to it” (Lynn, 2010, p. 5). By developing a rapport with each other and the owner, they felt to be more synchronized. One of the key elements to collaboration is developing strong working

relationships that support sharing information, "...create models on the job early with the owner and the architect to work collaboratively with them to create the design" (Charles, 2010, p. 2). Initially, there was more time spent in the design process of these buildings, "Through that whole process, and being collaborative on all issues in trying to figure out which one [LEED point] we are using and all that... is [that] everyone has to be in the room" (Mark, 2010, p. 13). Despite the criticism of spending so much time in the meetings, they were able to realize the benefits of doing so. In the design concept phase, the combination of planning and designing the buildings and integrating them into the campus both functionally and aesthetically was reported to be very beneficial to the success of the master plan. According to the informants, the concept of collaboration and bringing in the design team early, enhanced the experience and provided for a better design solution for the owner.

Having everyone on the design team early helped to generate a more accurate budget which created a more competitive bidding process for the subcontractors. Clearly stating it is a LEED project initially helped the subcontractors to provide a more accurate bid, saving time and money on the project, "...as long as it is done [stating up front it is a LEED project] and bid in a competitive environment it's not going to cost you a whole lot" (Andrew, 2010, p. 7). The subcontractors have to illustrate their understanding and implementation of the LEED requirements since they generate the submittals and the required documentation for the LEED points. Since LEED requires additional information for the Materials and Resource Credits, it is the responsibility of the subcontractor to be knowledgeable about the current market. Fortunately, with manufacturers being on board since the late 1990s, there are plenty of products, finishes, and materials to meet the specifications of the designers. Requiring green products and finishes increases the indoor air quality of the building as well as the overall quality and efficiency of the building.

Through discovering the current practices of LEED, considerations were incorporated into the programming and the design process for each building. Through time and collaboration, specific LEED points were agreed upon to obtain a minimum rating of Gold for Caruth and Silver for Simmons. In addition to collaboration, the designers had to work simultaneously in order to meet the design goals of the owner. By using the LEED criteria as a guide simultaneously with the owner's design requirements, certain LEED criteria have become a standard for the designers and SMU.

Innovation

One last attribute in which the designers agreed upon was that LEED affords the opportunity to be innovative. For both Caruth and Simmons, the primary Innovation Design Credit was Water Efficiency Water Reduction Credit 3 (WE3) for having more than 50% water use reduction. To help achieve with the water reduction, SMU's campus gray water system was used for both buildings. As for the landscaping, originally the campus was full of Johnson grass when the land was donated to SMU back in 1911. In order for plants and trees to grow on the land, the landscaping department had to spend time providing an environment where plants could grow. "So there's a lot of money and time spent in keeping what we have in good shape, but also trying to improve the conditions" (Kyle, 2010, p. 15). Now, SMU has implemented organic gardening throughout campus with the first installation occurring for the Caruth project. For Caruth, the organic gardening achieved the Innovation in Design Credit 1.4 (ID1.4), for which they obtained one additional point for proof of not using synthetic fertilizers as the facilities director, Jack stated, "Simmons, I'm not sure we went for that point or not, but on Caruth we went for the natural landscaping point" (p. 16, 2010). For Caruth, an additional Innovation in Design Credit 1.1 (ID1.1) was for the creation of brochures to educate people about how Caruth obtained LEED Gold.

For Simmons and using the 3.0 version of LEED, Regional Priority Credits are now considered additional to the Innovation in Design points. Therefore, the Regional Priority points obtained for Simmons were Sustainable Sites Credit 3 Brownfield Redevelopment (SSC3) and Sustainable Sites Credit 5.1 Restore Habitat (SSC5.1), in which they tore down old housing and restored the landscaped areas. The third Regional Priority point was Materials and Resources Credits 3-5 (MR3-5) and the Material Reuse and Recycled Content, due to demolition of that area, created a recycled content of over 50%. Obtaining these credits kept materials out of the landfills.

Despite the criticisms, there are several attributes to the implementing and using of the LEED criteria in everyday design practices. The SMU designers made it clear that the LEED requirements “raised the bar” (Dave, 2010, p. 1) in sustainable design with the criteria focusing on sustainable sites, water efficiency, energy and atmosphere, materials and resources, and indoor environmental quality, and it truly has brought about a “green revolution,” as one of the construction project managers for Caruth, Charles stated (p. 3, 2010). Being more responsible in how the profession utilizes materials and resources, plus the overall criteria for sustainable buildings, creates a win-win situation, especially by utilizing more recycled materials and using less or no natural resources. However, with the criticisms and attributes about LEED, the informants had some recommendations for the LEED process.

Recommendations: Standardizations

Through varied experiences and perspectives of the design team for both projects, and despite the criticisms and attributes, many had recommendations. They felt that these recommendations would help to simplify the LEED process to make it more efficient. Therefore, the concept of Standardization is two-fold because SMU developed their standards in a collaborative effort with the Facilities Management and Sustainability department based on

their initial experience with the Embrey Engineering Building and LEED. Specific points were sought and implemented through the design process. The specifics that SMU uses are energy points, waterless fixtures, gray water system, and controls for the HVAC systems, and organic gardening. Glen, the project manager for SMU on Caruth stated “There are certain points we’ll always go after now like energy points, design concept things like waterless urinals, gray water systems, low and no VOC paints, and the variable drives on our HVAC systems... are written into our design standards” (p. 1-2, 2010).

Another suggestion mentioned was for LEED to make specific consultants a standard, as they require a LEED consultant for the project. This stems from issues with telecommunications, “I haven’t found a company in the local area that specializes in telecommunications and that’s a problem in the design industry-in my opinion” (Glen, 2010, p. 11). Currently, AV (Audio Visual), IT (Information Technologies) and telecommunications all fall under the electrical plan, and there is a lot of information that has to be conveyed to the contractors. Separate plans are drawn up and added to the set, but there is a lack of experience incorporating the technology used today. “Maybe what LEED needs to focus on is every design has to have a specific consultant who is or has the experience and knowledge to design a specific system. Because, yes, even though telecommunications falls under the electrical, it really is separate like plumbing” (Glen, 2010, p. 12).

Through experience and lessons learned by the design team in using both the 2.2 and 3.0 versions of LEED for both Caruth and Simmons, respectfully, the LEED criteria and online process for documentation, the designers felt that standardizing a few more requirements would help simplify the documentation process as a whole. A few examples that were stated were to provide separate line items for special design conditions such as a computer chip room, or clarifying acceptable durable flooring materials, especially for laboratories. Certification costs

should be minimized considering many of the requirements are being implemented into state and local municipal codes. Additionally, the standardization of how waste was managed on the job sites was due to LEED's requirements for recycling which both contractors on these two jobs created and implemented these requirements into their standards. "Upfront, right now, it might be a cost to the contractor, but more and more contractors are pretty much making it a standard" (Leslie, 2010, p. 15). Some of the finishes used are now industry standards, such as the low to no VOC paints and adhesives, 100% recycled carpets, and utilizing various "green" finishes for the interiors. Over time, LEED itself will become a standard despite upgrading to stricter standards. "There will be a day where we won't need LEED anymore because that's going to just be the standard" (Leslie, 2010, p. 16). However, there needs to be a verification system or an audit system to make sure pertinent information is not missing.

There was some noted skepticism by the project managers about LEED certification and verification. Despite all the documentation presently required, there is not an auditing system in place to notify the owner if something is missing or needs to be resubmitted after a project is completed. One example that was given is the thermal comfort survey, which is done around the 10th month of the building's operation and then submitted for approval by the USGBC. "Thermal verification is up to 18 months after you have occupied the building. Therefore, why is it 18 months after were already done and *after* we've gotten the certification from LEED? This isn't part of the recertification... this is part of the certification process" (Glen, 2010, p. 32). The concern was that if the thermal comfort survey was done around 18 months of occupancy, then that survey could be used twice, once for the initial certification and then again for recertification (Glen, 2010, p. 33). However, the building can be awarded its certification before the survey is actually completed.

The USGBC realizes there are information gaps within the LEED criteria, and is addressing them through continued research. One in particular, is the data about energy usage of a building. Presently, it is required that the data collected contains the information not only for certification, but to see if there are design issues that need to be addressed within the criteria. For the energy calculations, looking at comparative energy modeling within the same building for comparison to see if there are any deficiencies over time makes more sense than trying to compare with other unrelated buildings. Since this is a university setting, it only makes sense to do a comparison with the baseline calculations of the same building over time. “Do your modeling, do base modeling, then do your modeling against what you have installed and then show your results against that. I would think that would be ideal and more accurate” (Jack, 2010, p. 7). This is one section that LEED is in the process of developing a system to monitor energy usage for LEED buildings over time. Presently, SMU uses Energy Star as their main energy evaluation system.

Another recommendation was to develop a better process to gather information such as a shared database for construction information and submittals. This would limit the paperwork through simplification, and there would be fewer errors in transferring data from the manufacturer’s specifications to the actual submittal, therefore keeping this process electronically controlled. “I kind of made a format so that I could collect the information more efficiently. I basically sent it out to my subs as a LEED form and asked them to fill in the information I needed, that they already had, so they just plugged it in to my form and I calculated what I needed” (James, 2010, p. 16).

Another item that makes information gathering tough was the actual requirements for telecommunications and finding creative ways of minimizing waste. Both Simmons and Caruth have excess cabling in place for future use, “What’s sad is you have hundreds of feet of cable

and then if you start looking at the unused cable, is just what amazes me. About half you use and half is spare” (William, 2010, p. 8). Sometimes the room’s usage changes due to changes in the design creating extra cable and wire to become useless. It is understood that technology is constantly changing and that they are trying to plan ahead, but having data that reflects what is actually used versus what was not used would facilitate better planning than just relying on user group needs.

For better programming and better design solutions, LEED should require a minimum of five people in a user group representing different departments. This became evident with Caruth when the Dean was the only member. “We had a user group of one person and I think that’s something LEED needs to define what a user group is and that it needs to be more than one person...they need to set a minimum of five people, and they all can’t be from the same office” (Glen, 2010, p. 9). This affected the design and its outcome in which the actual end users and students were not completely satisfied. This “committee of one” has caused some post occupancy changes in furniture and equipment for Caruth in some of the classrooms and computer rooms.

As for Simmons, there were five participants in the user group that gave a well-rounded view of what the building needed, despite the fact they had already outgrown the building because of departmental programs being added, “One for Caruth, and you had five at Simmons...you can’t please everybody, and five was a nice size” (Cheryl, 2010, p. 25). Having a better representation for the users for all buildings and sharing information would have helped designers to meet the owner’s expectations more efficiently.

Gathering Data

Another recommendation that was mentioned, which LEED is addressing, since the landscape architects felt limited in their designs, is research in the Sustainable Sites Initiative

Guidelines published by the American Society of Landscape Architects in 2009. These initiatives deal with traditional landscaping design that LEED does not presently acknowledge in the criteria as landscape architect for Simmons. Neal pointed out, “From the standpoint of LEED as a standalone system, LEED is not setup for traditional landscape development” (p. 4, 2010). LEED acknowledges the site and how its relationship to the building, but not the actual landscaping itself. However, LEED has implemented a pilot study testing these initiatives so they can address this issue for future design standards of LEED certified buildings.

The program is participating in a pilot study with 200 projects around the country those are presently participating to discover how these initiatives work with the goal to utilize some of these standards, or some measure of these by incorporating them it into the LEED framework over time (Neal, 2010, p. 5). In addition, it would be great for them to acknowledge saved trees, which are valuable in North Texas and to SMU. Presently, there is no credit given to save an existing tree or trees as the director of landscaping for SMU, Kyle stated, “So if LEED could somehow give more value to saving trees of significant size again, making it more economically advantageous for whoever is doing it, that would be a big help” (p. 20, 2010). For Caruth, the tree in front of the building was saved and designed around to do so, see Image 4.1. Originally, they were going to remove it to create a courtyard by adding trees back in, but between the president of SMU and the project manager Glen, it was suggested it stay, so it was incorporated into the design.

Unfortunately, for Simmons a red oak was lost, but its wood will be used for furniture pieces within the



Image 4.1-Saved Tree at Caruth Hall

building. Again, there is no credit that addresses this, “And it was a gorgeous, gorgeous big red oak and they tried to design around it” (Kyle, 2010, p. 21). Another suggestion about saving existing trees to gain LEED credit is to devise a measurement system based on the diameter of the trunk. “If you save a tree that is 12” is one point, 18” is another point, or whatever the case might be, then it’s easier for them [designers] to justify saving the tree or the cost of relocating it” (Kyle, 2010, p. 22). Perhaps when LEED reviews the information obtained from the pilot studies utilizing the Sustainable Sites Initiative Guidelines, more projects can receive credit for saving trees. Even as technology advances to include other types of documentation, and a more accurate existing site plan is reviewed, existing trees can be saved and/or relocated as part of the design solution.

Technology

One final recommendation that would help to simplify the documentation process would be to implement Building Information Management (BIM) technology with the LEED process, “Lean Construction and Integrated Project Delivery and Building Information Modeling...argue for early involvement, so the quality and delivery process will improve” (Charles, 2010, p. 7). BIM already addresses the energy modeling so why not use this software to generate the documentation required by LEED. Presently, BIM can be used as part of the Integrated Project Delivery or IPD, which is another type of design-build system that reinforces the idea of working collaboratively, and BIM is now a tool that is a shared resource for all the designers on a project. Having it initialize the standardization of specific LEED requirements would increase the list of prerequisites and allow the building design more opportunities to be efficient. By expounding on the categories of Criticisms, Attributes, and Recommendations, the subcategories within the categories help to discover the core category of LEED for this study.

Axial Coding based on Design

The category of *Design* is about how LEED certification changed the interaction of programming, the design process, and the decision making process. Therefore, it seems logical that the focus is on *design* because it is based on the outcome from the design process for both buildings. Each subcategory is what influenced the categories in the overall process, therefore the design outcome of the buildings. Illustration 4.2 is a cognitive map developed from the axial coding for *Design*. Through the axial coding process, the categories of User Groups, Budget, Designers and Design emerged, however through the selective coding process these categories became more refined.

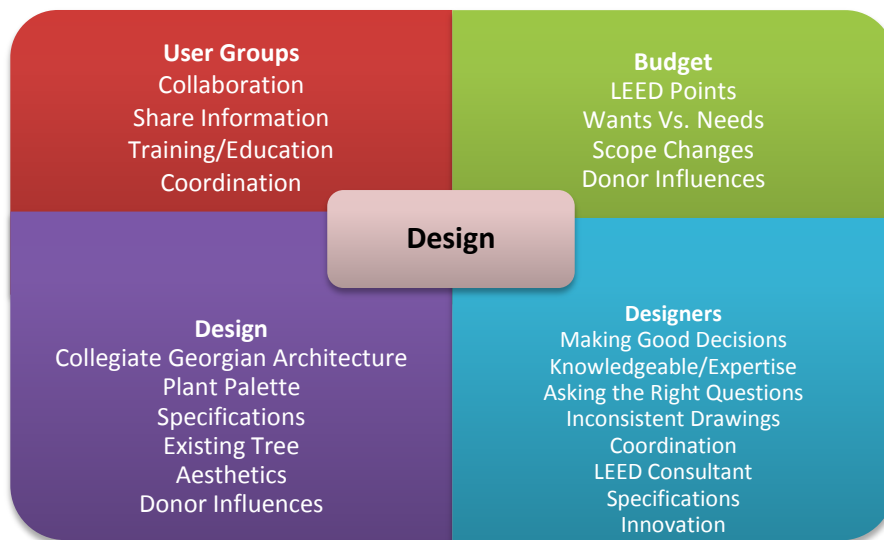


Illustration 4.2: Axial Coding based on Design

Selective Coding based on Design

For *Design*, the LEED certification process has changed the interaction of programming, the design process, and the decision making process because it generated a new set of design standards. Table 4.2 lists the key categories as Budget, Designers/User Groups, and Design Expectations with the subcategories below discovered through the axial coding process and the selective coding process where the subcategories were refined to reflect phenomena more accurately.

Budget	Designers/User Groups	Design Expectations
<ul style="list-style-type: none"> • LEED Points & Cost • Donor Influence • Scope Changes 	<ul style="list-style-type: none"> • Collaboration • LEED as Guidelines • Design Decisions in Academia 	<ul style="list-style-type: none"> • SMU vs. LEED • Design Challenges • Georgian Architectural Challenges • Innovative Design

Table 4.2: Categories and Subcategories based on Design

Findings based on Design

Budget: LEED Points and Cost

Budgets influence the decisions and changes in design that affects materials, finishes, furnishings, and landscaping just to name a few. With LEED’s interaction with programming, design process, and decision-making, the budget can affect them all. The categories discussed are LEED Points, Donor Influence, and Scope Changes and how budget played a role in these areas.

Some points for both projects are considered standard; however, it is discussed if a point might be too costly to achieve. Together, the design team decides collaboratively, based on the design concept as Cheryl mentioned, “Then you have to analyze is this a cheap point, or is this an expensive point, and if you have the funds and you need it, you go for it. If not, you get all of you cheap points first” (p. 10, 2010). For Simmons, this was the case with the storm water quantity and quality that would have been too costly as Mark mentioned, “And if someone is pursuing LEED, then these are both expensive credits to get. This is not always something to do on all projects” (p. 1, 2010). The points Sustainable Sites Credit 6.1 Stormwater Design-Quantity Control (SS6.1) and Sustainable Sites Credit 6.2 Stormwater Design-Quality Control (SS6.2) were not sought because there was no room for the storage tanks due to an underground stream. It would have been too costly to excavate 25 to 30 feet below grade and

still provide enough support for the building, “You have to have empty tanks to store water, it’s fine if you have the extra capacity to store water, but on Simmons, we would have to go in and input a ton of money into empty tanks...and that doesn’t make sense” (Mark, 2010, p. 2). There are collection tanks at the central plant, which is located across the street from Caruth, and a water tower to the east that collects storm water run-off that was utilized for these credits for Caruth. The values of various LEED points are explored during programming and are discussed throughout the project.

Despite the additional time required, the cost of designing and building a LEED structure adds 1% to 5% to the total project budget depending upon the level of certification. Many designers said they add about \$10,000 in administrative fees to their contracts because of the documentation time, longer meetings, and more design time, “This cost is factored in, so we add administration costs for documenting the points, and online even if it is the same information, it takes time and costs to document it” (Dave, 2010, p. 3). Several though, said these costs are becoming minimal because they are becoming more familiar with LEED despite LEED updating the criteria requirements. Besides the increased administration costs added by the designers, the filing fees for a LEED certified building have also increased, thereby increasing the total project budget. As for SMU, all new construction on campus has to meet LEED Silver certification as a minimum. Remodels and renovations are reviewed on a case-by-case basis depending upon the cost allocation and design limitations.

The university buildings are funded based upon private donations. The president told the project managers the allotted budget for each project. “The president always has the final say on budget, and basically what he’s saying--not that you can’t spend this money and not that I can’t lend you this money, but this is how much I think can be raised” (Cheryl, 2010, p. 7). For the construction costs for both buildings, the market at the time for bidding did influence the

budgets. Caruth was designed and the drawings were issued before the economic shift in 2008. This resulted in a higher construction cost priced from \$16.2M to \$20M. “They were 20% higher; it went from \$16.2M in preconstruction to a \$19M GMP” (Glen, 2010, p. 24). Scope changes in the project were added to include equipment and labor for the AV installation, so the final budget was \$20.4M construction cost. Caruth came in on budget despite the contractor extending the substantial completion date by six months. As for it being a LEED Gold certified building, an estimated amount of 3% additional cost due to LEED was included in the total project budget.

For Simmons, it went out to bid a year later than Caruth and benefitted from the downturn in the economy. Originally, it was priced out at \$17M, and the president wanted it down to \$16M. The final total project cost came in at \$14M. “So instead of having a \$17M dollar budget we brought it down to \$12M...we’ve got some breathing room to play and it ended up being right around \$14M” (Cheryl, 2010, p. 8). The addition of burying the utilities added \$1M to the \$12M total project budget. Actually, Simmons came in under budget by 18% despite donor influences and scope changes.

Donor Influence

As for donor influences, Caruth had one donor with specific design intentions for one of the laboratories. A separate design team designed the Hunt Laboratory for the donors, and it was still within budget.

As for Simmons, the donor was adamant about the position of the building on the site and changed a few finishes on the first level to accommodate a portrait, and additionally requested a rose garden. Fortunately, these items were within the budgetary limits of the project. As for the building orientation, as mentioned before, a red oak tree was lost, “Because on Simmons we lost an opportunity to save a huge gorgeous red oak on the southwest corner of

the building and they actually looked at shifting the building, but the donor was adamant about the building facing University Drive...They didn't ask us what it would cost to relocate it" (Kyle, 2010, p. 21).

The request of the donor was to have a rose garden on the south side of the building. "But normally the donors don't really have any input into the landscape except for this donor where she likes roses, and she was promised to have a rose garden, and that's being built" (Kyle, 2010, p. 13). Since SMU raises money through private donations, they tried to expand the rose garden to the north side as well, but they did not have any interested donors for additional rose gardens.

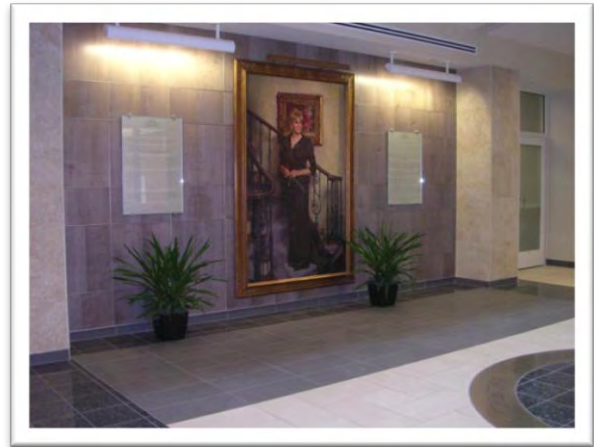


Image 4.2 Simmons Hall Lobby

The last change requested by the donor was the color of the wood panels in the lobby where the portrait is installed. Originally, the color was dark cherry, but because of the frame color for the portrait, the donor wanted a lighter wood, so the panels were manufactured in natural cherry with a warm gray finish, (see Image 4.2). For the Simmons building, the donor did influence changes and fortunately, the changes were within the budget.

Scope Changes

Because of LEED, a scope change for the landscaping occurred because they were actually considering an organic garden and were transitioning away from the traditional landscaping that required synthetic pesticides, herbicides, etc. Therefore, through the collaboration between the landscape architect and SMU, the organic garden was designed. "It was considered an innovation design credit so we did research and we worked with SMU

landscape team, and that provided us a lot of the information, and we put it together” (Lynn, 2010, p. 12).

For Simmons, the addition of a few offices, a workroom, and a conference room was added to the scope, and was within budget. “We didn’t touch our contingency, I mean the part where we went over was either scope changes by the donor, or additional scope requested by the department” (Cheryl, 2010, p. 8). Due to changes in the educational programs being offered at Simmons, modifications occurred all the way through construction, “There wasn’t a lot of moving around, or shifting until more space was needed on the third floor, which happened after construction began” (Cheryl, 2010, p. 13). These types of scope changes affected the design for each building but with little impact on the budget, unlike some items that had to be value engineered out due to cost.

End users wants versus needs are always part of a project that goes through a value engineering process. As for Simmons, a few items were valued engineered out such as dishwashers and garbage disposals for all the break rooms. “Dishwashers were pulled out of the project, and now it’s one of those things that wasn’t caught until the end, and now it’s a wish list item... they have to get it [money] out of the operations fund” (Cheryl, 2010, p. 17). The Furniture, Fixtures and Equipment (FF&E) budget was maximized for both buildings, so any additional furniture would have to come out of the annual operations budget.

For Caruth, there were finishes and AV value engineered out of the scope of the project. As for finishes, being able to use all terrazzo floors for the entire first floor and for the main stairwells was too costly, so terrazzo was used in the rotunda area only. The amount of Mesquite flooring was limited to just a transition area from the corridor to a major conference room despite it being a locally grown material due to cost. In the original design, the use of a translucent floor at the rotunda would have let the natural light from the light column

penetrated through to the basement corridors. However, fire code would not allow this due to it being a three-story open atrium. The designers had one concept to backlight a faux translucent floor, but this was too costly. “Decisions were based on dollars; I mean there was some major scope cuts from the project” (Glen, 2010, p. 24). As for the AV, due to wants versus needs as well as personnel changes, components were value engineered out. A compromise was worked out for the distance education classrooms and the auditorium. “He [committee of one] was smart enough to bring in his directors in charge of this equipment and they helped design and specify what they wanted. Two of the people were later removed from the university, so now their replacements want to use it, and are saying they need it like this...” (Glen, 2010, p. 10). Despite the change in personnel, it was too late in the process to modify the design, so the end users had to adapt to the space or the cost for changes comes from the annual operations budget.

Designers and User Groups: Collaboration

Through LEED, the word *collaboration* was elevated in meaning compared to the general concept of working together. Many designers expressed that to them collaboration meant working as a team. “I have noticed that I have felt more involved with the team because we have to go to so many meetings and ...we kind of feel related to each other because we are all working towards a goal” (Lynn, 2010, p. 7). The MEP engineer, Dave, stated that, “Most projects are now more collaborative and now that you put it that way, people say they work collaboratively, and it meant something else, now we work as a team from the beginning” (p. 4, 2010). Since LEED required everyone to be committed from the start, this facilitated communication and teamwork, despite the extra time required for design meetings. It was expressed that people who participate in a user group had their opinions, needs, and wishes for their departments or space discussed in which they worked collaboratively with the designers.

This was the case for the Simmons building, but unfortunately, it was not for Caruth. When it was time to decide on the sizes of the spaces, furniture and equipment, the department heads or end users were not involved. “He’s [the Dean] the one who decided how big spaces would be, what the building would look like, what he wanted in it, what the finishes were--he did everything, and there were a lot of unhappy occupants” (Glen, 2010, p. 9). Obviously, one person should not handle the entire design concept of a building. It takes a more collective and collaborative effort in order to produce a better design solution. It has become an SMU standard to have a minimum of five people from varied departments to participate in a user group. Originally, on other projects, people in the user groups attended user group meetings only. “What happened was when we had several user group meetings through programming, then user group meetings stopped once the building was under construction” (Cheryl, 2010, p. 4). Once it was felt that the designers had all the information required, the user group meetings disbanded, except for Simmons.

For Simmons having a user group of five, they knew what they wanted and needed in their building for the various programs being offered. “They said this is what we want, and we’d go to build it and be in construction and then, oh, you know what we need...” (Cheryl, 2010, p. 5). However, there were design changes implemented even during construction because of modifications within their educational programs, but through a collaborative effort between the design team and the user group/end users, a design solution was developed and built. One user group representative, Sue, who is the Assistant Dean of Finance and Operations for Simmons, attended the Owner, Architect, & Contractor meetings until the building was completed, as did Kyle, the Director of Landscape Management from facilities. For Caruth there were no user group, end user, or facilities representatives present. It is now a standard for SMU that one person from the user group and one person from facilities continue to participate in the Owner,

Architect, & Contractor meetings until the building is completed. This standard facilitates collaboration to continue after the programming phase and into the construction phase.

Another area discussed was that some of the user group participants did not have the design aptitude for understanding 2D drawings for three-dimensional spaces. Sometimes, they did not fully grasp the design intent because they are not trained or educated as designers to read construction documents, “We don’t even notice decorations and we’re not interior design minded, but on that category I would say...we’re the kind of people that don’t think of things like designing buildings from the ground up” (Sue, 2010, p. 7). Everyone involved in the project, including the user group, had the opportunity to review the plans. “Everybody gets to review the plans, the user group reviews the plans over and over again, and all of our departments, Facilities, Maintenance and Sustainable (FM&S), Risk Management, and the Operations Information Technology (OIT) department. They all have a chance to review the plans before they go out to bid” (Cheryl, 2010, p. 27).

However, if they are reviewing something they do not fully understand then design issues occur. For instance, on Simmons a door was left in the wrong place after a redesign and it was not realized until it was built. “I saw the diagrams of the building for months that involved a door where it shouldn’t have been where it was, and yet it never occur to me because I couldn’t make the visual connection until I could actually see the building done and that the door was in the wrong place” (Sue, 2010, pp. 12-13). The drawings made the design intangible until the components were built and realized in person as the MEP engineer Lou, for SMU pointed out, “In the drawings it looked different, and now that it’s built, oh, that’s not what we thought it would be, so now we have to make changes” (p. 17, 2010). These issues are typical in design projects, and it can be tough to communicate the design concept despite the use of drawings

and perspectives. However, user groups are necessary in order to help the designers to develop a design solution to the best of their abilities, and build the spaces to meet their needs.

The designers collaborated with the educational institution to design the learning environments. They knew that the primary end users were actually the students and faculty, despite the inequality of the user groups. The designers were able to provide what was needed, which was more space for the various educational programs for both Caruth and Simmons. They had to work within the minimal technological/electrical standards that SMU had in place. "We have a standard of two [outlets] in each office, two data, and one phone line" (Cheryl, 2010, p. 24). For the learning labs, additional electrical outlets and data were supplied. Both buildings have wireless access to the internet and intranet for the students. Providing the minimum standard was designed in some areas because of constant changes due to personnel substitutions, and insufficient programming. "I haven't seen how the AV equipment works in there, but they seem pretty standard, very typical, and basic" (Tina, 2010, p. 12). The actual classrooms and learning laboratories were designed more in depth.

As for the classroom designs the occupancy and orientation of the room was designed based upon the type of teaching being conducted. For instance, if it is a computer lab, then it is space planned to accommodate desks, seating, and computers. For Caruth, the furniture selections were driven by the department administrators. "A lot of people put on the user group were higher level, they're not the end user, and they're not in the trenches" (Tina, 2010, p. 8). If it is a lecture room, mobile furniture is selected so the room can change orientation based upon the learning activity, "it's more faculty driven then design driven" (Tina, 2010, p. 15). For Simmons the user groups reconvened to discuss the furniture selection and to review the furniture plans. Interestingly, this group was more concerned about the aesthetics of the space as opposed to function. "They were really concerned with style, look, and finishes in their

own offices, more than the whole function of the room” (Tina, 2010, p. 16). Understanding how the standards applied to FF&E helped the end users understand what they can utilize within their space. Another component for the user group, which really transitions into the end user, is making sure they understand the implications of LEED and the recycling programs that are required.

LEED as Guidelines

LEED facilitates continuous communication between the design team and the owner. “Communication, because we’re a very involved owner. I don’t think a lot of consultants understand how heavily involved we are” (Glen, 2010, p. 12). Another facet that was realized is the necessity of having a LEED consultant on the project that fully understands LEED and can aid in the design process. “It’s better to have an outside consultant for it. It makes it easier because they’re up on all the standards because it’s their full time job to ensure LEED” (Cheryl, 2010, p. 22). It was stated having outside consultants as opposed to an in-house LEED consultant was more beneficial since they are dedicated to the project, and fortunately, for both buildings they are a part of the architecture firm used for both building projects. Requiring a LEED consultant, as well as sustainable practices in the forefront, exposed limitations and promoted innovation. By working as a collective entity with LEED, they assisted the owners in meeting their goals.

In designing both Caruth and Simmons, and from the experience of designing and building Embrey to LEED Gold, the points obtained for Embrey were used as a guide. Through that experience, many of the LEED points became standard in the majority of projects for SMU:

So we started with the Embrey checklist marked with any mistakes we had made and then went from there. So you basically go through a charrette about what points you’re going to do, and you have most marked as “maybe’s” when you are at that level. Then as you go through the process of the design of the

buildings, then construction of the buildings, all of those that were “maybe’s,” go one way or the other--yes or no (Jack, 2010, p. 11).

Once construction was half way completed, and the LEED design points were finalized for the project and were submitted for review by the USGBC. “Those LEED points that we were going after were flushed out pretty much after the CD phase” (Glen, 2010, p. 25). In essence, the design and the LEED points that were achievable happen simultaneously throughout the design process. “It is simultaneously-sometimes it leads the design and sometimes it follows the design” (Clayton, 2010, p. 7). A couple of designers expressed their concern about designers focusing solely on specific LEED credits and not utilizing the best design solution for the client. “I think they [designers] understand the implications for the point. I just think they are so bound and determined to get that credit that they throw a lot of the good design decisions away, and then some of the design decisions aren’t made” (Mark, 2010, p. 3). Fortunately, this was not an issue for either Caruth or Simmons because the owner was actively involved with each project and they see LEED as it is, as a set of guidelines to design sustainable buildings. “I don’t think they look at the credits. The architect can control a lot of the credits, and the MEP can control a lot of the credits, and the site controls a few credits, and when you get down to structure, like I said, there’s the kind of almost “gimme” points because structural steel is 95% recycled material” (Edward, 2010, p. 8). Using the LEED criteria as guidelines for designing both buildings was aided with the requirement of third party verification through commissioning to ensure the buildings operation systems were appropriate and worked as intended.

As discussed previously, budget, scope changes, and donor influence affect design decisions; however, from the designer’s perspective other factors were considered in designing the outcome for both buildings. These factors were about programming and asking the right questions, participants being proactive throughout the process, design changes based on the

owner and LEED points, and the long-term perspective of the landscape's lifecycle. Despite the programming efforts for both buildings, there were not only concerns about the right amount of people participating in user groups, but asking the right questions throughout the design process. Some information, through hindsight, never came to the forefront. Transitions within specific departments and personnel changes hindered the communication process despite both buildings turning out well. "With the people in the trenches, they might have asked questions, but not asked the right questions to the users to get the right answers relayed up the tree" (Tina, 2010, p. 8). From the perspective of the user group, they did not know what questions they needed to ask or answer; there was a disconnect within this process,

We answered the questions we were asked as far as I can remember. We never really initiated much it was they who asked questions. It was probably there were many questions for us that should have been asked, but were not. Then we weren't proactive in that regard either (Sue, 2010, p. 8).

For both buildings and for the people involved, the majority were in various stages of understanding and incorporating LEED into their processes. "We learned another lesson on what level we need to be involved" (Kyle, 2010, p. 8). Through better communication, many of the design decisions could have been more collectively decided. "That the decision making process should have involved more people than even just the few in the meetings we had" (Sue, 2010, p. 2). Another example of not asking the right questions was the growth anticipation for Simmons. "What we were short sighted on, was we were not planning for the growth that we have had since we began the process, literally we have actually outgrown the building" (Sue, 2010, p. 13). It has been noted that there needs to be better programming in order to make sure the end users are satisfied. "Programming is an issue too, because they don't know the questions to ask" (Tina, 2010, p. 9). Presently, SMU is creating more finite questionnaires to aid

in the programming to facilitate better design solutions, since Tina stated there were information gaps within the programming.

Design Decisions in Academia

Design decisions were based on the LEED points that became standard, and others that were a possibility based on the owner's requirements. For both Caruth and Simmons an example is the use of a gray water system to satisfy both Sustainable Site Credit 6.2 Stormwater Design-Quality Control (SS6.2), and Water Efficiency Landscaping Credit 1 (WE1) and are standards that drive the landscape design. Design decisions were made about the type of plants that can be used because they have to consider the lifecycle of the plants versus the building itself as Neal, landscape architect for Simmons stated:

In site development were dealing with a living entity that has to functions on the same level the first day it's completed, but we also have to look out at 5, 10, 20, 50 years to understand how that site's going to evolve and change over time...some of this material is going to require that it be redeveloped, and what form that it's going to take over time (p. 2, 2010).

Another design decision for the landscaping was the type of irrigation system to use since they use the gray water system is used for irrigation. The two types of irrigation systems considered were drip and spray. For SMU, spray is preferred because it is easier to maintain compared to the drip system. The drip system is underground and any breaks in the line are hard to locate. Another issue was that during the dry season, small animals could infiltrate the lines and destroy them. Therefore, through a collaborative research effort from SMU and the landscape architect, the decision to use the spray system was designed and is an SMU irrigation design standard. "So I just wanted to show you how we [she and SMU facilities department] went through this process of researching and talking with the different experts, and one of them said that rodents get into the tubing" (Lynn, 2010, p. 15). Through collaboration and research,

design decisions were made by the design team and owner. However, that does not mean the design team did not have challenges in meeting the expectation of designing and building both Caruth and Simmons.

Design Expectations: SMU vs. LEED

The focus of the design expectations for both of these buildings was to have SMU be completely satisfied with the design outcome for both buildings. The designs had to meet the basic standards and expectations SMU has in their standards manual. Standards included following the Collegiate Georgian architectural style of the campus, building above design standards so the buildings lifespan is around 100 years, the specifying of green finishes with low to no VOCs, using low flow fixtures, and selecting the proper brick color to blend in with campus. It was challenging to the designers to meet the expectations SMU put forth because of SMU's commitment to being involved with all steps of the design process and decision-making. SMU had communication expectations of the designers and the consultants, which at first, the designers did not take seriously. SMU has a very elevated consciousness about sustainability and what it requires, as well as what it expects. Besides the standards discussed, SMU's additional design expectations for both buildings were quality, aesthetics, flexibility, durability, and efficiency.

The SMU community considers itself to be the "Harvard of the South," so quality of the materials being used both in the interiors and on the exterior are very important to maintaining their "brand." Emphasis is placed on the brick selection, and was done as soon as possible as Cheryl expressed, "Because of Georgian architecture and the brick is such a huge quantity factor, and a high percentage, that we are restricted to the type of brick used, and that sometimes poses issues on where it comes from" (p. 10, 2010). With LEED requiring a radius of 500 miles for local materials to count for the Materials and Resources Credit 5.1 Regional

Materials 10%-20% Extracted (MR5.1), and Materials and Resources Credit 5.2 Processed & Manufactured Regionally (MR5.2) for version 2.2, and Materials and Resources Credit 5 Regional Materials (MR5) for version 3.0, SMU more than met the quantity requirements. The president of SMU has the final approval for the brick based on an 8' by 8' mock-up panel. This is just one example of SMU's expectation for the quality of the material, and with aesthetics equally considered.

Aesthetics is important to SMU because of its obligation to the stakeholders to provide the best designed facilities, the best landscaping, and the best finishes representing the university. For the designers it does help them to know what the expectations are, as interior designer Leslie mentioned, "With them, it is knowing what they expect and then meeting that expectation or exceed their expectations" (p. 28, 2010). With the university's colors being blue and red, it was tough to implement those colors without looking like primary colors as Leslie stated. "How many different ways can you make blue and red look without making them look like blue or red?" (p. 7, 2010). SMU's resource coordinator, Tina said this about her experience with material selections and the people's response: "They were more concerned with the number of bodies that could be in a room, and that's pretty much it, and how it looked finish wise. They wanted it to look "pretty," I think it looks pretty" (p. 17, 2010).

There was a similar concern with the landscaping in meeting the end users' expectations as well as SMU's despite feeling limited to what LEED would allow them to use as Kyle of facilities stated, "I guess in our point of view it just restricts what our options are when you are thinking about landscaping and the buildings in relationship to expectations of how it's supposed to look with the rest of the campus" (p. 1, 2010). SMU likes to use a variety of plants so that it does not become monotonous over time. "It can make it restrictive so it can become boring because you have the same plan material from one building to the next because, yeah,

that works and you use it the next time...and you don't have the chance to expand your plant palette" (p. 2, 2010). Besides the beautification through the landscaping, the quality and durability of the plants must be considered to minimize time and cost for maintenance and materials.

In addition to aesthetics and durability, flexibility in the space planning was not only an expectation, but also a requirement as SMU has so many functions planned throughout the year. The flexibility of furniture arrangements for the classrooms had to reflect the varied teaching styles of the faculty, and had to be multi-functional as Tina mentioned, "Other functions for the room other than for teaching are still school functions, just not teaching functions" (p. 17, 2010). For Caruth, there was a change in what the philosophy for the role of the engineer as project manager Glen said "They are trying to get engineers to start thinking as ambassadors and cultural enlightenment. More aware of culture in other countries, and the problems that exist out there, outside of engineering" (p. 17, 2010). The incorporation of glass for full and partial partitions was used throughout Caruth to facilitate open communication. This was something that engineers were not always comfortable with as Glen mentioned:

In Caruth, you'll notice a lot of glass in all the office doors, or a lot of them are glass. It is so professors do not sit behind closed doors and block themselves off from the world. Even the corridor walls are glass, so people can see what is going on. It's very open, no longer can you go and hide, and it's going to draw many people out (p. 17, 2010).

The designers did meet this expectation to provide flexibility in accommodating communication for the faculty and students. Despite the flexibility of the spaces to suit a variety of activities, efficiency of space, energy, and water conservation were equally expected regardless of LEED.

Despite LEED requiring energy and water efficiency, SMU requires this as well. It is considered intelligent design as well as common sense to be environmentally conscious. Both

project managers said energy efficiency is expected in all new construction on campus. “We would have had a quality designed and energy efficient building...whether we pursued LEED or not” (Glen, p. 27, 2010). It was also mentioned by SMU’s quality control MEP engineer Lou that the buildings have to be designed efficiently. Energy conservation is always a consideration for SMU. “We in general try to incorporate as many energy measures to reduce energy usage in the buildings as we can. We did that before there was LEED” (p. 1, 2010). One of the main requirements is increasing the insulation value for the walls to reduce the amount of thermal transmission. Lou discussed how LEED helped with the concept of daylight harvesting and better usage of light, “More efficient light sources with LEED because of a bigger impact of trying to do daylight harvesting and taking advantage of ambient light levels” (p. 1, 2010).

It is expected there would be an efficient use of water, which SMU had already implemented in a gray water system a long time ago due to Dallas enduring droughts and watering restrictions. This way, SMU limits the strain on the domestic water usage for the surrounding areas. For Caruth, the Stormwater Quality and Quantity credits were easily achievable, but for Simmons, as mentioned before, it was not. However, all new buildings are tied into the gray water system as Mark explained, “SMU stores water quantity because SMU does try to reclaim rain water run-off for use in irrigation as gray water, and the system is set up to save the water, pump the water, store the water, and reuse the water” (p. 1, 2010). So for SMU it is expected to conserve as much water and use it more efficiently for irrigation and flushing. For SMU the expectations are high because they want to be environmentally responsible as well as provide efficiently designed spaces that can be used effectively for teaching and learning, with a strong reflection of good design decisions.

In addition to dealing with the Georgian architecture, site planning influenced the design orientation of the buildings. For Caruth, a tree located at the northwest corner was

designed around despite no recognition or credit from LEED (See Image 4.3). Unfortunately, for Simmons, and because of donor influence, a red oak was lost due to the insistence of the orientation of the building. Preservation is important to SMU, but the university's president has to take into account all considerations for the building as well as for aesthetics. The university president makes the final decisions for the brick, landscaping, and interiors in order to maintain the SMU "brand" and their ideology.

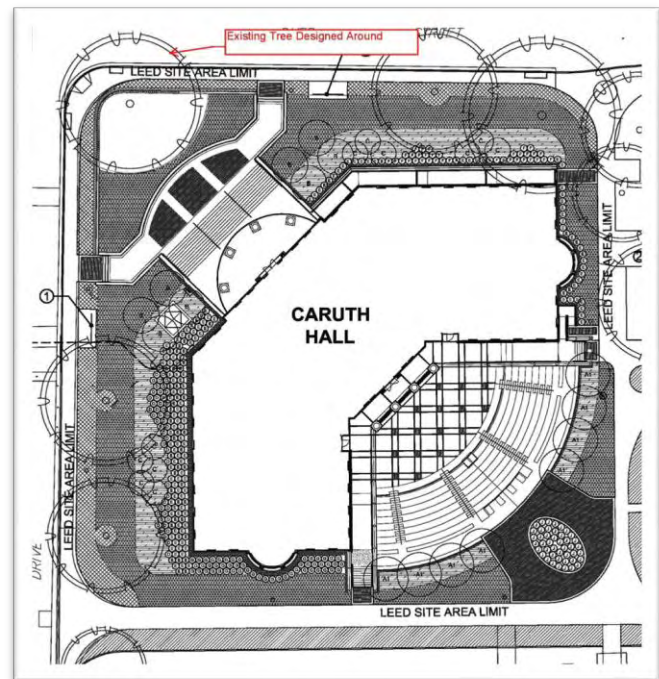


Image 4.3 Caruth Hall Site Plan

Design Challenges

One challenge for the designers was the coordination of the drawings. As usual, changes were made but not everyone received a copy of the changes. This happened from designers through to the contractors. Changes in space planning cause changes in the electrical plans and depending on whose drawings were used; some of the information was missing. "The drawings, as it turns out, that it was just on those that the designer used, and not on the others. So when I saw them, I saw the data lines there, yet that was not what the contractor's was seeing, so it was extremely difficult" (Sue, 2010, p. 11). In reviewing the furniture plans, there were gaps in the space planning of areas that were not addressed. Fortunately, these errors were caught and rectified as Tina discussed, "I thought just looking at the plan, the drawings I had had gaping holes that I thought were missing and went over those things with the end

users” (p. 9, 2010). Besides coordination issues with the drawings, coordination between the designers and the contractors was more challenging than usual. “It’s more of a coordination issue between us, architecture and mechanical, and that was our roof drains coming down into the building. Where they came down a chase or a wall, it’s supposed to be that these fit into a six inch wall...” (William, 2010, p. 20). The pipe that was specified started out at eight inches and tapered to five inches, so it caused the chase to be furred out more, causing the furniture not to fit within the allocated space properly. Changes made on the furniture plans were not updated on the electrical plans, causing outlets to be installed in the wrong places. “So you’re trying to follow up and catch everything, but sometimes that’s why it comes up where there is a data outlet on a wall that doesn’t have furniture, well the furniture got moved” (Leslie, 2010, p. 9). These types of issues caused a domino effect in the construction of the design, and it came down to coordination.

The designers had challenges with planning the technology. Despite clarifying what the end users would need and strong input from the faculty, there were problems with the location of the equipment and the type of equipment being specified. One issue for Simmons was the planning was back in 2007 and technology had advanced. “We started planning in ’07 and moved in ’10. Through the planning we had our IT and AV consultants, even from the time it went out to bid which was last July ’09, technology changed, and it’s hard to plan for those changes” (Cheryl, 2010, p. 24). Installation was a challenge and is apparently so for every project, “Very confusing. I mean it was because you have the user, but then when the AV people get in there...it changes so much” (William, 2010, p. 8). Trying to plan for the future with ever-changing technology is extremely difficult for new construction projects.

Georgian Architectural Challenges

The new Caruth Hall is more efficiently designed compared to the old Caruth Hall. The old Caruth Hall had a 43% efficiency rate in useable space compared to the present Caruth with a 72% efficiency rate of use. Glen mentioned, “The classrooms are shared across campus and we’re going to get, hopefully, 72-75% utilization of all spaces” (p. 21, 2010). The older Caruth Hall had thicker full height walls and wider corridors compared to the new Caruth Hall. With the corridors more streamlined producing more usable space for offices, conference rooms, laboratories, etc., this feature will accommodate the varied functions SMU schedules. Cheryl mentioned that because of the Georgian architecture, space planning is not efficient. “Our buildings are not an efficient use of space because of the Georgian architecture, and it makes it hard to design. You’re not getting a great net square footage usage for the spaces” (p. 11, 2010). Fortunately, for both Caruth and Simmons, despite the Georgian architectural exterior, the interiors are designed more efficiently with a contemporary aesthetic.

A design challenge for the design team was working within the confines of Collegiate Georgian architectural style of the SMU campus. The points for Daylight and View in Environment Quality Credit 8.1 (EQ8.1) and Environment Quality Credit 8.2 (EQ8.2) for LEED in versions 2.2 and 3.0, respectfully, were not achievable for both buildings despite the innovation of adding a light column in the atrium of both buildings, “We had beneficially, but you have to get light into the interior, and some places we had borrowed light, but we couldn’t get enough, and we had a partial basement” (Alan, 2010, p. 5). Georgian architecture lends itself to sash windows that started out originally on some of the buildings as nine-over-nine panes. The architect, Alan, specified the largest windows that were coordinated with the Georgian style, but they still were not able to achieve these credits. “They are champions of LEED. The restrictions of the campus architecture wouldn’t allow you to do everything that was LEED

friendly” (Alan, 2010, p. 5). Despite not achieving the daylighting points, they were able to achieve Indoor Environmental Quality Credit 6.1 Controllability of Systems-Lighting (IEQ6.1) with daylight harvesting by using occupancy sensors.

Another design challenge mentioned by Edward was getting the details for the structural steel, “There’s a lot of structural steel trigger work that goes into the masonry which is typically the most challenging part is getting all those details right on these projects” (p. 16, 2010). For Caruth, there is a massive cupola that required extra support and framing for it to be set correctly. “The big copulas are always fun to frame out...we have to frame those things out with extra wood and steel” (p. 16, 2010). These added architectural elements were a bit challenging, but were accomplished. Another Georgian architectural feature is the side gabled pitched roof done in slate that has dormers placed symmetrically on both sides. With this requirement, they could not obtain the Sustainable Sites Credit 7.2 Heat Island Effect-Roof (SS7.2) for either building since these credits are for flat roofs.

Innovative Design

An innovative design feature for Caruth is that it has a 45° angle splitting the building into two wings providing an exterior amphitheater (See Image 4.4). As for Georgian architecture, Glen stated, “We stretched the boundaries of Georgian architecture on Caruth-there’s a 45° angle and it’s not a strict Georgian architectural building like the rest of

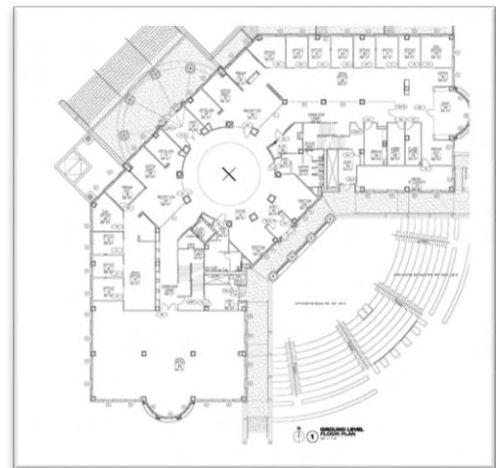


Image 4.4 First Floor Caruth Hall

the campus” (p. 22, 2010). By including an exterior amphitheater, it allows teaching and visiting lecturers to be outside since Texas has nice weather most of the time. It gives the students more freedom for interaction, and they have access to wireless systems within the university.

Another innovative design feature was the use of a variety of finishes illustrating a more contemporary aesthetic compared to traditional Georgian architecture. The use of glass for partitions, glass tile, terrazzo, granite, Texas Shell stone, stone, ceramic tile, laser-carved MDF board, polished Venetian plaster, paint, wood, and wallcoverings entailed much more than just



Image 4.5 Caruth Hall Lobby

rendered view, Images 4.5, of the atrium in Caruth with a close up of a few of the interior finishes, shell stone, glass tile, and tile illustrate these finishes in Image 4.6.

typically painted and tiled partitions. The glass tile used was made of recycled glass. The shell stone is a local stone used in several SMU buildings. The use of recycled and local materials fit right in with

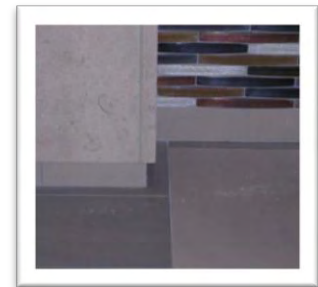


Image 4.6 Caruth Finishes

the LEED requirements. A

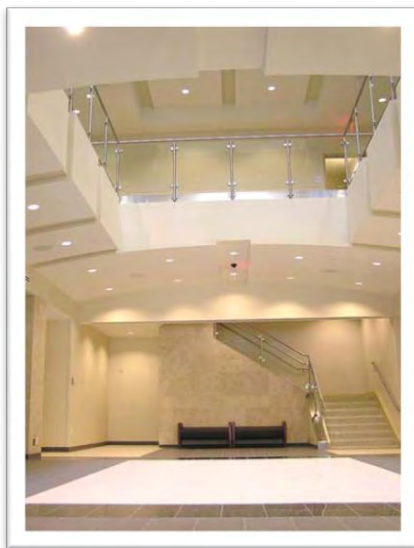


Image 4.7 Simmons Hall Atrium

Fewer of these finishes were used for Simmons, but it is a smaller building compared to Caruth. For both buildings though, a light column is centrally located within the building and washes the interior with plenty of natural light on all floors. Despite not being able to achieve the daylighting LEED credits, the light column has now become a design standard for SMU. Pictured is the finished light column from the first floor in Simmons (Image 4.7).

The learning environments for SMU focus on student learning in the sense of making sure the students had access to the information they need. For example, in Caruth, there are seven distance education classrooms that are set up to record and

broadcast a professor's lecture, so that information can be obtained remotely. "Distance education is a huge thing for the School of Engineering, so again we have designed all the technology required for that purpose" (Glen, 2010, p. 16). The primary learning laboratory is the Innovation Gym:

It is a huge, it's a very large space that is so multi-functional that they can change the configuration in minutes, and they can build projects in there that cannot be built in regular classrooms. It's open 24/7 so the students can get in there and work, and it houses the most recent technology (Glen, 2010, p. 15).

This space actually houses the Skunk Works Laboratory modeled after Lockheed's secret research laboratory. It is a secured, partial glass-partitioned space located on the first floor of Caruth. The idea of utilizing glass partitions for many of the spaces was to increase visibility, see Image 4.8. In this laboratory the students



Image 4.8 Skunk Works Laboratory

are encouraged to solve all types of problems creatively and innovatively. The Dean of Engineering is very progressive, and has provided the best possible learning environments for the students, "He is a very forward thinker, and we've got two excellent spaces that are very forward thinking, and will expand the way engineering is taught to students" (Glen, 2010, p. 15). Other design features that facilitate learning are meeting areas. "We have a lot of break-out spaces, so if someone gets an idea they can grab four or five people and go right to the space and talk through the idea's inspiration" (Glen, 2010, p. 18).

In addition to the Skunks Works Lab is another learning laboratory called the Hunt Space. The official title is The Hunt Institute for Engineering and Humanity. This space is housed

on the second floor in Caruth, and the donor had explicit instructions and used an outside design team for this area. (See Appendix F, Caruth Hall, Second Floor). This space is for the students to focus on solving third world problems in housing and to improve the quality of life through engineering as Glen discussed:

Hunt's space is for thinking about today's problems in third world countries and how that can be addressed. Their first assignment is to provide sustainable housing in third world countries that can be put up in 24 hours after a disaster, and can be lived in 24/7/365 days a year(p. 16, 2010).

This laboratory is another example of progressive thinking by the School of Engineering.

A third space that has all the latest technology with the ability to record, broadcast throughout campus, and via the web two-way, is the Vester Hughes Auditorium on the first floor of Caruth. (See Appendix F, Caruth Hall, First Floor). Besides just being a lecture hall, it exposes the students to a variety of prominent people in the community and within the varied engineering disciplines.

The Vester Hughes Auditorium is a 144-seat auditorium with one projector screen right now with provisions made for an additional two screens. It's has cameras and is all controlled by a control room which contains all the latest and greatest AV equipment which allows them to broadcast anywhere in the world (Glen, 2010, p. 17).

Simmons has a few distance education rooms and several classrooms. Its main classroom or laboratory is the Locomotor Performance Laboratory for the Department of Applied Physiology and Wellness Laboratory located on the first floor of Simmons Hall. A research laboratory provides the students with real experience in monitoring and learning about human physiology (See Appendix G, Simmons Hall, First Floor). This space has treadmills and

computers to monitor stress activities, metabolic activity, and performance duration due to exercise for master's and PhD students:

The students are totally practicing on live subjects, and those subjects are actually performing right there in the space with the treadmills on the force plates, and the computer technology, whether you're watching the person run, or if you're analyzing the data once it's been sent back to the computer (Cheryl, 2010, p. 3).

This space went through several changes, even during construction, due to personnel changes. The faculty researcher was involved in the design and electrical requirements for the variety of equipment needed for this type of research. "The space incorporates high speed cameras, I think the AV package in the building facilitates that, and the moveable furniture--it's not your typical classroom setting" (Cheryl, 2010, p. 3). This is a very prominent learning space for Simmons Hall.

For both Caruth and Simmons, the incorporation of monitors and green screens to aid in recording and broadcasting lectures, the use of mobile and stationary marker boards, projectors and screens, and moveable furniture to accommodate activities and functions was provided as well as extra electrical and data outlets for the students. "They did provide the students with power and data access, that's so if they have their laptops, their phones, they're things you need to do business and to communicate. Now there's a lot more power access in the classrooms, and they can access it from the floor or wall" (Tina, 2010, p. 22). As for the space planning of the classrooms, mobile furniture was used to facilitate learning activities. "I still did mobile tables that they could reconfigure" (Tina, 2010, p. 15). An interesting observation was given about the classroom sizes from the end user:

We wanted to have space where visibility was good from all points in the room. The feeling would be that class would not feel as large as it actually was. So we

wanted a feeling of smallness, so the students wouldn't feel overwhelmed. In fact, if there were a lot of student in there, typically you get that feeling better with a square room then with a long room because the students in the back feel isolated and removed. Therefore, with the square room, you can make the distance less between the instructor and the student sitting in the far back (Sue, 2010, p. 5).

This was a great piece of information, especially for designing learning environments. Simmons Hall is the School of Education, so occupants and end users should have a clearer concept about what it entails to create and design strong learning environments. Through innovative design solutions of implementing a light column, an exterior amphitheatre, the use of various finishes and creative learning environments gives both buildings a more contemporary feeling by having provided aesthetically pleasing spaces to enjoy for years to come.

Axial Coding based on Decision-Making

The focus for the axial coding process for *Decision Making* was on how decisions were made throughout both projects that affected time, cost, and the quality of the built environment for both Caruth and Simmons. In the axial coding process the interrelationships that become evident are Sustainable Materials, Quality Issues, Time, Cost, and Quality. The cognitive map, Illustration 4.3, is showing the initial categories and the variables that emerged from analyzing the data.

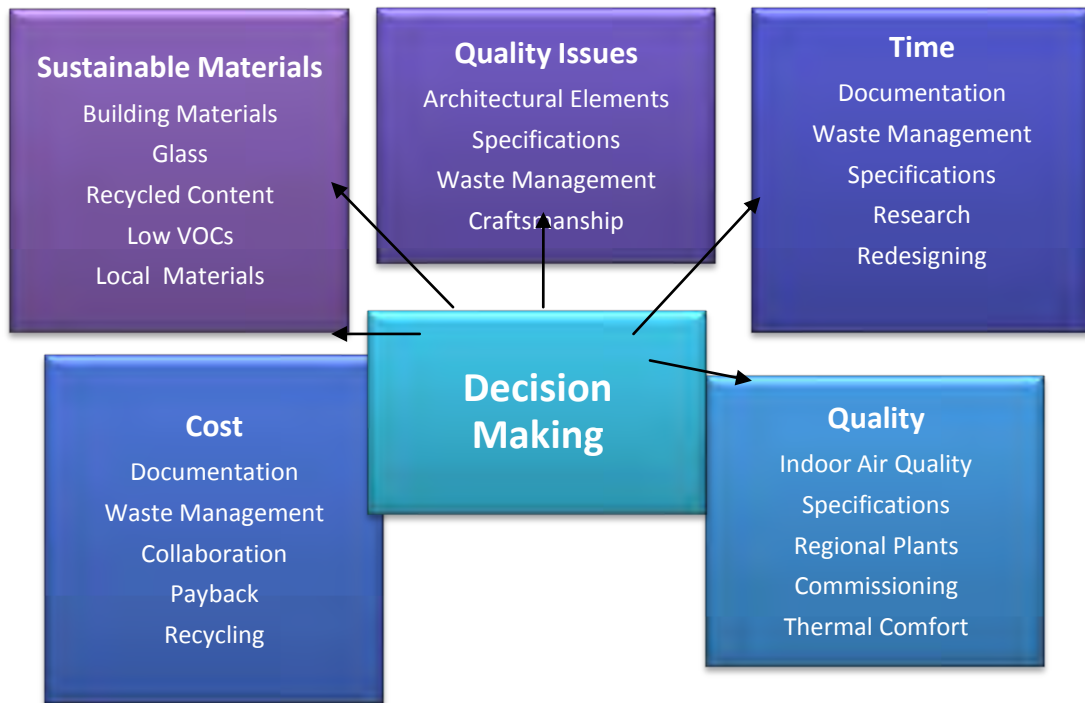


Illustration 4.3: Axial Coding based on Decision-Making

Selective Coding based on Decision-Making

Based upon the current practices, the programming, the design process, and the decision making process for these two LEED certified buildings, the following influenced *decision-making* and the quality outcomes for both buildings. For *decision-making*, the analysis within the selective coding process revealed the interrelationships within the categories, for example, analyzing a material based on quality and cost for construction, the result is refined to Time, Cost, and Quality for the overall projects.

Time	Cost	Quality
<ul style="list-style-type: none"> • Design Process • Documentation 	<ul style="list-style-type: none"> • LEED Points • Recycling • Payback for SMU 	<ul style="list-style-type: none"> • Built Environment • Green Finishes • Sustainable Construction Materials • Commissioning: Start Early

Table 4.3 Categories based on Decision-Making

Findings based on Decision-Making

Time: Design Process

Time was more of a factor for Caruth compared to Simmons in completing construction. Through issues with design, installation, documentation, and the impact on the schedule, several items took longer than anticipated due to human error and the design team going through a learning curve. So more time was spent reinstalling parts, redoing forms, and concrete pours, which extended the substantial completion date for Caruth. For the contractor, documentation for the LEED construction points took more time to keep records of all the recycled materials and gathering the recycled content information from the subcontractors for the calculations for the construction points.

One item that took a considerable amount of time was the amphitheater concrete design. SMU wanted a more aesthetically pleasing two-toned concrete for a contrast, but after a few months of rehashing the design, and obtaining pricing, it was considered too costly, so they ultimately decided to revert to the original design. The contractor felt they spent too much time meeting on it. “We spent a lot of time on it ...was the concrete for the amphitheatre...spent a lot of time trying to redesign and re-price it, and then we went back to what was originally drawn” (Andrew, 2010, p. 12). The structural engineer, Edward, changed the drawings and discussed the use of a



Image 4.9 Caruth Hall Amphitheatre



Image 4.10 Caruth Hall Amphitheatre Seating

topping slab so the finish could be controlled more. “Fortunately they decided at some point they couldn’t get the finish the university wanted without pouring a finish slab on top of it...had us change the drawings, then they decided that it costs too much to pour structure and then a top slab” (p. 5, 2010). Despite the time used, the amphitheatre was nicely designed and built (See Images 4.9 and 4.10).

One element that repeats itself for all the buildings is installing the signage on behalf of the donor’s name in both proportion and scale; it was very challenging. Despite SMU



Image 4.11 Caruth Hall Signage



Image 4.12 Simmons Hall Signage

standards on the font, Times Roman, and the distance in between lettering of $3/8$ ”, determining the location of the joints in the stone was crucial to the proportion of letters and the overall aesthetics. This attention to detail takes time, but through collaborative efforts between the contractor, owner, and design team, the president was able to make a decision and give his approval. Images 4.11 and 4.12 show the installed signage reflecting the donor’s names as designed for both Caruth and Simmons.

Documentation

Verifying materials that have not been used before by comparing LEED specifications to manufacturer’s specifications took time for both the subcontractors, contractors, and the architect. The assistant project manager of construction for Caruth discussed the challenge of obtaining the information needed. “That’s just trying to pull everything together and most of that is trying to get it from other people...but it’s one of those things that you’re budgeting your

time for” (James, 2010, p. 10). There was the issue of verifying substitutions in materials as William states, “The worse thing is when we check shop drawings and they try to change a material, then trying to do a comparison to make sure you know that not just the material, but that it’s the LEED aspect and that too, is time consuming” (p. 4, 2010). The same was expressed for Simmons. As mentioned before, both contractor teams implemented a Waste Management program, which is required for LEED points Materials and Resources Waste Management Divert from Landfill 50% (MR2.1) and Materials and Resources Waste Management Divert from Landfill 75% and (MR2.2) for the 2.2 version. For LEED 3.0 version, it is Materials and Resources Construction Waste Management (MR2), and up to 2 points can be awarded, which was achieved for both Caruth and Simmons. However, it did take additional time to document this information but it truly pays for itself and keeps materials out of the landfills.

Cost: LEED Points

Costs have been discussed throughout this chapter, but for quality, the costs being discussed here are about how cost influenced decisions that affected the time and outcome of the projects. Some of these costs are allocated to the project, the contractor, the designers, the subcontractors, and some costs are LEED influenced. It is an added cost to the subcontractors if they do not install materials according to specifications or drawings or there are substitutions, as William discussed:

We go through the trouble up front to make sure with what we specified. Then a lot of times what happens, either a time issue, or they delayed ordering, then they try to find something else... we make sure it’s equal to that and that we aren’t losing a point (p. 4, 2010).

The subcontractor had to find acceptable substitutions in materials that coincide with the specifications and/or drawings and by not planning ahead, additional costs in shipping or the

substitution was more expensive. Verification of this information by the construction administrator and designers takes more time as well.

LEED requires a minimum level of commissioning which can be expensive, but it is a worthy investment to know that the equipment being specified is installed and operating correctly. “Our fees are a small percentage of the project costs for what you get. You are paying someone to make sure it all works” (Steve, 2010, p. 29). With a LEED building, the option of doing the Enhanced Commissioning is that of the owners because of the prerequisite for basic commissioning. The requirement for the Energy and Atmosphere Prerequisite 1: Fundamental Commissioning of Building Energy Systems is that there is a commissioning agent on board at the beginning; at least before construction documents are started. As Steve, the commissioning agent for Caruth said, “Then we have the design process, so we’re a part of the design process” (p. 4, 2010). The commissioning agent has the role of third party verification. Enhanced commissioning does cost more because the commissioning agent checks all mechanical, electrical, domestic hot water systems, renewable energy, drawings, specifications and submittals. The owner can participate as well, as Steve mentioned, but there are repercussions:

The owner can say they’ll do the design review with the designer, and they’ll strike through that we don’t need a third party. Well, if they do that they can’t get their LEED Enhanced Commissioning [point]. So, yeah, there is an extra cost, and they think there is, but we always provide pricing because we want to do it, and it’s a matter of budget for them. (p. 29, 2010).

For Simmons they did not do the enhanced commissioning but wished they had. It is beneficial to do enhance commissioning on all new construction LEED buildings despite the extra cost because it ensures that the designed operating systems are working correctly. Dave stated, “It’s valuable for LEED to requiring this. Commissioning is the key, the building systems have to be set up right and commissioning helps with the quality of the building” (p. 4, 2010).

Interestingly, Charles mentioned that the cost of designing and building a LEED certified building is becoming “cost neutral” as he stated:

The early assessment of LEED is that it was 2% to 5% cost premium, and the stuff in the articles these days and the claims I’ve seen, is that it is cost neutral or cost beneficial, and so that’s just for the cost in the boundaries of the projects that doesn’t take into account the external costs such as healthcare problems (p. 8, 2010).

Perhaps as LEED is adopted more often, the costs will become cost neutral; however at present there is still a cost associated with designing and building LEED buildings.

Recycling

As for the occupant’s a recycling program has to be implemented per LEED. The newly constructed buildings will eventually move into an existing building category and will have to become recertified over time to maintain their status as a LEED Gold certified building. However, LEED requires a recycling plan that has to be integrated into how the occupants use the building.

I always like to do the example that in new construction that the owners live in a LEED building, and that they are not necessarily “green,” okay. So they live in a green building, but are not necessarily green, but when you do an existing building, now they **have** to be green (Jack, 2010, p. 10).

Since these buildings will move into the Existing Building category and LEED will not only require a recycling plan, but a plan to monitor how much recycling occurs. “There’s a big shift now, and it matters how much you’re recycling, not the fact you have recycling containers” (Jack, 2010, p. 10). The actual training of the end users is done based on information provided to the directors or managers of those departments. They are developing strategies to include training in the student, faculty, and staff orientations on the policies for recycling. “We have flyers that go out, and we work with the managers of each of the buildings so they can do it [training]” (Jack, 2010,

p. 22). The flyer and recycling bin plans are located in Appendix H. So through collaboration and information sharing between consultants and facilities, end users should understand how the buildings perform. By training and educating the people using and maintaining the building, it helps to enhance the operation of the building as it was intended.

Payback for SMU

Since LEED requires monitoring of waste, the contractors now have a waste management plan in place to help monitor, track, and calculate how much of each building material is being recycled or discarded. Both contractors said initially that this was an added cost because of the labor involved in the separation of materials. Now with as many as five dumpsters on site, and with the subcontractors being more cognizant about discarding the materials, the recycling that is being done either cancels the cost or it is a cost benefit for the project by generating revenue that can be circulated back into the project. Andrew stated: “We get a rebate on many of the metals that you collect in the big dumpsters for metal, and take them in, and they may give you \$400 to \$500 to recycle. So we’re able to take that and fund other things throughout the project with that money” (p. 4, 2010).

Another cost benefit is to plan and design for LEED up front. This saves time and money and the owners can decide if they want to obtain LEED certification. “I don’t think it costs you more if you start early enough to get certified. Now if you want Silver, Gold, or Platinum, yeah, you are going to pay a premium” (Andrew, 2010, p. 15). For new construction, LEED Silver is the minimum and as for renovations and remodels, SMU decides if it is cost effective to register the projects for LEED certification. SMU has in place a gray water system used for every newly constructed building to save water in flushing water closets and for irrigation, therefore in considering the costs and cost benefits for a LEED certified building, it is obvious how the quality of the built environment has been enhanced.

Some materials are coming down in cost, and paint is one that was very expensive in the beginning because only one or two manufacturers even made low VOC paints. Now low to no VOC paints are more readily available and becoming a standard as Andrew mentioned, “[It used to be]that paint is a lot more expensive and there are only two or three people that make it, and it’s going to cost you more to do this. Where now, oh yeah, it’s a standard and all our stuff is low VOC (p. 8, 2010). Over time, more products will follow suit and be less expensive.

Increasing the indoor air quality, use of materials, and better water and electrical efficiencies provided the owner with a monetary payback. Over time, SMU will receive the monetary benefits of both buildings through energy efficiencies and operational costs as was mentioned by William, the construction administrator representing the architectural firm and SMU, “I think for a university like that, you have a long lead time in order to achieve that payback. There are a lot of private organizations ...that LEED doesn’t work because they’re not looking for the long term payback” (p. 1, 2010). SMU employs an energy monitoring system for their buildings so they can monitor high-energy peaks and regulate it more efficiently. Additionally, there is a huge anticipation of the energy savings in the future due to the longevity of the buildings.

Quality: Built Environment

For this case study, *quality* had several meanings or references. *Quality*, based on LEED, referred to indoor air quality and green finishes. Additionally, *quality* also meant craftsmanship, and the overall quality of the building based on construction. In the construction process of these two buildings, both had some quality issues with materials, craftsmanship, and installation despite using the traditional materials of steel frame and studs, sheetrock, sash windows, slate roof, copper gutters, concrete, steel, brick, and stone, etc.

One of the main goals of LEED is to enhance the indoor air quality of the built environment because of its direct and indirect effects on the occupants. In the past for buildings, it was thought that just providing air conditioning was enough, and as a result, sick building syndrome became a problem. Charles stated, “We sort of got lazy to think we could air condition everything and that would solve all our problems. So [LEED] really has caused us to focus on the quality of the building for the end users and occupants” (p. 4, 2010). One other factor that does affect the indoor air quality is the finishes and any off gassing that occurs. Two huge types of finishes that were analyzed are paints and adhesives. Originally, these products contained potent compounds in the binders and carriers in order to cover the surface, which caused headaches, nausea, and respiratory problems. Presently, manufacturers have addressed these issues and have produced low VOC alternative paints and adhesives, which are much better for the interior built environment. With the implementation of outside air providing better ventilation due to LEED requirements improves quality as Clayton stated, “Even the most minor things, because it is the quality of life for the end user is what LEED aspires to is what it is about and improving the quality” (p. 13, 2010). Through thermal comfort for the occupants, they have more control over their environment because LEED requires 50% of the spaces have control over the room temperature. So more thermostats were added creating more zones for the HVAC. The commissioning agent stated this was easier for them to do the balance checks as well. “The thermostats, more than 50%, is easier for us because there’s a live VAV (Variable Air Volume) that serves six offices in the past, so there’s a lot to balance, and now that every office has its own VAV it’s a lot quicker for us to do our job” (Steve, 2010, p. 10).

Despite these two buildings being LEED, there are always construction issues. However, one issue that occurred on both buildings was leaks due to the use of a wrong type of waterproofing liner. For Caruth, the contractor took a gamble by installing sheetrock for the

interiors without the building being completed sealed. Texas received 45 days of rain that flooded the building. “There was a lot of sheetrock wasted because it rained in the building, so we had to get rid of all of it” (Andrew, 2010, p. 2). The sheetrock was removed and reinstalled because of black mold issues. Simmons had leak issues, but on a smaller scale due to the faulty waterproofing liner that gave away after a very heavy rainfall in the spring. A few offices flooded, and the carpet and any damaged sheetrock was replaced. This added cost and time to the projects.

Other issues dealt with corrosion and poor welding. On Caruth, one of the interior stairwells was redone due to poor welding, and the work was rejected by both SMU and the structural engineer. Corrosion was evident in the bolts and the embed joints. As for the bolts, they somehow ended up in bucket that filled with rainwater and naturally rusted, so the structural engineer rejected the bolts. “In Caruth they actually had some badly corroded things and some bolts that weren’t taken care of. They were supposed to go back and clean those up” (Edward, 2010, p. 21). As for the embeds, Edward mentioned that there can be areas that are burned through, but will not weaken the integrity, unless it is severe, “They burn through it on the deck, the metal deck that sits on top of the joists, that happens all the time” (p. 19, 2010).

A couple of main issues for Caruth were subcontractors not following the specifications and drawings, the wrong valves were installed on the lavatories, and it took three times to correct, not following the irrigation drawings and using faulty forms for the front steps. The contractor stated, “Yeah, for the stop valves, it was from not reading the specifications” (Andrew, 2010, p. 19). A similar issue occurred for the irrigation system, in which the drawings were not followed as Andrew explained, “We just installed it wrong. That was the only thing wrong with the irrigation, not following the drawings” (p. 13, 2010). The structural engineer investigated the front steps and completely rejected the work, and he explained why. “There

were some construction issues and they had to chip it out. The forms were leaking out, so they came and chipped it down to almost nothing...we tried to save it, but it was in bad shape so they removed it all and replaced it” (Edward, 2010, p. 4). Fortunately, it was not the concrete mix it was the forms. The contractor, Andrew agreed, “We had to redo them [the forms], and it was based upon bad workmanship. It didn’t look good, so we tore them out and did it again. Had nothing to do with the concrete, it was just bad forms...so we started over and had to spend more time on it” (p. 13, 2010). So between decisions of the structural engineer and the contractor, the front steps were completely redone. Fortunately, these issues were rectified despite adding time to the project.

Another issue was craftsmanship, and more so for Caruth than Simmons. Perhaps Caruth had the most trouble because it was a more complex building compared to Simmons. Simmons has the traditional rectangular footprint, very typical of a Georgian architectural style building. Caruth, as mentioned before, had more finishes on the interior than Simmons. However, there was one issue of Simmons on using a caulk that did not qualify under LEED, as James described, “There’s an issue, there was some caulk that did not adhere to metal, and then to the stone...where it needed to meet LEED or to use a LEED product instead of a regular compound” (p. 11, 2010). Another craftsmanship issue was the installation of the accent tile in the restrooms of Simmons. This stemmed from a walk through on the projects with Lou, SMU’s quality control engineer, right after they installed the tile. For this type of tile the edges were irregular and



Image 4.13 Simmons Hall-Tile Edge

could be quite sharp, so they either had to reinstall it by reversing the joint, or file down the sharp edges. Despite the availability of the tile, the option was to file down any sharp corners, see Image 4.13.

Green Finishes

Green finishes are considered not harmful to the natural environment or the built environment such as using low to no VOC paints, adhesives, and green wallcoverings. The LEED points for these finishes are Indoor Environmental Quality Credit 4.1 Low-Emitting Materials-Adhesives and Sealants (IEQ 4.1) and Indoor Environmental Quality Credit 4.2 Low-Emitting Materials-Paints and Coatings (IEQ4.2), both credits are the same for both version 2.2 and 3.0, and were achieved on both projects. Many have mentioned that paint has improved in achieving low to no VOCs. “They’ve come a long way your paints are low VOC, it looks good, the carpet looks good, your furniture has all green certified wood unless it had a stamp on it, you wouldn’t know any difference that it’s LEED” (Leslie, 2010, p. 13).

Besides the selection of green finishes, the recycled content had to be measured and documented for LEED credits Materials and Resources Credit 4.1 Recycled Content -10% (MR4.1), and Materials and Resources Credit 4.2 Recycled Content-20% (MR4.2) for version 2.2, and Materials and Resources Credit 4 Recycled Content, (MR4) in version 3.0. This was obtained by using 100% recycled carpet. “We look at what is green in what we specify post-consumer, pre-consumer content, especially in carpet” (Leslie, 2010, p. 2). To obtain the points in LEED, a certain quantity has to be achieved, “The biggest thing is trying to get the quantity, and carpet is an easy one. There’s a lot of quantity on that, and if you can get the recycled content or the post-consumer content and all that, you can help fulfill a need in those categories” (Leslie, 2010, p. 2). Carpet and paint are the largest green finishes used in the built environment.

One common goal for the buildings is durability in the materials and finishes so it limits time and cost for maintenance. With the use of green finishes, there were some concerns from the designers about the durability of these finishes. Since many are relatively new there has not been enough time to test the durability of the finishes as Dave suggested, “From what I have heard, some of the LEED products are not well tested and aren’t as durable” (p. 2, 2010). Over time, such tests will reveal the durability of such finishes such as low and no VOC paints.

With the use of the LEED design criteria for green finishes, specifications are more in depth due to the required calculations for the Materials and Resources Credits 2 through 5 (Waste Management, Materials Reuse, Recycled Content, and Regional Materials) in both 2.2 and 3.0 versions for LEED certification. This caused the modification of the submittal process to accommodate the extra data required by LEED to make sure the materials met the specifications as Brian, the assistant project manager of construction on Simmons stated, “Like for the submittal process you have to look for more things. There are LEED submittals called out in the specs for everything” (p. 2, 2010). As mentioned before, another contractor created a form for the subcontractors to fill in the required information so he could do the calculations required by LEED.

Another standard the user groups were aware of is the furniture and the equipment requirements that SMU has in place in which furniture is made of green materials and finishes. Even with AV (Audio Visual) and IT (Information Technologies) consultants, SMU standards are applied to the decision process of what the end user can have. SMU is a traditional university and a hierarchy is represented by the finishes selected for the furniture for the faculty and staff as compared to the tenured faculty, deans, administrators, etc. Project Resource Coordinator, Tina for SMU stated, “If you’re a faculty member you get laminate desk, credenza, and return bridge. If you were a Dean, you got wood, or if you were tenured faculty or someone higher up,

you got wood. There was a little bit of a status level within it, but that was kind of how the purchasing agent for SMU defined it” (p. 18, 2010). Since LEED requires green and sustainable furniture for points Material and Resources Credit 4 Recycled Content (MR4) and Material and Resources Credit 6 Rapidly Renewable Materials (MR6), and Materials and Resources Credit 7 Certified Wood (MR7), all furniture projects have to meet these requirements in order to obtain the credits. Fortunately, manufacturers started revamping their manufacturing processes in the late 1990s, so it is not that hard to obtain the appropriate points. However, SMU did not try for these points for either building because they did not have the personnel available at the time when furniture was selected. For future projects, it is now an SMU standard to obtain the furniture credits.

Sustainable Construction Materials

The construction materials for both buildings reflected the Georgian architectural style. Brick, cast stone, concrete, steel, slate, copper drains, sheetrock, and glass were the primary materials in which the majority of these are sustainable. The use of pre-cast stone is a trait of Georgian architecture used for the columns, porch aprons, surrounds, windowsills, headers, lintels, and coping. For this type of construction additional supports were required to keep the cast stone and brick separated as Edward described, “Supporting all the masonry that they put on those buildings, there’s an amazing amount of kicker angles and shelf angles, and lots of tiny little pieces of steel that we have to bury in the wall because they have the different size cast stone” (p. 15, 2010). These small components were also required to support the brick and stone for the faux chimneys at either end of the gabled roofs for both Caruth and Simmons. These faux chimneys sometimes house the exhaust pipes or other ventilation requirements as Edward mentioned. “Sometimes nothing [is in there], sometimes its and exhaust, but for us it’s a big brick box that we have to support on a steel roof, so there’s steel framing that goes into those

and really, the masonry is the biggest thing” (p. 16, 2010). There are no actual fireplaces in either building. Fortunately, as mentioned before, steel is made up of 95% recycled material, and any leftover steel was recycled.

Another sustainable construction material used in great quantities and type was concrete. As a standard, the concrete used for the foundations and floor slabs contains 20% fly ash and helps meet the recycled content for LEED. Fly ash is a byproduct resulting from the burning of coal, so using it in concrete recycles it instead filling landfills. The higher the percentage of fly ash, the more increased tensile strength of the concrete, but it also takes longer to set:

If someone really wants to get the recycled content up, they’ll ask for really high volume fly ash, a replacement for Portland cement in the concrete...one of the biggest things is it slows down the set time for the contractor, so it’s difficult for him to finish it because he has to wait a long time (Edward, 2010, p. 2).

Edward also mentioned that using increased amounts of fly ash makes the concrete less permeable to water (p. 2, 2010).

Another form of concrete that SMU uses for pedestrian malls around Caruth and Simmons are pavers. The use of pavers qualifies for the LEED credit of Sustainable Sites credit 7.1 Heat Island Effect-Non-Roof (SS7.1) for both the 2.2 and 3.0 version of LEED. Open areas are a part of the hardscape design; even the exterior amphitheatre was made entirely of concrete, and as long as the Solar Reflectance Index (SRI) is at least 29, the area qualifies for this point, “The concern to meet the SRI... you could have poured any concrete out there and met the requirements” (Andrew, 2010, p. 12). The landscape architects performed the square foot calculations for the area of concrete and submitted drawings to meet the documentation requirements for this point.

Quality was important for the plant selection for both Caruth and Simmons. Lynn mentioned the benefit of how regionally plants naturally fend off pests:

Gray water helps save money and it kind of works towards the landscaping that if the plantings are native or adaptive to the region they use less water. It's like a self-maintenance thing, you still water them, but not as often and you don't have to worry about pesticides...the plants are part of the region that will be adaptive (p. 6, 2010).

Facilities Manager Kyle stated it well, "If the contractor does the job right and brings in quality plants, then design does not make a difference" (p. 5, 2010). By using quality plants, it keeps the costs down for maintenance, less plant replacement, and using adaptive plants keeps the use of pesticides and herbicides down.

Commissioning: Start Early

A quality issue and decision making impact is the requirement by LEED to have third party verification. This is where the role of the commissioning agent is very important. Their job entails verifying the specifications the MEP engineers have supplied and the drawings to make sure the equipment selection is correct for the building, "LEED has certain requirements that we check, and it's both--we check that the drawings and specs to make sure that they're LEED because they are going for LEED, so we check for items such as 50% control of the thermostats in 50% of the spaces" (Steve, 2010, p. 16). Through site visits during construction, they verified the equipment was installed correctly and functioned as specified. Commissioning agents, such as Steve, are supposed to be part of the design process from the beginning, as it was so for Caruth. Unfortunately, for Simmons, the original commissioning agent was relieved and SMU was not notified until after construction started. "I think we would bring in our commissioning agent earlier so we could get the enhanced commissioning as well because they have to be in on the very, very beginning" (Cheryl, 2010, pp. 13-14). LEED brought to the

forefront the importance of having a commissioning agent on board for more than just third party verification.

With LEED and the emphasis on indoor air quality, flush-out is required, and if doing full commissioning, this adds two weeks to the project time line as Lou described, “The only other issue I saw with time is the flush-out consideration requirement needing one to two week flush-out period in the building completion structure is sometimes a problem” (p. 22, 2010).

Unfortunately for Caruth, and because the contractor was not able to finish the building in a timely manner in order to do the full flush-out, the Construction Indoor Air Quality Management Plan During Construction Credit 3.1 (IEQ3.1) , and Construction Indoor Air Quality Before Occupancy Credit 3.2 (IEQ3.2), were forfeited. Presently, there have not been any issues with the indoor air quality, and the designers feel it is because the LEED design criteria was followed and the ventilation systems were operational during construction and constantly monitored. However, coordination issues were easier with Simmons compared to Caruth as one designer, Mark, stated, “The building was much simpler because of the coordination and the relationship that he and I have compared to the landscape architect on Caruth. So it’s the whole thing, the team worked better together, the contractor worked better together...because the contractor was in a position to get in and build it right.” (p. 4, 2010). LEED does affect the schedule for new construction because of documentation, coordination, and the flush-out requirements.

Once the building is occupied, the training of facilities personnel and educating the occupants to facilitate the functionality of the building so that it is maintained efficiently is required. LEED requires training, as part of the commissioning process, to make sure the building’s mechanical systems operated as it was designed. Steve, the commissioning agent for Caruth explained, “We have training verification and the 10 month Operations Review. So LEED requires at 10 months we go back and do a re-check of the building’s operation” (p. 7, 2010). In

addition to onsite training, manuals are prepared in hardcopy and electronically for online access, “Then each tab is each piece of equipment. Says here, the systems that we included in this manual and why, and because of LEED” (Steve, 2010, p. 26). From the perspective of the facilities department, obtaining the manuals are helpful but feel they are still within a learning curve themselves because of LEED’s requirements, “...but it is also important in taking us and teaching us what LEED is, and someone hands us a LEED building and you have to maintain it as a LEED building, what does that mean?...it’s a total shift in attitude” (Kyle, 2010, p. 30). The facilities department is slowly training everyone on how the LEED buildings are to be maintained and carrying those practices over to the other existing buildings on campus.

Chapter Summary based on Research Questions

Research Question 1

For research Question 1, “What are the current practices and considerations for two LEED certified buildings at SMU?” This question was analyzed based upon Criticisms, Attributes, and Recommendations of implementing LEED into the design process. There are direct and indirect influences that happened somewhat simultaneously. Direct considerations and practices are working more collaboratively and understanding that they (the designers) have to work simultaneously. The practice of setting up the project as though it was a LEED building, regardless of certification, saved time and money. The designers felt that with the municipalities incorporating parts of LEED into code, that LEED would become a building standard. The designers are automatically setting up their projects to be LEED from the programmatic design to the final specifications. The specifications coincide with the LEED criteria and are now part of the standard specifications. The initial stages of LEED require more time and increased costs, yet with municipalities adopting LEED, the time and cost should decrease. Overall, LEED elevated the consciousness of designers by requiring the learning of

sustainable design practices and adopting these new design standards. The realization that LEED was causing changes within the design standards; therefore, through the exploration of LEED, the standards have evolved, and will continue to evolve because LEED is perpetuating the concept of better buildings with the least effect on the environment. In this study, it became evident that LEED defined new standards, influenced the redefinition of others such terms as Collaboration and Specifications as well as the time, and cost in executing a project. Diagram 4.1 below, illustrates how LEED affected the practices and considerations by redefining the standards.

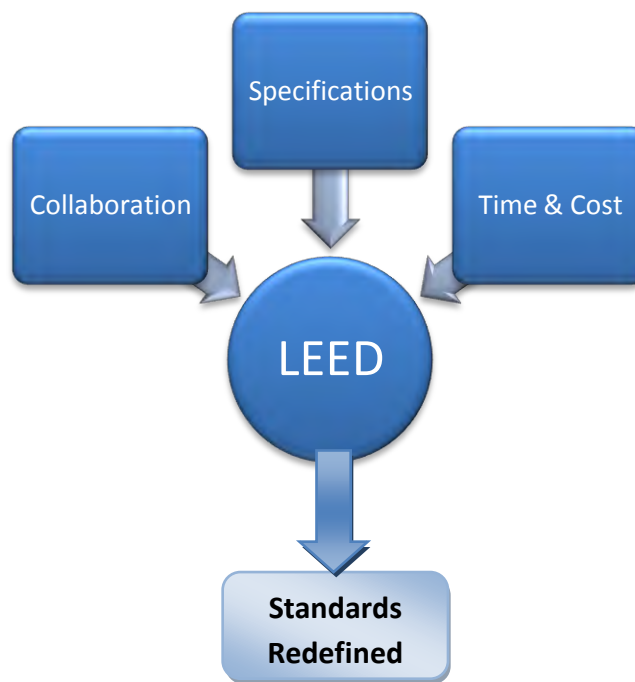


Diagram 4.1 Standards Redefined

As for the indirect aspects, experience, or lack thereof, knowledge of sustainable principles, ecological design theory, research, etc., as well as the learning curve for the designers and the owner, all affected the outcomes as well as the standards by being redefined. For example, the current practices of implementing recycling plans for construction and LEED buildings in general, affects the design process of analyzing the cost savings for both the owner

and the contractor. With the standards enhanced and the exploration of LEED's impact on programming, the design process is addressed. Through the integration of LEED, the standards are enhanced through additional practices, while other standards are being redefined. Additionally, the aspects of these questions are interdependent, as are the variables analyzed in answering the questions.

Despite the criticisms about LEED, everyone connected to the SMU project felt that LEED is moving the design, construction, and manufacturing industries in the right direction. By bringing to the forefront sustainable principles, the designers felt they are doing their due diligence for SMU by designing buildings that are better for both the built and ecological environments is conscious design. Having access to the many resources about sustainable design, and then integrating them into practice for the designers, was beneficial. For the designers they felt LEED would become standard over time as structural engineer Edward stated, "The certification process may become obsolete--well that's the thing, we want a Gold building or a Platinum building, and that may decrease. I think the concept is certainly here for a long time, but it might take on a different form" (p. 13, 2010).

Research Question 2

For research Question 2, "How did seeking LEED certification change the interaction of programming, the design process, and the decision making process?" The operative word within the question is *interaction* because LEED directly influenced how programming was done as well as the other steps within the design process. For programming, asking the right people the right questions at the very beginning was essential to the success of the project. Moreover, it can be said that this happened before LEED. However, LEED is taking programming and the design process to another level through teamwork by coordinating charrettes, more design time, additional meetings, and site visits in order to understand the owner's goals. Through this case

study, it was realized immediately what did not work for Caruth was having a single person user group and not having equal representation, as Simmons had throughout the project. For Simmons, that lesson learned was rectified, and SMU modified their standards as to include interaction among all who were required to attend/participate on all projects.

As for the design process and understanding how the designers were traditionally trained in a linear process as opposed to the new integrated design process, many had readdressed their standards based on LEED, and redefined their roles. Based on the LEED criteria, the integrated design process parallels the LEED criteria, creating a much more efficient process. Additionally, the designers are not solely viewed as experts, but as co-learners working collectively to develop a design solution that meets owner's goals and design expectations.

For Question 2, Budget, Designers/ User Groups, and Design Expectations had an impact on the design process based on LEED the primary outcome was an improved design solution. It takes everyone involved with a clear understanding of the budget, design goals, and the designers' knowledge and experience to design a building that meets the owner's expectations. Of course, all the way through this process, decisions have to be made, but made based on the best information available. Like standards, time and cost are variables in the decision-making process. In addition, technology and solid research help to fuel those decisions made in a timely manner for projects of this caliber. Therefore, in this investigation, the interaction of LEED strategies changed programming, the design process, and the decision-making processes because of the budget, designers/user group relationships and design expectations, the outcome produced better design solutions as Diagram 4.2 illustrates these causal relationships. For example, having the designers working collaboratively and collectively with the user groups on a more pragmatic level enhances the programming process and reflects the current

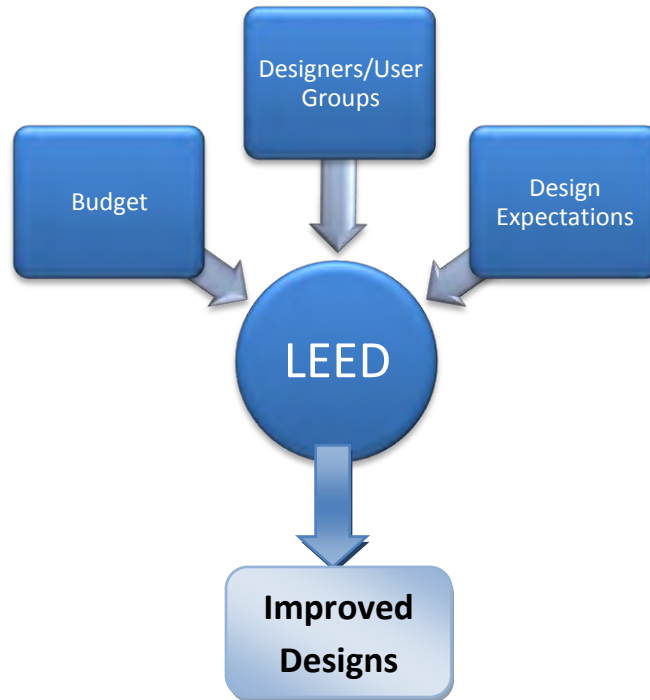


Diagram 4.2 Improved Designs

practices of LEED. Instead of having someone from outside conduct the programming, it is done collectively by the design team, which produced a better outcome for the owner. For construction, the continued decision making process incurred more time and cost, but increased quality.

Research Question 3

Research Question 3, “How did decisions affect time, cost, and the quality of the built environment?” For this question Time, Cost, and Quality were all causal components based on the core category of LEED, and its criteria helped to increase the quality of the built environment. LEED obviously drove the indoor air quality with strict requirements, which in turn, improved the quality of life for the occupants. For the materials being selected and used, including the recycled content of these materials has to be documented by the contractor in order to obtain LEED points for Materials and Resources. In essence, the decisions made were based upon the LEED criteria and in meeting the owner’s goals based upon materials, time, and

cost that enhanced the quality of the built environments, in this case the Caruth and Simmons buildings.

Additionally, the documentation process took more time due to changes in the LEED criteria from the 2.2 version to the 3.0 version and the addition of the website for the 3.0 version of LEED. Eventually, the designers realized that spending more time in meetings, and really exploring all design possibilities was essential in order to solve problems sooner than later within the design process. Through LEED, and despite construction issues, recycling plans were

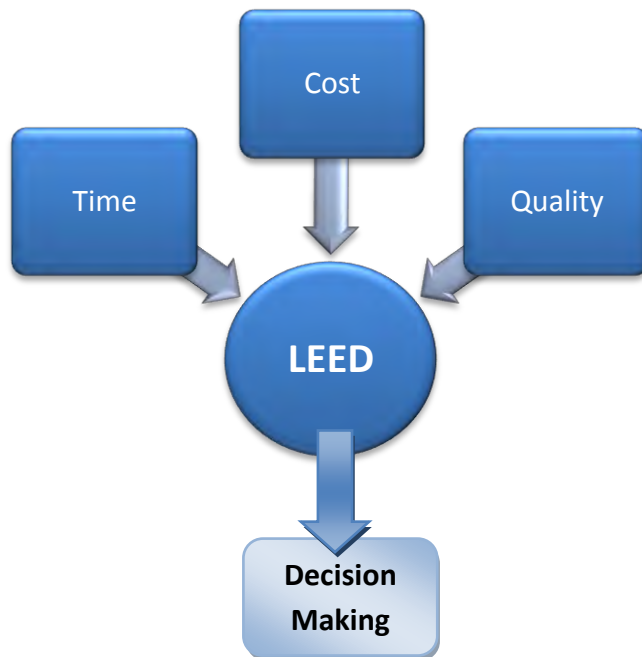


Diagram 4.3: Decision Making

implemented, green finishes were specified and used, and regardless of the added time and cost, better quality buildings, i.e. Caruth and Simmons resulted. As for cost, the cost of registering the projects, having a LEED certified professional on the design teams, the commissioning agents, and the added construction costs are the main costs associated with the total project budget. Recycling construction materials was determined to be from a cost neutral variable to a cost benefit. Diagram 4.3 illustrates the causal relationships of the variable affecting quality because of LEED.

Research Question 4

Research question 4, “What issues regarding LEED standards may be unique to university buildings?” For this question, several unique issues became evident throughout this study which were integrating LEED into SMU’s building standards as well as all building codes, size of the user groups, credit for saving trees, donor issues, influence of the dean and president, Collegiate Georgian Architecture, advances in technology, project delivery methods, and the time involved in completing the buildings.

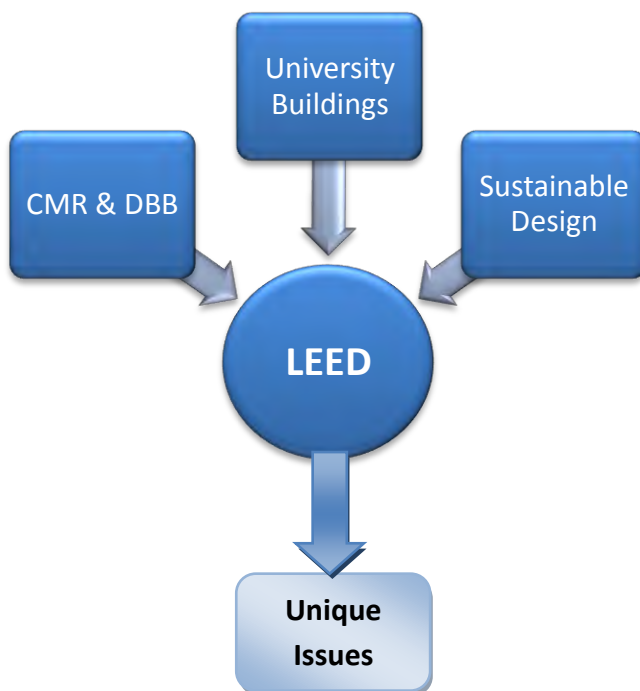


Diagram 4.4: Unique Issues

Realizing that SMU had adopted many of LEED’s requirements into their standards and that several of the participants mentioned that LEED would become a standard in the design build industry was evidence how quickly the industry is changing. With LEED requiring integration of all participants, it was interesting that defining user group’s sizes, equal representation was logical, and that SMU recognized this during the Caruth projects.

Understanding how valuable trees on campus are and that LEED should make the same acknowledgements, and will through the Sustainable Sites Initiatives. Since SMU is a private college, it was clear how much influence the donors have in designing the buildings. Besides the donors, the dean for Caruth had strong insights to how the School of Engineering was designed as well as the president in allocating budgets and making final decisions about the aesthetics for each project. In addition, challenges for the designers in dealing with Collegiate Georgian Architecture and incorporating as much sustainable design through LEED as possible.

Advancement in technology and the idea that some faculty do not want to utilize the new technology despite the dean requiring specific equipment due to his forward thinking in how the school is to instruct the students as well as meeting the current technological needs of the students in this day and time. Understanding how the two delivery methods, Construction Management at Risk for Caruth, and Design Bid and Build for Simmons, affected the schedules in which Caruth missed its substantial completion date by six months, and Simmons was on time. These unique issues resulted from SMU wanting to design sustainable buildings based on LEED and smart, conscious design. Becoming aware of the unique issues that can happen at a university can help design future academic buildings.

Summary

Through the cross-case analysis, disparities within the design process were revealed as well as LEED's contributions to close those gaps. For the design industry, cause and effect is the backbone of the design process of developing the final product. If a wrong decision is made based on incomplete data, then many variables are affected such as material use, time, cost, and quality. The same is true for good decisions based on the most complete data, in which the project commences more smoothly and finishes on time or ahead of schedule. Reducing the data down revealed the categories that represented the processes and practices in place. The

concept of collaboration, teamwork, and working collectively are now better understood by the researcher. Obviously, better design solutions are generated when everyone is working toward a common goal. As in this case study, if owners, designers, and contractors build by integrating the LEED criteria into the design process, then the standards increase, a better design solution evolves, that in turn, results in a higher quality buildings all due to conscious design.

Additionally, being aware of the unique issues that can emerge on projects at a university helps to illustrate any gaps in the design process through lessons learned on previous projects.

For Chapter 5, Analysis and Interpretation, the implications of the findings are discussed in order to understand the information learned from conducting this case study. By discussing the findings, a possible theory is developed based upon the integration of LEED into the design process. Through additional analysis, applications and generalizations are reviewed to suggest how this information can be applied to future design projects. In addition, there are recommendations for future research based on LEED and the design process.

Chapter 5

Analysis and Interpretation

This chapter discusses the findings as they relate to the research questions of this case study as well as a brief overview of the research problem and methodology. LEED is discussed relative to previous research and how this study's findings add to the body of knowledge about design processes on a college campus. Theoretical implications are explored through design theory to suggest plausible theory about the integration of LEED into the design process. Any possibilities and constraints are discussed as they relate to the study of these two LEED buildings. Additionally, a brief discussion about the practical applications and recommendations that can be used for future university LEED projects and further research are presented.

Statement of Problem

The purpose of conducting this case study was to learn how design professionals incorporated LEED into the design process for two LEED buildings on a university campus. By acknowledging that the design process itself is very encompassing, the research questions are listed as follows:

- What are the current practices and considerations for two LEED certified buildings at SMU?
- How did seeking LEED certification change the interaction of programming, the design process, and the decision-making process?
- How did these decisions affect time, cost, and the quality of the built environment in an academic setting?
- What issues regarding LEED standards may be unique to university buildings?

By studying LEED buildings at SMU, the findings reflect how the design process incorporated LEED in order to design and build Caruth and Simmons. This study is an in depth

analysis of learning and understanding how LEED was incorporated into the design process. Within the data, based on the research questions, it became evident there was information missing within the traditional design process. The answers to the research questions showed that specific information was required based on LEED principles to be integrated into the design process.

By integrating LEED into the design process, several variables surfaced in the design process. For example, there was not enough research and information sharing at the beginning of the study compared to the end of the study, because the designers learned to work as a team over time. Integrating facilities personnel and user groups more efficiently at the beginning of the decision process was very beneficial in the programming stage. Before using LEED, the owner was not forthcoming with knowledge and experience that could benefit the design outcome. Spending more time at the beginning designing, reviewing, and incorporating feedback was vital to the success of the design solution despite the learning curve of the team. Other nuances, such as issues with communication and coordination always occur on projects, but by utilizing the integrated design process, it should minimize these problems in other projects.

Review of Methodology

By using the grounded theory paradigm of a three stage coding process of open coding, axial coding, and selective coding revealed the causal core and the effects of the core on the design process. Through synthesizing the information in the matrices for each research question, a cross-case analysis was conducted until all outcomes were exhausted. The cross-case analysis revealed patterns and themes throughout the data. Below is Diagram 5.1 illustrating how the core category of LEED produced the effects from the cross-case analysis of each of the research questions. Another realization about the data was the independent

variables funneled down to one core variable, which is LEED, while the effect variables (or outcomes) are defined as Standards, Design, Quality, and Unique Issues.

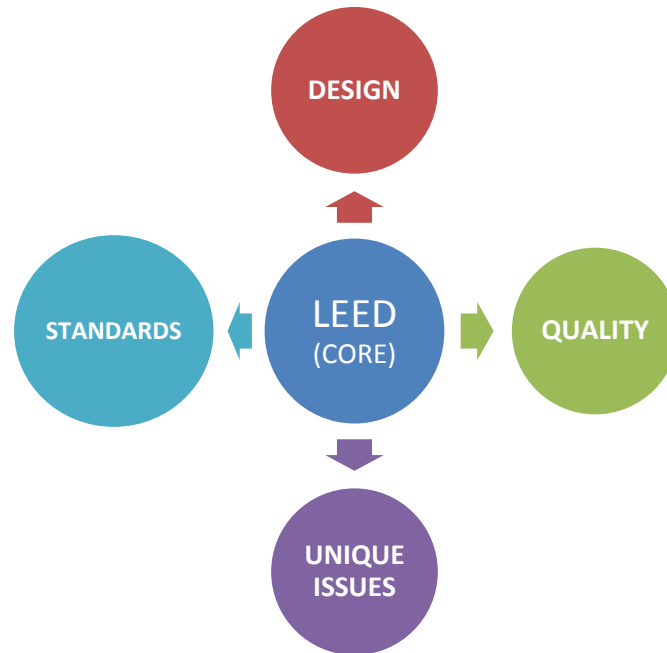


Diagram 5.1: Core Category & Effects

In the selective coding process, the subcategories were explained so that their relevance or causal connections were revealed from the data within the study. Through the frequency of specific variables, patterns and themes emerged. These specific variables are Recycling, Documentation, Collaboration, Innovative Design, Decision Making, Quality, and Unique Issues within an academic setting. To clarify, the relationship of the outcomes as they related to the actual research questions and the core category are illustrated in Diagram 5.2. Through this diagram, and from diagramming analytical memos, this illustrates that the core is LEED, and the descriptors are the effects resulting from the integration of LEED. This information was revealed through the axial and selective coding processes providing applicable information to answer what is involved in integrating LEED into the design process. These effects (or outcomes) were the result of the cross-case analysis.

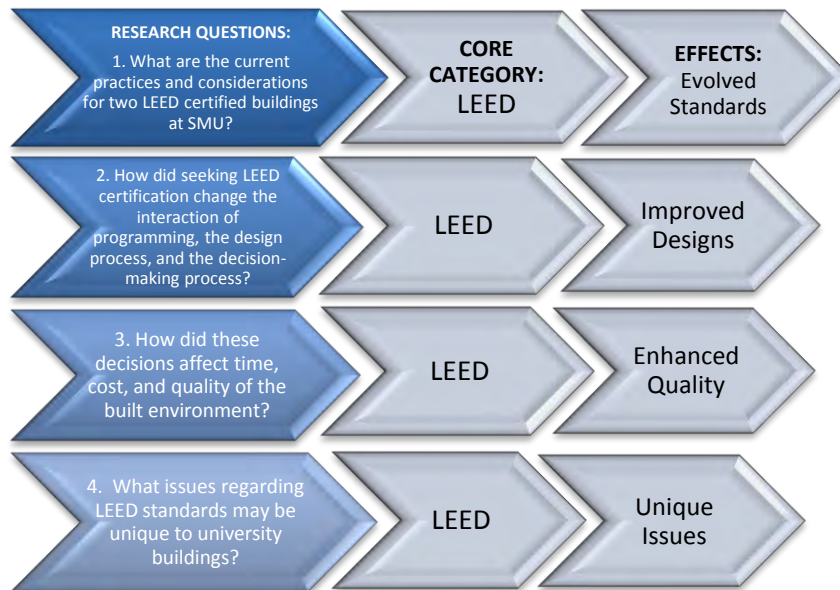


Diagram 5.2: Research Questions and Core Category

Researcher’s Insight

Research Question 1: Standards

Through the coding process, criticisms, attributes, and recommendations were revealed within the data. Question 1 revealed how current practices for LEED buildings with LEED as the core category have influenced how *standards* have evolved. In requiring more collaboration in the beginning with the design team, programming and understanding the goals was achieved more efficiently and more extensively by utilizing the LEED criteria as more than a checklist. SMU had already implemented several sustainable practices, so delving further into sustainable sites, water efficiency, energy efficiency, materials and resources made exploring innovative design points logical. Despite the criticisms about the processes being time intensive, the benefit of the experience was rewarding for both the design team and SMU. For the design team, a clearer understanding of collaboration, which evolved to mean “teamwork,” and collective research became a part of their design standards, such as more in depth specifications, and knowing which LEED points are standard protocols for SMU.

Based on what the integrated design process requires, this process is still evolving as the steps of reflection and feedback have yet to be implemented into the designer’s standards. Thoroughly developing the design solution between the design concept and the design

development phases was desirable as compared to the traditional method of having to design in the construction document phase, or during the construction of the building. This occurred on both Caruth and Simmons. For Simmons, the School of Education had several changes during construction, due to changes in space planning that occurred on all three floors to accommodate the various educational programs. LEED guidelines did propel this group of designers out of the traditional design process. They realized they had to polish their skills and knowledge set, which, in time, became second nature through their redefined design standards. For example, both the designers and SMU incorporated a majority of the LEED criteria into their design process.

As discussed in Chapter 4, Findings, attributes and recommendations were all based on the design team's experience and knowledge of the two LEED projects. However, the design team does understand the benefits and the origins of LEED, acknowledging that it is moving the design industry in a positive direction. Collectively bringing their knowledge and experience from one LEED project to the next improved their design skills.

Research Question 2: Design Expectations

From the cross-case analysis for research Question 2, the focus was on how seeking LEED certification changed the interaction of programming, the design process, and decision-making, and the impact LEED had on design. Besides budget, designers/user groups, and design expectations, a better design solution was the result. Due to a collective and collaborative effort on behalf of the designers and user groups and between the budget and design decisions, this effort sustained itself throughout the project, especially for Simmons. Simmons was a more cohesive process as compared to Caruth due to major changes on campus and because of the prior experience from Caruth. The lessons learned on Caruth were quickly applied to the Simmons project. With LEED being the center of their design criteria, there will always be

improvements such as acknowledging traditional landscaping through the Sustainable Sites Initiative Guidelines. With a full understanding of LEED and its impact, the interaction of LEED has changed the programming, the design process, and the decision making process by having the design team and owner delve more deeply into the design concept phase.

The findings of this case study as well as continued research show that the design process is advancing in a university setting such as SMU. Despite witnessing a collaborative energy among the owner and designers for both Caruth and Simmons as a whole, SMU is not quite as integrated as the phenomenon described by Reed (2009) in the sense of sharing information internally between departments, but in time, the integrated design process may become the norm. There is a clear correlation between the LEED criteria and how projects are designed and built at SMU. The industry is progressing, albeit slowly. As SMU gains more knowledge through experience, continued research, and continued self-education it can integrate that information into its present design standards.

Research Question 3: Decision Making

For research Question 3, how decisions affect time, cost, and quality due to LEED influencing change, quality is enhanced. In the construction of these two buildings, time, cost, quality, and the interrelationships of these variables were influenced by the decision-making process. LEED impacted how the construction companies on these two projects managed waste. Presently, recycling is considered cost neutral to a cost benefit by the contractors for monitoring waste materials. Both construction companies discussed how the waste management program required by LEED has become standard practice for them whether or not it is a LEED project.

Understanding the time and cost implications of LEED for a construction project can be an issue. A LEED building costs more mainly due to the design time and documentation

processes during the design and construction phases, as well as the increased costs for LEED certified materials; however, the costs of these materials are becoming more affordable. Materials have changed for the better due to recycled content and using less, if any, natural resources. Construction techniques have not changed for SMU, but having an excellent construction company working on the project providing great craftsmanship by following the drawings and specifications enhanced the quality of the building, as did the commissioning process for a building.

The quality of LEED projects increases the quality of life for the occupants due to the indoor air quality, and the environmental impact of using sustainable construction materials such as steel, brick, concrete, slate, etc. By utilizing low maintenance materials, having implemented an organic garden, and using the gray water system for irrigation and flushing for both buildings limits the operational costs while conserving energy and water for SMU. With LEED implementation required documentation for energy consumption, and facilities personnel recording maintenance issues, the newer green finishes can be monitored for durability and cost. Through LEED, the quality of life for both the built environment and the natural environment by limiting the carbon footprint is beneficial and more synchronous with nature.

Research Questions 4: Unique Issues

Since this case study is unique in researching two buildings at a university, the unique issues that occurred cannot be ignored. Learning and realizing that LEED and sustainable design are becoming a standard in the industry and that using LEED at the university level will benefit generations to come. With SMU already being sustainably conscious in how the campus functions, continuing by embracing LEED into their design standards was logical. Typically, universities do not embrace change well and SMU was proactive in pursuing sustainable design and LEED.

With LEED requiring full participation of everyone involved in a LEED project, the issue of the user group, the donors, the dean and the president's influences would not have been as noticeable. Realizing that one person cannot and should not make decisions for those who are utilizing a facility and that donors should have limited control, but be heard, became very clear. Through this study, several recommendations that came forth will help the overall design process as well as LEED in redefining the criteria such as defining the amount of participants required in a user group. For SMU, student and faculty participation in user groups in the future is encouraged. SMU feels the design solution would be even more enhanced if the true end users such as the facility and students were involved from the beginning.

Additionally, LEED guidelines must acknowledge that universities have specific architectural styles and that Collegiate Georgian is not an easy style to obtain LEED points, especially in daylighting despite the innovative design of incorporating a light column. Not very many universities are going to change their master plans to accommodate contemporary architecture. With the majority of universities being over 100 years old obtaining credits for saving existing trees and designing with the existing trees should be encouraged as a sustainable design practice as either restoring or retaining the existing site.

For most universities, understanding how much the younger generation utilizes technology and providing for that need in the digital age helped to facilitate communication and learning. Instructors and students are not confined to the classroom anymore. With the distance education classes, technologically advanced lecture rooms that support broadcasting, information for learning is more obtainable, thus, creating very flexible learning environments.

Understanding how the project delivery methods have been affected by LEED and observing how a more traditional process of Design, Bid, and Build (DBB) method worked well with LEED due to the multidisciplinary integration during the design process helped Simmons to

be built on time and under budget compared to Caruth. For Caruth, using the Construction Management at Risk (CMR) method caused the schedule to be pushed back by six months despite its finishing within budget. Due to the design issues, weather, craftsmanship, the CMR method was more tedious for everyone working on the project, especially for the contractor. SMU is an owner that is heavily involved in the designing and building of its educational buildings. The SMU project managers on these two projects felt that the delivery methods worked well for them despite the time issues with Caruth. One facet for the learning curve for Caruth was having the contractor on board early and place limits on the amount of design changes. Based on the unique issues for these two university buildings, designers can become more cognizant of what an educational environment encompasses and plan accordingly in the programming phase of the design process.

Summary

In this case study, a clearer understanding of how LEED influenced the current practices, programming, the design process, the decision-making process, time, cost, and quality are defined. Additionally, how the unique issues that occurred due to the implementation of LEED can be acknowledged and addressed in the programming phase. LEED as a program is beneficial on both a professional and global level. It is clear that if the owners, designers, and contractors utilize the LEED criteria to design the built environment, then standards will keep evolving, thereby providing improved design solutions with enhanced overall quality due to conscious design. This study was conducted at the early stages of integrating LEED into the design process in which a clearer understanding of what sustainable and ecological design was about became evident through the duration of designing and building of both Caruth and Simmons. Acknowledging the unique issues that were revealed through this case study helped to understand the unique problems that an academic setting could encounter. In addition, SMU

realized these issues and provided solutions so those issues did not carry over to the next project. SMU is always trying to find ways to improve its processes.

In addition, learning how the design process has been re-evaluated to coincide with LEED will benefit all designers once the concept of integrated design process is fully accepted, taught, and instituted. Through the implementation of this modified design process, high performance buildings will be produced.

Relationship Between Current Research & Findings

LEED and Design Process

In using LEED for sustainable buildings, the standards for programming, the design process, and the decision making process is progressing. Concepts of recycling, innovation, the integrated design process, costs, and additional research are factors improving the design process. The design process was no longer a linear process as it was in the traditional teachings. Presently, by working collaboratively and simultaneously on the design solution in the design concept phase, the overall scope is clearer. This extends from the schematic design phase into the design development phase. Every alternative is explored at the beginning of the project and is known as “front-loading.” The owners were becoming more involved, especially for these university campuses compared to the commercial market. However, some processes that LEED requires are reshaping the design process as a whole. The design practices used on both the Caruth and Simmons projects were implemented into the design standards of the design and construction professions working on these projects.

In exploring LEED and the design process, it was realized that because of LEED there is available information about the integrated design process that coincides with LEED thanks to Reed (2009). Reed (2009) simplifies the integrated design process into more about developmental design, in which the design team is a group of co-learners, not solely revered as

experts. Therefore, designers need to consider modifying their attitudes and redefining individual roles. Reed (2009) mentions that in order to do things differently, we need to think differently (2009, p. 40). The integrated design process defines the predesign or conceptual design phases more in depth. The design concept phase is classified into a recursive Research/Analysis and Workshop pattern until the design team develops a solution (Reed, 2009, p. 107). In this Research/Analysis phase, habitat, water, energy, materials, and budget are taken into consideration. This encompasses what he calls the Discovery Phase. He simplifies the whole process into a three-part structure: 1) Discovery; 2) Design and Construction; and 3) Occupancy, Operations, and Performance Feedback (Reed, 2009, p. 107).

In Reed's Discovery phase, five elements are reviewed and the parallelism of LEED with these elements is obvious. The five elements are Habitat, Water, Energy, Materials, and Budget. To clarify the goals within these elements, the designers need to have a clear understanding of the owner's goals. Continued research, evaluation, and feedback are necessary and a constant in the discovery phase, thereby making collaboration a more multi-tiered task in the integrated design process.

The Discovery Phase incorporates prep, evaluation, and conceptual design. Once the conceptual design is agreed upon, the schematic design phase begins. Despite all the work done on the front end, it helps to flush out every idea and scenario analyzed to develop the best design solution. In the schematic phase, the design team is more fully informed and prepared to develop the design solution (Reed, 2009, p. 198). Most architects and engineers want to rush through the schematic design phase to document their systems, but in this part of the design phase, reflection needs to occur to make sure the program requirements are being met. By using BIM and energy modeling more in depth before the design solution is done, issues can be assessed before going into the Design Development phase. At this phase, systems, materials,

and costs are analyzed so reflection and assessment can occur again. SMU's Caruth and Simmons buildings were almost to the Discovery Phase. A deeper evaluation was the missing component for them on these projects, but in time, it will be part of the regular process.

According to Reed (2009), in the Design and Construction phase, the interrelationships of these systems are reviewed to assure all major decisions have been made (p. 263, 2009). The design development phase is completed in less time than in the traditional method, due to all the preplanning, research, and collaborative effort. The construction document phase is expedited due to the more fully developed previous stages, thereby creating more accurate drawings. The integrated design process is much more efficient and productive than the traditional linear design process. Collaboration redefined as teamwork is the pinnacle, but it is clear that research is vital to truly developing the design concept and not relying on a typical or standard approach. Every owner's needs are different and should be approached as such. However, for Caruth and Simmons, some design was still occurring during the construction phase, which is a habit that will be hard to break for designers.

For the third phase of occupancy and performance feedback, more creative ways to obtain constructive criticism would be beneficial to the industry to discover deficiencies within its design methods. Taking the time to evaluate the design and function through the end users would help future design solutions. Presently, the thermal comfort evaluations are performed because of LEED requiring it. A logical step that appears to be missing is the necessity for the designers to conduct their own post occupancy evaluations to help improve their design processes and services.

Another practice variable in the forefront is the documentation requirements for a LEED project. The documentation at SMU is becoming easier to conduct because the level of understanding that the designers have acquired through lessons learned on these two projects.

Even for new construction, recycling and recycled content is vital to the material and finish selections. With manufacturers already instituting sustainable principles, it makes it easier for the designers because of the variety of green finishes being produced keeping in line with McDonough's 2002 cradle-to-cradle concept. Additional documentation for the specifications of all materials such as low VOC paints and adhesives require the square footage calculations for the materials and finishes being utilized. Through the variety of materials and finishes being used, and the LEED criteria requiring more daylighting, ventilation, etc., designers could be more innovative, despite the Collegiate Georgian architectural style of SMU.

With the opportunity to be innovative, the designers worked more collectively and collaboratively. They did not scatter off with their portions of the design and then reconvene a week later, like in the traditional design process. They all had to be synchronized with the owner's goals clearly defined. To take it a step further, integrated design process is transforming the design process as a whole. Reed (2009) coined the phrase "Integrated Design Process" back in 2003, and defines it as seeking to unify technological and living systems into an increasingly life enhancing whole system. He sees buildings as living organisms, not as static structures. He defines the integrated design process mantra as "everyone, engaging, everything, early" and that integrated design "...means that the design team and owner will explore all the possible program possibilities, design permutations, and optimization of the many technical and natural systems engaged in the building, site, and watershed" (Reed, 2009, p. 62). He also stated a concept that parallels LEED, in which all natural systems must be integrated and work together not against each other, and to incorporate the genius of *nature* as well as see everything as a whole system (Reed, 2009, p. 106). This naturally is synchronized with sustainable construction principles.

Through further exploration, the cost of practicing this new design process will become minimal. With more in depth designing at the beginning there are fewer meetings, design issues, and change orders as the project progresses. Initially, there is more time involved in the discovery, or design concept phase. Additional time is set aside for the charette process and research, so that all ideas can be explored to the fullest. One architectural firm, Orcutt-Winslow Partnership stated that:

We've found that when we've completed the design development phase, we're already close to 60% finished with construction documentation. With the Virtual Building Model [BIM], we shorten the time required in documentation, resolve design conflicts and, overall, produce better documents. (Reed, 2009, p. 106)

So in essence, DD=60% CD's, which is great since inconsistencies with drawings and coordination have always been an issue, "No set of contract documents can ever be perfect, but high quality can be achieved by scrutiny, accountability to the initial program needs, and careful coordination among the technical consultants on the design team" (WBDG, 2010, p. 2). Another interesting practice is the emphasis of research by the design team. Preparation is vital to the success of the design concept, "Yet consistency is predicated on collaboration: Good buildings result from an appreciation of consistency of a project's ambitions by all members of the design team" (USGBC, 2010, p. 4). SMU worked collaboratively with the landscape architect to institute an organic garden using a spray irrigation system. This might not have been explored if SMU did not voice an interest, as well as wishing to obtain an Innovation in Design credit. Obviously, through the integration of LEED, the integrated design process is rendering the traditional process obsolete. Overall, Reed's (2009) guidelines and practices are reshaping the design process as illustrated in the Table 5.1 below.

Table 5.1: Integrated Design Process versus Traditional Design Process	
INTEGRATED DESIGN PROCESS	TRADITIONAL DESIGN PROCESS
Inclusive from the outset	Involves team members only when essential
Front-loaded, time and energy invested early	Less time, energy, and collaboration exhibited in early stages
Decisions influenced by broad team	More decisions made by fewer people
Iterative process	Linear process
Whole-system thinking	Systems often considered in isolation
Allows for full optimization	Limited to constrained optimization
Seeks synergies	Diminished opportunity for synergies
Life-cycle costing	Emphasis on up-front costs
Process continues through post-occupancy	Typically finished when construction is complete

Recommendations for Practitioners

Discussing the findings from the cross-case analysis revealed that Recycling, Documentation, Collaboration, Innovative Design, Quality, Integrated Design Process, and Decision Making were directly impacted by LEED criteria.

Recycling

Recycling has now become a standard practice for all new construction buildings regardless of whether it is a LEED building. Because of LEED, this has now become a common practice within the design industries. For LEED certified buildings, a recycling plan is mandated for all new construction buildings. Because of LEED and the benefits of keeping added waste out of the landfills, the construction companies involved in both projects designed and implemented Waste Management Programs to document recyclables. Documenting the amount of recycling a building produces helps the building to maintain and continue its LEED status.

Documentation

Because of LEED, Documentation is required for a LEED certified building; it enhances the specification documentation due to the green materials LEED requires. Monitoring recycled content, pre and post-consumer materials, as well as the recycling of these materials, are part of

the LEED process that has become a standard. There is time and cost involved , but eventually, in time, it will become second nature and possibly completely cost neutral as it is being adopted as a standard in the industry.

Collaboration

Within the past decade, the current concepts that are becoming standards are collaboration, integrative design process, and 3D visualization, which has aided the decision making process. All of these concepts are redefining how programming and designing high efficiency buildings are being built. Beginning with collaboration, this has evolved in meaning and context.

Collaboration was once thought of as simply working together, or meeting together about the project, but in a linear fashion. However, with the LEED criteria enforcing a forged design team from the beginning, collaboration is now an expression of ideas based upon the designer's research. This in turn, takes collaboration even higher to the concept of collaborative design, "The principle of collaborative design is that all disciplines work as a seamless team, adding value to each other's work. As collaboration replaces competition as the currency of the marketplace, strategic alliances, partnering, and joint ventures will become the new model of success" (Jones, 2005, p. 2). For both Caruth and Simmons, the researcher observed the collaboration and the working relationships of the designers because, "Knowing what's going on and truly understanding the implications are the best way to take full advantage of the collective wisdom of the team" (Simpson, 2006, p. 2). For the researcher to witness the collective efforts of the design team to produce the best design solution for the owner, as well as the owner's participation was evidence of a step forward in utilizing the integrated design process.

In acknowledging everyone's expertise and progressing to a co-design strategy, the designers were able to develop a dialog of ideas and viable solutions. According to Buchanan,

“Integrative thinking creates a third solution that combines the effective elements of the first two choices while addressing all aspects of a problem successfully” (Buchanan, 2009, p. 1).

With more research and information sharing through co-designing, better design solutions were produced due to more informed design decisions. High quality LEED buildings were produced despite the construction and coordination issues that occurred for both Caruth and Simmons. The owner and designers acknowledged the benefit of more time spent in meetings during the design concept phase. In addition, continued collaboration with the user groups, especially for Simmons, was highly beneficial because a representative from the user group participated throughout the process. It was interesting to discover how involved and knowledgeable the owner was throughout the process for both projects. Typically, owners do not participate or are as proactive as at SMU. Too often, people involved with a project attend the meetings but do not contribute or participate for whatever reason. Now with LEED fostering collaboration early with the design process it should encourage a more open dialog among the designers. Because of LEED, there was also more interdepartmental representation and participation throughout the design process for SMU.

Innovative Design

Despite LEED’s criteria being ambiguous to some of the designers and limited in the sense of landscaping materials, the other designers found they could be innovative with the design solutions. Besides feeling limited by the Collegiate Georgian architecture the creative use of interior materials and architectural elements such as the light column produced contemporary interiors that harmonized with the exterior architecture. Introducing more natural light into the interiors with the use of glass partitions, made the interiors feel more open compared to a closed plan typical of traditional Collegiate Georgian architecture. Through understanding how everyone congregates collectively to design in conjunction with LEED really

illustrated his or her understanding about sustainable design. Actually, all involved seemed to have conducted more research and presented it accordingly, which fueled information sharing. Through research and information sharing, it was evident that better design decisions were made and implemented.

Quality

Enhancing the indoor air quality and the quality of the building by using sustainable and green finishes combats the sick building syndrome. The importance of the commissioning agent's role was acknowledged and is logical, therefore should be viewed as an investment to ensure that the mechanical equipment operates efficiently providing proper ventilation for better indoor air quality. Through LEED's requirement of basic commissioning, it seems that eventually enhanced commissioning will become the prerequisite over time. By LEED bringing sustainable practices to the forefront of design, standards are increased through better documentation and research, thereby fueling innovation and design resulting in a higher quality building.

Integrated Design Process

A component that was fascinating was discovering the integrated design process and realizing that the early stages were actually happening on these two projects. It was beneficial bringing validation to what was being witnessed and researched. Immediately from the start of the study, it was evident how collaboration in the design concept phase was progressing. To learn that LEED spawned the redefinition of the design process by incorporating everyone early in the research of the preparatory stage, and to review, reflect, and obtain feedback throughout the discovery phase, was intriguing.

With Reed (2009) being a cofounder of LEED, it is clear how the integrated design process and LEED have evolved compared to the traditional design process. Studying that

habitat, water, energy, and materials parallel the LEED criteria of site selection/indoor environmental quality, water conservation, energy efficiency, and materials and resource are parallel to the sustainability design principles. LEED added prerequisites that are basic standards and are continually adding to that list as the criteria evolves. Besides having the Innovative Design points, they have added Regional Priority points to the 3.0 version of LEED. The Regional Priority points are considered additional bonus points and are achievable under the existing criteria such as Sustainable Sites, Water Conservation, etc., based upon zip codes. For our region, Site Development and Water conservation are the most applicable for new construction, but is still not inclusive enough. For example, these points should be used for saving trees, as mentioned before, yet there is no credit given for this opportunity. So, perhaps when LEED incorporates some of the Sustainable Sites Initiative Guidelines into their criteria, this issue can be addressed.

Developing a more integrated design process encourages the design team to repeat a pattern of research-analysis and team workshops. “Integrative design process assures that major design decisions already have been made by the end of the schematic design, so that such analysis can occur” (Reed, 2009, p. 263). Reed (2009) has brought the design process to another level by adding the Prep and Evaluation into what he calls the *Discovery Phase*, which takes place before the Programming/Conceptual and Schematic Design phases.

Decision Making

More informed decision-making processes occurred in the conceptual and schematic design phase due to the use of technology such as BIM (Building Information Management) for energy modeling (Simpson, 2006, p. 2). This process supplied the owner with more accurate information for more informed decisions, as it does for the designers to make appropriate recommendations. In addition, 3D visualizations provided more visual information aiding the

decision making process, since most owners and end users are not educated in reading two-dimensional drawings. “The point of all this technology is to make decisions visible and understandable to the people who need to know: clients, contractors, and consultants, and of course the architects” (Simpson, 2006, p. 2). Focusing on all the “whys” in the design discussions is crucial to the design solution. “Instead of evaluating design decisions, teams evaluate design motives” (Buchanan, 2009, p. 2). They do not want to design for a specific point if it does not warrant a proper purpose to the overall design solution. Some designers “point shop,” as it is called, in order to obtain points that are easily achieved. They need to see the criteria as whole, not as individual line item of points (Reed, 2009, p. 133). “There are few owners these days unfamiliar with sustainability as it applies to buildings, and an increasing number are looking for designs that will result in some level of LEED certification” (Hancock, 2010, p. 1). As owners are more educated regarding sustainability, so are designers, which reinforce the concept of utilizing the integrated design process for high performance buildings.

Plausible Theory

In the evidence and information discovered in conducting this case study, it became clear that LEED, the core category, directly influenced the design process and outcome for both buildings. The four research questions were answered with LEED being the primary element. It is clear that the design process evolved because of integrating LEED into design practices. By adopting the integrated design process as the standard for the design industry and how it coincides with LEED, the designer’s enhanced problem solving can facilitate better sustainably designed buildings. It is still pertinent for designers to understand sustainable design principles and ecological design theories, which are the backbone of LEED. LEED practices are steering the design industry in the right direction by raising the bar for standards, providing improved design solutions, and by enhancing the quality of life and the quality of the building with minimal

impact on the environment. If owners, designers, and contractors integrate the LEED criteria into the design process for sustainable buildings, then the standards will evolve, improved design solutions will evolve, and the overall quality is enhanced due to conscious design.

Practical Applications for all Design Projects

Despite this case study's involving two educational buildings on a college campus, many of the findings are applicable to commercially designed buildings. The key elements that are applicable are collaboration, recycling (waste management programs), in depth documentation (specifications) due to LEED requirements, designing simultaneously, and understanding that the LEED process is time consuming at first and incurs more initial cost because of the lack of familiarity. Understanding the importance of enhanced commissioning for quality control is vital to verify that all systems operate as designed, since this is presently a minimal requirement for commercial buildings.

In addition, if one has a clear understanding of LEED and its background in theory and principle then the criteria can be applicable to any project. Learning to design with LEED is crucial to the success of a project by utilizing better design decisions. Utilizing current technologies such as BIM provides better understanding of energy modeling and driving better informed design decision solutions.

Albeit, LEED is not a perfect system, the realization that there are so many variables involved in designing a building, that it will take time to capture all the nuances and possibilities for the practitioners involved with LEED projects. Developers are striving to improve all areas of concern, but it will take time and patience. Hopefully, technology will meet the demands of the industry. At least LEED is steering designers away from the linear design process and into a much more integrated design process. It is hard to design in isolation when collaboration and collective talent can create a better design solution and this includes good stewardship in

utilizing sustainable practices, enhancing the quality of life from the eco-systems to the built environment is a logical progression, considering the effects of global warming and the limitation of natural resources. Planning for the future instead of planning for the moment is pertinent and logical.

Generalization for Academia

In experiencing the nuances of conducting qualitative research on a college campus, there are some generalizations for a university type project. It is clear there was an understanding of the owner’s goals through the collaborative efforts and constant communication. SMU provided a set of defined standards that was new to the Caruth design team that was implemented for the Simmons project. For the design team, a clear understanding of the SMU standards, utilizing the LEED criteria optimally for SMU, is applicable to all SMU construction projects. In addition, working collaboratively and having the collective thinking of the design team helped to develop appropriate and efficient educational buildings through innovative design for the School of Engineering and the School of Education.

In addition, it became clear that LEED buildings do take more time, especially up front in the design process, such as in the discovery phase as Reed (2009) discusses. Also, it is necessary

to save time on the backend of the project in the construction document phase. From a more thorough review of areas needing improvement based on the integrated

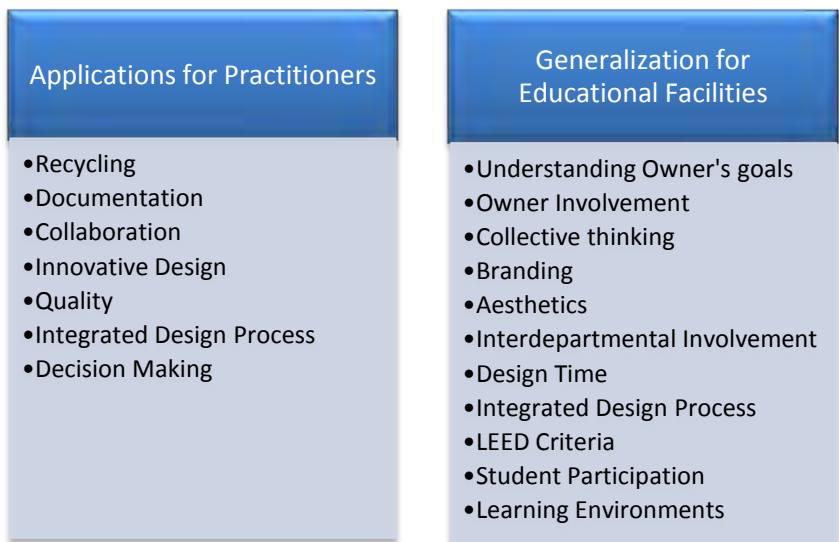


Illustration 5.1 Applications and Generalizations

design process, designers can take that information to re-evaluate and update their design standards and processes. Illustration 5.1 lists the key elements that were revealed in this study for practitioners and for educational LEED projects.

Uniqueness of Study

Through the utilization of an established relationship with SMU made the concept of studying both Caruth and Simmons ideal. Being able to dedicate the time required attending meetings, building tours, dedications, and to be available to observe the present practices was vital to the success of this study. In order to conduct a study of this caliber, time and resources have to be considered. The trust that was built among the participants truly helped in obtaining more information about the nuances of each project, especially since they considered the researcher as part of the design team. Since this study has developed the groundwork for future studies, others might not have to dedicate as much time to conduct their studies. Besides time, building trust and relationships with the participants was vital to obtaining pertinent data in order to make or develop applications and generalizations that can be applicable to future buildings implementing LEED or not.

As for the constraints or limitations, these are educational facilities built with specific purposes. Each having classrooms, laboratories, assembly areas etc., which spurs additional research questions coming from this unique case study:

- Will the original purpose for each building still be applicable in 10 years?
- Will the technology used in these buildings change, and will it possibly have to be updated?

Unique Issues in Academia

For SMU the unique issues discussed can be applicable to any university. Some of these unique issues were problematic to the project but were acknowledged and steps were taken not to repeat those issues. However, a few of these unique issues that occurred, and with the recommendations on how to rectify the situation, some of these could be applicable to commercial projects. For instance, credit for saving trees, having a specified number of participants for user groups, and analyzing which project

delivery method works best for that specific project. Illustration 5.2, Unique Issues lists those issues that resulted from this case study at SMU.



Illustration 5.2: Unique Issues

Additional Research

For this case study, the possibilities are endless for continued research and follow up research. It would be interesting to come back in five, ten, or fifteen years to see how these buildings are being maintained and if they are being used as they were intended, and to see the effects of time on a LEED building. For future research, a more in depth comparative analysis of the LEED criteria as it evolves versus the traditionally built building criteria might reveal more information about the quality of LEED buildings. Another interesting component to the integrated design process is the implementation of reflection and feedback. Another component would be feedback from the end users of the building by assessing the actual use and intentions of the spaces that were designed. Presently, there is not enough user feedback generated for the designers to make assessments because of the time and cost involved.

Possible future items for additional research about LEED and the integrated design process based upon the findings of this case study.

- Eventually, newly constructed LEED buildings will move into the existing building category, so how will these buildings be maintained for recertification?
- How much energy has been saved compared to a traditionally built building, and how can that technology be applied to older, existing structures?
- Will these buildings still meet the 100 year goal because of the materials, construction, and quality?
- How has integrating feedback into the design process improved the design outcome?
- How has the feedback based upon post occupancy evaluations enhanced and provided for a more usable structure?

Reed (2009) is correct in mentioning there needs to be more innovative ways to conduct reviews, reflection, and feedback into the design process in order to produce a better product.

With the incorporation of collaboration, it would be interesting to chart the dynamics of collaboration by working both collectively and simultaneously to design better buildings.

Additional research questions from a scientific viewpoint can be considered as well:

- How have ecological systems benefitted from the implementation of sustainable practices of LEED and sustainable design?
- Can the indoor air quality be enhanced any more, and what are the direct measurable effects on the occupants?
- Are there more innovative ways to save energy and water, and/or what evidence is there for energy efficiencies under the LEED criteria, and how will it affect future LEED criteria?

Truly, there are endless areas of research that can be addressed and based on the impact of LEED on the built environment. A clearer understanding of integrating the LEED criteria into the design process to produce high performance, better quality buildings should be the standard for all designers, whether it is an educational facility, high-rise, or a mixed-use building.

APPENDIX A

**INSTITUTIONAL REVIEW BOARD
INFORMED CONSENT DOCUMENT**

Internal Use ONLY

This Informed Consent document was approved by the Campus Institutional Review Board for use as follows:

1. Title of Project: **An Evaluation of Current Practices of LEED Projects: A Case Study at Southern Methodist University**
IRB # 1161957
2. Date of Approval February 26, 2010 Expiration Date: February 25, 2012
3. Signature of Campus IRB Official _____ (Title) _____

**Campus Institutional Review Board
Informed Consent Document**

Researcher's Name: Kim Rich

Researcher's Contact Information: 2517 Rochdale Street, Garland, Texas 75040

Phone: 972-530-2978

Email: kimco1966@yahoo.com or kcrmxc@mail.mizzou.edu

Project Title: An Evaluation of Current Practices of LEED Project: A Case Study at Southern Methodist University.

YOU ARE BEING ASKED TO VOLUNTEER TO PARTICIPATE IN A RESEARCH STUDY

You are being asked to participate in a research study. This research is being conducted to help understand the processes involved in designing and building LEED certified projects. When you are invited to participate in research, you have the right to be informed about the study procedures so that you can decide whether you want to consent to participation. This form may contain words that you do not know. Please ask the researcher to explain any works or information that you do not understand.

You have the right to know what you will be asked to do so that you can decide whether or not to be in the study. Your participation is voluntary. You do not have to be in the study if you do not want to. You may refuse to be in the study and nothing will happen. If you do not want to continue to be in the study, you may stop at any time without penalty or loss of benefits to which you are otherwise entitled.

If during the process of this study you conduct an interview and then decide to withdraw from the study all information will be stricken from this study.

This research is not funded.

There is no financial conflict of interest for this study.

For this study, participation can be anonymous or you can consent for the researcher to use any information you provide by using direct quotes and giving proper credit.

Why are they doing this study?

As global warming continues its impact on the environment, designers, architects, and engineers are trying to do their part through environmentally friendly and sustainable design. With the inception of LEED (Leadership in Energy and Environmental Design) by the USGBC (United States Green Building Council) in the 1990s they, USGBC, have been pushing to standardize the design and materials used in the built environment, even though it is a voluntary system, the goal is to design and build "green buildings." The built environment and preserving the environment is essential in helping to minimize global warming. LEED's methodology and rating system combines points and options which allow architects and designers to acquire certification for their project. This approach to design and construction seems to be logical and an essential progression to the preservation of our planet. Other considerations concerning improvements could be implemented to increase efficiency from the initial

concept through the schematic and design development phases to ensure success. Therefore, the focus of this study is to learn about the current practices that are being used for LEED certified buildings. By thoroughly researching existing procedures for LEED certified buildings, I hope this study will reveal pertinent information and that it will increase the understanding of current programming, design processes, and LEED requirements.

How long will I be in the study?

This study will take approximately up to 1 hour of your time to complete. Appointments will be made with each volunteer to meet their schedules. The plan is to interview and then possibly observe you demonstrating your programming and design process procedures.

What am I being asked to do?

You will be asked to participate in open interviews as well as demonstrate your processes for programming and for design process. Also, your use and opinions about LEED will be asked as well. You will be recorded so that I can transcribe and analyze the data. Possibly share any documents that you feel are relevant to the study to help illustrate points.

How many people will be in the study?

Presently there will be approximately 30 people in the study.

What are the benefits of being in the study?

Your participation will benefit other designers and students in our respected fields that work on LEED projects by sharing your experiences and expertise in this subject of programming and designing LEED projects. An additional benefit is recognition if consent is given to use names and titles to give appropriate credit.

What are the risks of being in the study?

Your participation in this study is not expected to cause you any risks greater than those encountered in everyday life.

What other options are there?

You may also to choose another alternative such as illustrations to make your points. You also have the option of not participating in this study, and will not be penalized for your decision.

Confidentiality

Your identity and participation can be confidential. Again, it is your choice if you would like your name to be shared with the public and the academic world.

Will the researcher tell me if something changes in the study?

Informed Consent is an ongoing process that requires communication between the researcher and the participants. The participants should comprehend what they are being asked to do so that they can make an informed decision about whether they will participate in the research study. You will be informed of any new information discovered during the course of this study that might influence your welfare or willingness to be in this study.

Where can I learn more about participating in research?

The Campus Institutional Review Board offers educational opportunities to research participants, prospective participants, or their communities to enhance their understanding of research involving human participants, the IRB process, the responsibilities of the investigator and the IRB. You may access the Campus IRB website to learn more about the human subject research process at <http://www.research.missouri.edu/cirb/index.htm>

Who do I contact if I have questions, concerns, or complaints?

Please contact Kim Rich if you have questions about the research. Additionally, you may ask question, voice concerns or complaints to the research team.

Investigator Contact Information

Kim Rich
2517 Rochdale Street
Garland, TX 75040
972.530.2978
Kimco1966@yahoo.com

Who do I contact if I have questions about my rights, concerns, complaints or comments about the research?

The Campus Institutional Review Board approved this research study. You may contact the Campus Institutional Review Board if you questions about your rights, concerns, complaints or comments as a research participant.

You can contact the Campus Institutional Review Board directly by telephone or email to voice or solicit any concerns, questions, input or complaints about the research study.

Campus Institutional Review Board
483 McReynolds Hall
Columbia, MO 65211
573-882-9585
E-mail: umcresearchcirb@missouri.edu
Website: <http://www.research.missouri.edu/cirb/index.htm>

NOTE: If English is a second language, the researcher is required to assure the subjects can comprehend the Informed Consent Process.

Will I get a copy of this form to take with me?

A copy of this Informed Consent form will be given to you before you participate in the research.

Signatures

I have read this consent form and my questions have been answered. My signature below means that I do want to be in the study. I know that I can remove myself from this study at any time without problems.

Your Signature

Date

APPENDIX B

INTERVIEW SCHEDULE

Interview Schedule and Timeline

Person	7/27/10	7/28/10	8/4/10	8/6/10	8/6/10	8/6/10	8/12/10	8/16/10	8/25/10	9/1/10	9/15/10	9/19/10	9/20/10	9/21/10	10/5/10	11/16/10
Dave	9:30am 35min															
John		11:30am 35min														
Alan		10:30am 30min														
Mark			12:00pm 25min													
Charles				2:00pm 42min												
Lynn					11:45am 44min											
Steve						9:00am 1hr 7min										
Clayton								2:30pm 47min								
Kyle									2:00pm 1hr 9min							
Tina										11:00am 50min						
Lou										2:00pm 1hr 3min						
*Cheryl											10:00am 52min					
Sue											11:15am 40 min					
Ray & Brian											1:15pm 45min					
Leslie & William											3:00pm 53min					
Glen												11:30am 1hr 10min				
Jack													10:00am 43min			
Neal														9:30am 28min		
Andrew & James														11:30am 38min		
Edward															1:30pm 47min	
*Cheryl 2 nd Int.																10:00am 15min

APPENDIX C

INTERVIEW GUIDES

Questions for Project Managers at SMU

Interview Questions Part 1: Focusing on design process and programming

1. Based upon what was learned in designing and building Embrey, what were the considerations and/or similarities for the Caruth building?
2. How have you implemented the LEED criteria into your design standards?
3. Despite the cost and time implementing LEED, do you have any criticisms or attributes about designing with LEED?
4. Do you recall or can you give any examples of any problems in regard to programming, design solutions, or construction issues for Caruth/Simmons building? Alternatively any lessons learned?
5. For both Caruth and Simmons, what elements were considered for the classroom and the labs that would help facilitate student learning?

Interview Questions Part 2: Focusing on decision making

1. User groups were defined early to help with the programming for both buildings. Was a particular sub-group such as the faculty, more or less helpful in discussing the design outcomes for the classrooms and labs to facilitate a learning environment?
2. Besides the budget and scope for each building, for the end-user, how much of their influence affects the decision making process for the final outcome?
3. For both Caruth and Simmons, what elements were considered for the classroom and the labs that would help facilitate student learning?
4. At what point is it decided which LEED points are attainable? Is it simultaneously or decided separately from the design solution? Or is it decided upon after the design solution?

Interview Questions Part 3: Focusing on time, cost, and quality

1. Overall has the design and LEED requirements of these building had any significant impact on cost, time, and quality?
2. From your experience in constructing LEED buildings, are the construction points effective in saving money and/or cost within the project? Can you say the same for both time and quality of the building as well?
3. SMU uses Georgian Architecture with Greek, Roman, and 18th Century influences, have these requirements made using the LEED criterion challenging for the design solutions, if so, how?

Interview questions for Architects/Designers:

Interview Questions Part 1: Focusing on design process and programming

1. Is the concept of sustainable design rationale to you and do you feel it should be implemented into all architecture?
2. Based upon what was learned in designing and building Embrey, what were the considerations and/or similarities for the Caruth building?
3. Currently, with all the wiring for the technology required in both Caruth and Simmons how does this not affect the energy model of the buildings? Do you think this component will ever be a factor with LEED?
4. How have you implemented the LEED criteria into your design standards?
5. Despite the cost and time implementing LEED, do you have any criticisms or attributes about designing with LEED?
6. Do you recall or can you give any examples of any problems in regard to programming, design solutions, or construction issues for Caruth/Simmons building? Alternatively any lessons learned?
7. For both Caruth and Simmons, what elements were considered for the classroom and the labs that would help facilitate student learning?

Interview Questions Part 2: Focusing on decision making

1. User groups were defined early to help with the programming for both buildings. Was a particular sub-group such as the faculty, more or less helpful in discussing the design outcomes for the classrooms and labs to facilitate a learning environment?
2. Besides the budget and scope for each building, for the end-user, how much of their influence affects the decision making process for the final outcome?
3. At what point is it decided which LEED points are attainable? Is it simultaneously or decided separately from the design solution? Or is it decided upon after the design solution?

Interview Questions Part 3: Focusing on time, cost, and quality

1. In an observation by Dean Orsak, he mentioned that you cannot literally “see” that the Embrey building is sustainable. Do you think the quality of the design and the finish-out helps the building to blend in with traditional architecture?
2. SMU uses Georgian Architecture with Greek, Roman, and 18th Century influences, have these requirements made using the LEED criterion challenging for the design solutions, if so, how?

3. Besides enhancing the quality of life for the end-user, does the criterion of the LEED requirements enhance the quality of the buildings?

4. From your experience in constructing LEED buildings, are the construction points effective in saving money and/or cost within the project? Can you say the same for both time and quality of the building as well?

Caruth and Simmons

Interview Questions for Part 3

Focus is on time, cost, and quality.

1. Do you see the benefits of “green design” for the construction industry due to the LEED requirements for the waste management plan? For example, material recycling, etc?
2. Based upon the field reports by SMU, several “quality” issues occurred such as rusting of the steel supports and holes burned through from welding angle braces, to name a few, were these issues resolved? Or were they even a concern?
3. Overall has the design and LEED requirements of these building had any significant impact on cost, time, and quality?
4. From your experience in constructing LEED buildings, are the construction points effective in saving money and/or cost within the project? Can you say the same for both time and quality of the building as well?
5. Do you recall or can you give any examples of any problems in regard to programming, design solutions, or construction issues for Caruth/Caruth building? Alternatively any lessons learned?
6. Besides enhancing the quality of life for the end-user, does the criterion of the LEED requirements enhance the quality of the buildings?
7. Despite the cost and time implementing LEED, do you have any criticisms or attributes about designing with LEED?

APPENDIX D

CASE STUDY PROTOCOL

Case Study Protocol

Kim Rich

Dissertation:

DESIGN AND CONSTRUCTION PROCESS OF TWO LEED CERTIFIED UNIVERSITY BUILDINGS: A COLLECTIVE CASE STUDY

Overview

Sustainability & LEED
Case Study: SMU Caruth & Simmons Buildings
Case Study Site
Relevant Readings
Methodologies

I. Procedures

- A. Field Procedures
 - Scheduling Field Visits
 - Preliminary Information-Embrey
 - Verifications and Access Procedures
- B. Determination of Persons to Interview
 - Attending OAC Meetings: Caruth & Simmons
 - LEED Meetings: Caruth & Simmons
 - Direct Observation Memos
- C. Document Review
 - Archival Information Review-DeGoyler Library, SMU
 - Articles: Past & Present
 - Quality Control Reports, SMU
 - Meeting Minutes: OAC & LEED for Caruth & Simmons

II. Case Study Research Questions

- A. Research Question 1: What are the current practices and considerations for two LEED certified buildings at SMU?
- B. Research Question 2: How did seeking LEED certification change the interaction of programming, the design process, and the decision-making process?
- C. Research Question 3: How did these decisions affect time, cost, and the quality of the built environment?
- D. Research Question 4: What issues regarding LEED standards may be unique to university buildings?

III. Topics Researched Prior to Interviews

- A. Architectural Training: Role of the Architect
- B. Construction Management: Role of the General Contractor
- C. History of Southern Methodist University: Inception through present
- D. Research Methods: Grounded theory, Coding, Cross-Case Analysis
- E. LEED: History, Versions 2.2 & 3.0
- F. Design Process
- G. Programming
- H. Sustainable Construction
- I. Sustainability and Ecological Design
- J. Decision Making: SMU Protocols

IV. Analysis Plan and Case Study Reports

- A. Individual Case Studies: Caruth & Simmons
 - Descriptive Information
 - Explanatory Information
 - Developed matrices for each research question
- B. Coding
 - Open Coding
 - Axial Coding
 - Selective Coding
- C. Cross-Case Analysis
 - Descriptive
 - Explanatory
- D. Results
 - Generalizability
 - Theory
 - Applications

APPENDIX E

LEED PROJECT CHECKLISTS



LEED 2009 for New Construction and Major Renovations

Project Checklist

Project Name

Date

Sustainable Sites		Possible Points: 26
Y	? N	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Prereq 1 Construction Activity Pollution Prevention
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Credit 1 Site Selection
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Credit 2 Development Density and Community Connectivity
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Credit 3 Brownfield Redevelopment
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Credit 4.1 Alternative Transportation—Public Transportation Access
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Credit 4.2 Alternative Transportation—Bicycle Storage and Changing Rooms
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Credit 4.3 Alternative Transportation—Low-Emitting and Fuel-Efficient Vehicles
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Credit 4.4 Alternative Transportation—Parking Capacity
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Credit 5.1 Site Development—Protect or Restore Habitat
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Credit 5.2 Site Development—Maximize Open Space
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Credit 6.1 Stormwater Design—Quantity Control
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Credit 6.2 Stormwater Design—Quality Control
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Credit 7.1 Heat Island Effect—Non-roof
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Credit 7.2 Heat Island Effect—Roof
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Credit 8 Light Pollution Reduction

Water Efficiency		Possible Points: 10
Y	? N	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Prereq 1 Water Use Reduction—20% Reduction
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Credit 1 Water Efficient Landscaping
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Credit 2 Innovative Wastewater Technologies
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Credit 3 Water Use Reduction

Energy and Atmosphere		Possible Points: 35
Y	? N	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Prereq 1 Fundamental Commissioning of Building Energy Systems
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Prereq 2 Minimum Energy Performance
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Prereq 3 Fundamental Refrigerant Management
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Credit 1 Optimize Energy Performance
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Credit 2 On-Site Renewable Energy
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Credit 3 Enhanced Commissioning
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Credit 4 Enhanced Refrigerant Management
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Credit 5 Measurement and Verification
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Credit 6 Green Power

Materials and Resources		Possible Points: 14
Y	? N	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Prereq 1 Storage and Collection of Recyclables
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Credit 1.1 Building Reuse—Maintain Existing Walls, Floors, and Roof
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Credit 1.2 Building Reuse—Maintain 50% of Interior Non-Structural Elements
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Credit 2 Construction Waste Management
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Credit 3 Materials Reuse

Materials and Resources, Continued		Possible Points: 15
Y	? N	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Credit 4 Recycled Content
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Credit 5 Regional Materials
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Credit 6 Rapidly Renewable Materials
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Credit 7 Certified Wood

Indoor Environmental Quality		Possible Points: 15
Y	? N	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Prereq 1 Minimum Indoor Air Quality Performance
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Prereq 2 Environmental Tobacco Smoke (ETS) Control
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Credit 1 Outdoor Air Delivery Monitoring
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Credit 2 Increased Ventilation
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Credit 3.1 Construction IAQ Management Plan—During Construction
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Credit 3.2 Construction IAQ Management Plan—Before Occupancy
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Credit 4.1 Low-Emitting Materials—Adhesives and Sealants
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Credit 4.2 Low-Emitting Materials—Paints and Coatings
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Credit 4.3 Low-Emitting Materials—Flooring Systems
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Credit 4.4 Low-Emitting Materials—Composite Wood and Agrifiber Products
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Credit 5 Indoor Chemical and Pollutant Source Control
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Credit 6.1 Controllability of Systems—Lighting
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Credit 6.2 Controllability of Systems—Thermal Comfort
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Credit 7.1 Thermal Comfort—Design
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Credit 7.2 Thermal Comfort—Verification
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Credit 8.1 Daylight and Views—Daylight
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Credit 8.2 Daylight and Views—Views

Innovation and Design Process		Possible Points: 6
Y	? N	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Credit 1.1 Innovation in Design: Specific Title
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Credit 1.2 Innovation in Design: Specific Title
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Credit 1.3 Innovation in Design: Specific Title
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Credit 1.4 Innovation in Design: Specific Title
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Credit 1.5 Innovation in Design: Specific Title
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Credit 2 LEED Accredited Professional

Regional Priority Credits		Possible Points: 4
Y	? N	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Credit 1.1 Regional Priority: Specific Credit
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Credit 1.2 Regional Priority: Specific Credit
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Credit 1.3 Regional Priority: Specific Credit
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Credit 1.4 Regional Priority: Specific Credit

Total		Possible Points: 110
Y	? N	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	1
<input checked="" type="checkbox"/>	<input type="checkbox"/>	1
<input checked="" type="checkbox"/>	<input type="checkbox"/>	1
<input checked="" type="checkbox"/>	<input type="checkbox"/>	1

Certified 40 to 49 points Silver 50 to 59 points Gold 60 to 79 points Platinum 80 to 110



LEED for New Construction v 2.2 Registered Project Checklist

Project Name: _____

Project Address: _____

Yes	?	No	
			Project Totals (Pre-Certification Estimates) 69 Points
			Certified: 26-32 points Silver: 33-38 points Gold: 39-51 points Platinum: 52-69 points

Yes	?	No	
			Sustainable Sites 14 Points
Yes			Prereq 1 Construction Activity Pollution Prevention Required
			Credit 1 Site Selection 1
			Credit 2 Development Density & Community Connectivity 1
			Credit 3 Brownfield Redevelopment 1
			Credit 4.1 Alternative Transportation, Public Transportation 1
			Credit 4.2 Alternative Transportation, Bicycle Storage & Changing Rooms 1
			Credit 4.3 Alternative Transportation, Low-Emitting & Fuel Efficient Vehicles 1
			Credit 4.4 Alternative Transportation, Parking Capacity 1
			Credit 5.1 Site Development, Protect or Restore Habitat 1
			Credit 5.2 Site Development, Maximize Open Space 1
			Credit 6.1 Stormwater Design, Quantity Control 1
			Credit 6.2 Stormwater Design, Quality Control 1
			Credit 7.1 Heat Island Effect, Non-Roof 1
			Credit 7.2 Heat Island Effect, Roof 1
			Credit 8 Light Pollution Reduction 1

Yes	?	No	
			Water Efficiency 5 Points
			Credit 1.1 Water Efficient Landscaping, Reduce by 50% 1
			Credit 1.2 Water Efficient Landscaping, No Potable Use or No Irrigation 1
			Credit 2 Innovative Wastewater Technologies 1
			Credit 3.1 Water Use Reduction, 20% Reduction 1
			Credit 3.2 Water Use Reduction, 30% Reduction 1



LEED for New Construction v 2.2 Registered Project Checklist

Yes	?	No			
			Energy & Atmosphere		17 Points
Yes			Prereq 1	Fundamental Commissioning of the Building Energy Systems	Required
Yes			Prereq 1	Minimum Energy Performance	Required
Yes			Prereq 1	Fundamental Refrigerant Management	Required
<p>*Note for EAc1: All LEED for New Construction projects registered after June 26, 2007 are required to achieve at least two (2) points.</p>					
			Credit 1	Optimize Energy Performance	1 to 10
			Credit 1.1	10.5% New Buildings / 3.5% Existing Building Renovations	1
			Credit 1.2	14% New Buildings / 7% Existing Building Renovations	2
			Credit 1.3	17.5% New Buildings / 10.5% Existing Building Renovations	3
			Credit 1.4	21% New Buildings / 14% Existing Building Renovations	4
			Credit 1.5	24.5% New Buildings / 17.5% Existing Building Renovations	5
			Credit 1.6	28% New Buildings / 21% Existing Building Renovations	6
			Credit 1.7	31.5% New Buildings / 24.5% Existing Building Renovations	7
			Credit 1.8	35% New Buildings / 28% Existing Building Renovations	8
			Credit 1.9	38.5% New Buildings / 31.5% Existing Building Renovations	9
			Credit 1.10	42% New Buildings / 35% Existing Building Renovations	10
			Credit 2	On-Site Renewable Energy	1 to 3
			Credit 2.1	2.5% Renewable Energy	1
			Credit 2.2	7.5% Renewable Energy	2
			Credit 2.3	12.5% Renewable Energy	3
			Credit 3	Enhanced Commissioning	1
			Credit 4	Enhanced Refrigerant Management	1
			Credit 5	Measurement & Verification	1
			Credit 6	Green Power	1



LEED for New Construction v 2.2 Registered Project Checklist

Yes	?	No		13 Points
			Materials & Resources	

Yes					Required
			Prereq 1	Storage & Collection of Recyclables	
			Credit 1.1	Building Reuse , Maintain 75% of Existing Walls, Floors & Roof	1
			Credit 1.2	Building Reuse , Maintain 95% of Existing Walls, Floors & Roof	1
			Credit 1.3	Building Reuse , Maintain 50% of Interior Non-Structural Elements	1
			Credit 2.1	Construction Waste Management , Divert 50% from Disposal	1
			Credit 2.2	Construction Waste Management , Divert 75% from Disposal	1
			Credit 3.1	Materials Reuse , 5%	1
			Credit 3.2	Materials Reuse , 10%	1
			Credit 4.1	Recycled Content , 10% (post-consumer + 1/2 pre-consumer)	1
			Credit 4.2	Recycled Content , 20% (post-consumer + 1/2 pre-consumer)	1
			Credit 5.1	Regional Materials , 10% Extracted, Processed & Manufactured	1
			Credit 5.2	Regional Materials , 20% Extracted, Processed & Manufactured	1
			Credit 6	Rapidly Renewable Materials	1
			Credit 7	Certified Wood	1

Yes	?	No		15 Points
			Indoor Environmental Quality	

Yes					Required
			Prereq 1	Minimum IAQ Performance	
			Prereq 2	Environmental Tobacco Smoke (ETS) Control	
			Credit 1	Outdoor Air Delivery Monitoring	1
			Credit 2	Increased Ventilation	1
			Credit 3.1	Construction IAQ Management Plan , During Construction	1
			Credit 3.2	Construction IAQ Management Plan , Before Occupancy	1
			Credit 4.1	Low-Emitting Materials , Adhesives & Sealants	1
			Credit 4.2	Low-Emitting Materials , Paints & Coatings	1
			Credit 4.3	Low-Emitting Materials , Carpet Systems	1
			Credit 4.4	Low-Emitting Materials , Composite Wood & Agrifiber Products	1
			Credit 5	Indoor Chemical & Pollutant Source Control	1
			Credit 6.1	Controllability of Systems , Lighting	1
			Credit 6.2	Controllability of Systems , Thermal Comfort	1
			Credit 7.1	Thermal Comfort , Design	1
			Credit 7.2	Thermal Comfort , Verification	1
			Credit 8.1	Daylight & Views , Daylight 75% of Spaces	1
			Credit 8.2	Daylight & Views , Views for 90% of Spaces	1



LEED for New Construction v 2.2 Registered Project Checklist

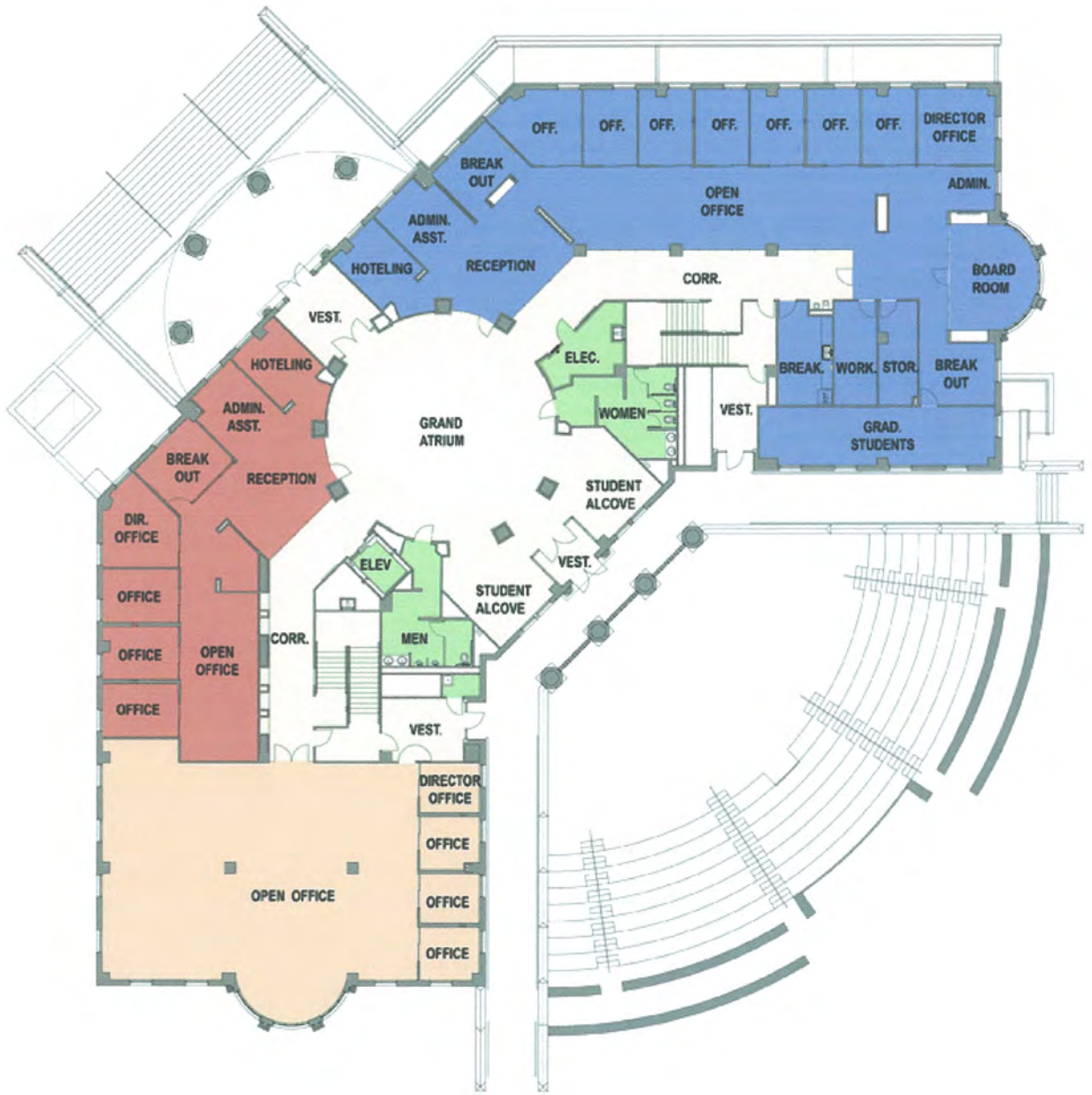
Yes	?	No		
			Innovation & Design Process	5 Points
			Credit 1.1 Innovation in Design: Provide Specific Title	1
			Credit 1.2 Innovation in Design: Provide Specific Title	1
			Credit 1.3 Innovation in Design: Provide Specific Title	1
			Credit 1.4 Innovation in Design: Provide Specific Title	1
			Credit 2 LEED® Accredited Professional	1

APPENDIX F

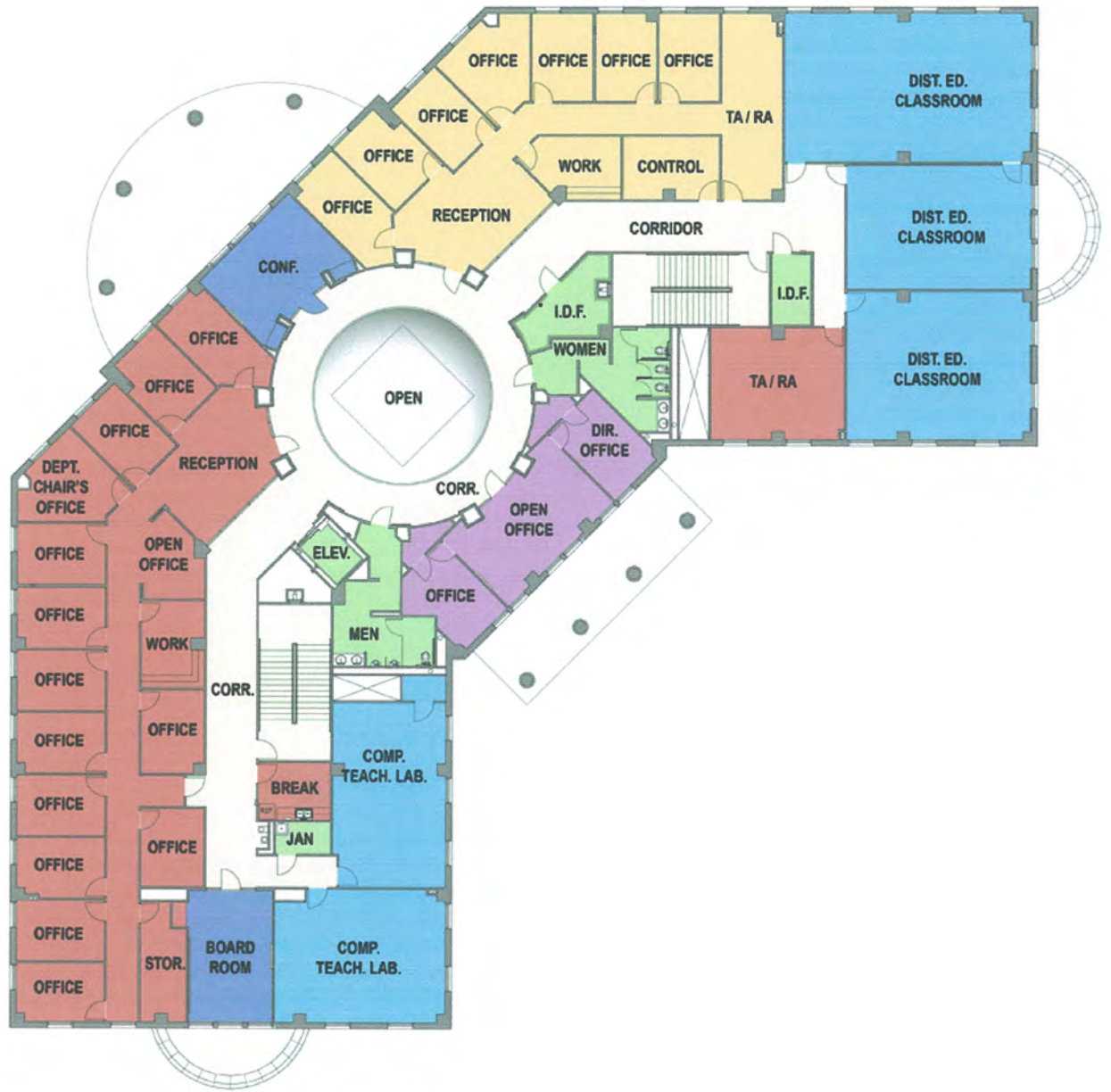
CARUTH HALL FLOOR PLANS



Caruth Hall, Southern Methodist University, First Floor



Caruth Hall, Southern Methodist University, Second Floor



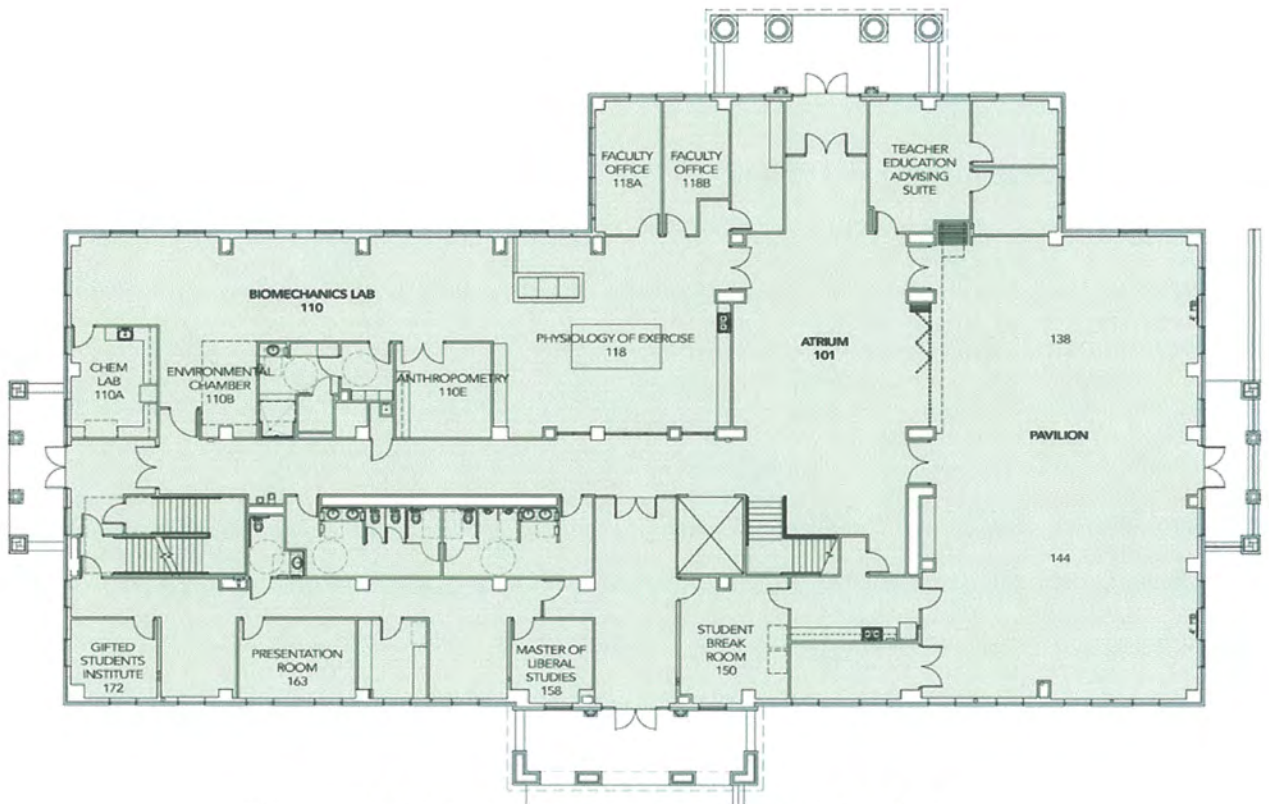
Caruth Hall, Southern Methodist University, Third Floor



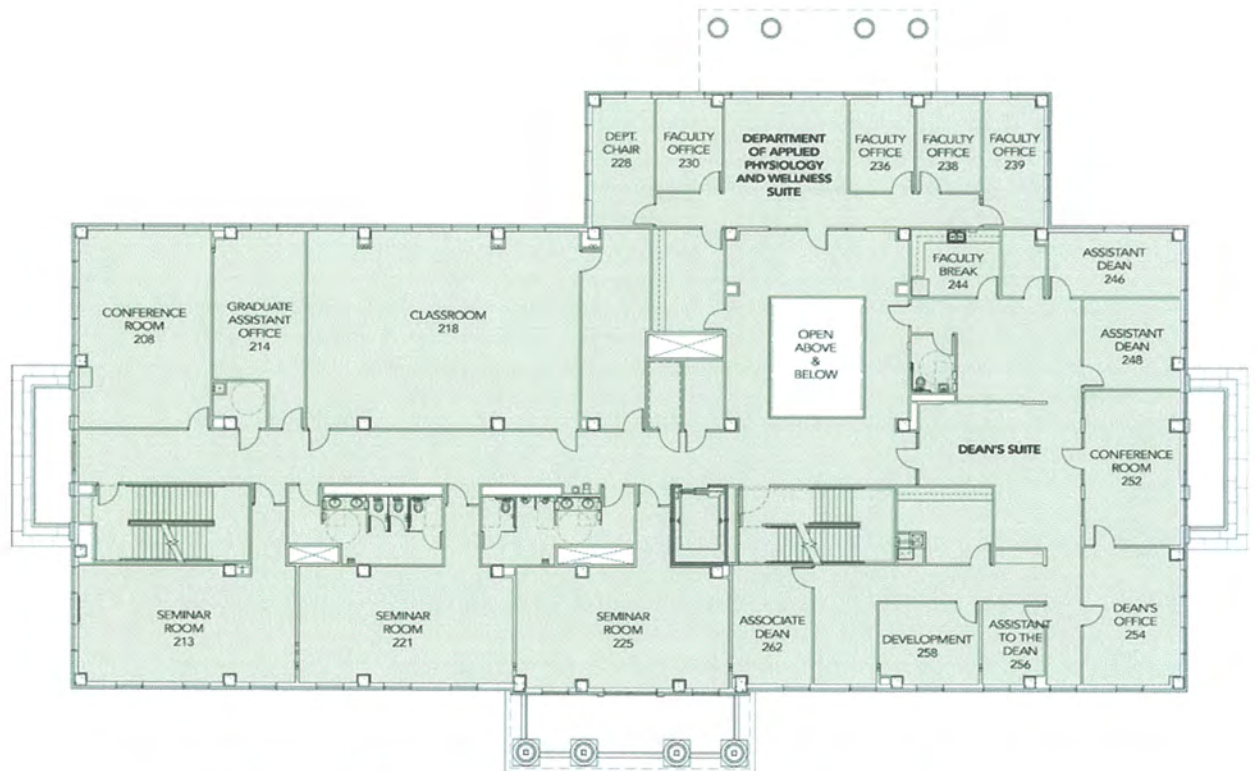
Caruth Hall, Southern Methodist University, Fourth Floor

APPENDIX G

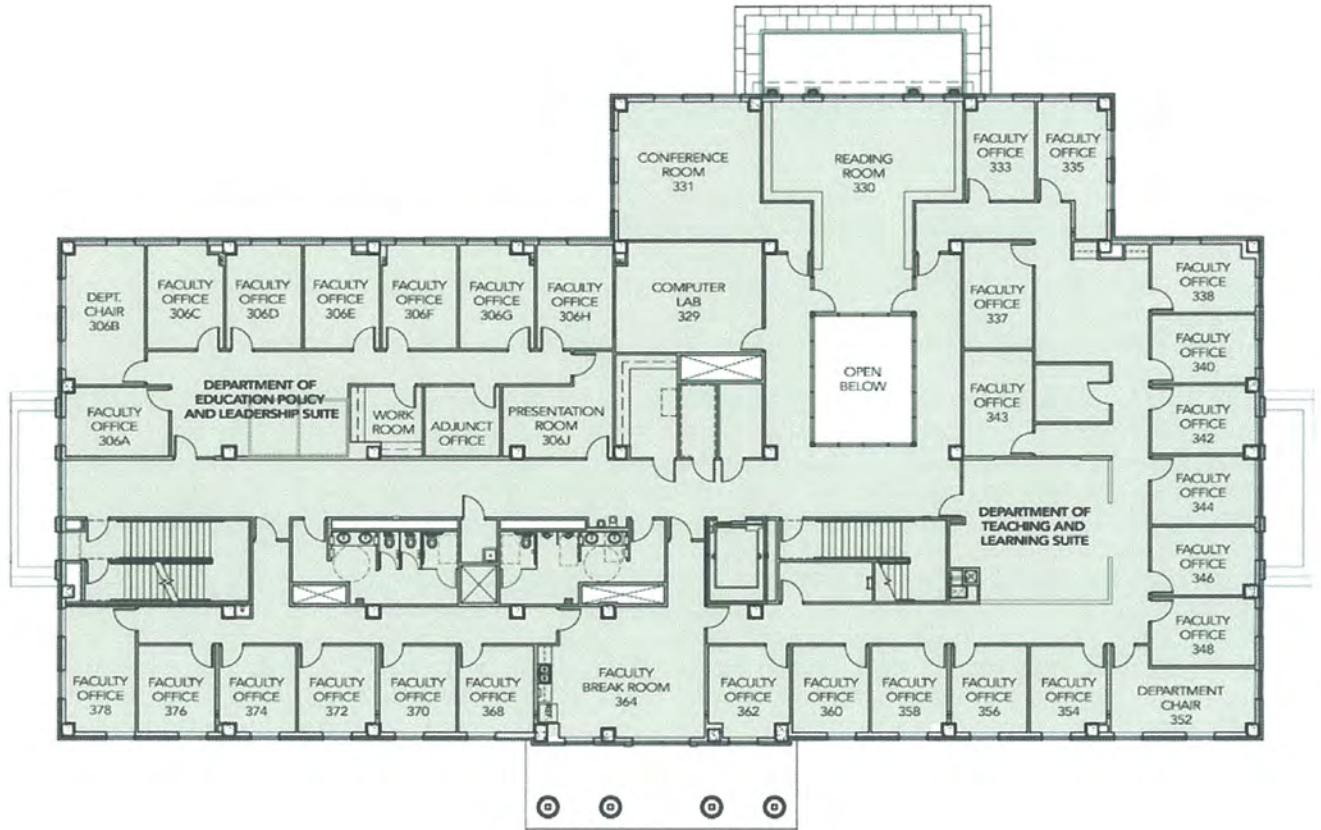
SIMMONS HALL FLOOR PLANS



Simmons Hall, Southern Methodist University, First Floor



Simmons Hall, Southern Methodist University, Second Floor



Simmons Hall, Southern Methodist University, Third Floor

APPENDIX H

SMU RECYCLING PROGRAM





Recycling at SMU



Single Stream Recycling

The Big Picture

SMU contributes 6,700 tons of trash to landfills annually! Single stream recycling allows us to recycle 4,100 tons of that which means reducing the landfill contributions to only 2,600 tons annually! (a 60% reduction)

Single stream recycling allows SMU to decrease  the amount of trash we currently send to the city landfills and increase  the amount of materials we send to local recyclers!!!

Separating and collecting these materials is a logistic nightmare and requires continual effort from everybody. Frankly, there is no efficient way to do it. With Single stream recycling, everything you throw in a trash can (other than wet trash and food waste) is recyclable material. Single stream recycling takes advantage of the fact that these recyclable materials can be *commingled* when collected and then separated later at the recycling center. So much of the dry trash produced at SMU can now be recycled!

What's in it for me?

- a. No more small white recycling box to get in your way.
- b. No more hunting for recycling containers around campus.
- c. All of the trash in your trashcan will be recycled including: paper, plastics, aluminum cans, steel containers, metals, newspaper, glass, corrugated cardboards, telephone books, soft cover books and other paper products. (Remember no wet goods or food waste.)
- d. You are instantly a greater recycling participant, helping to reduce the amount of waste going to landfills and increasing the amount of materials recycled -- all with much less effort than active recycling!

HOW "SINGLE STREAM RECYCLING" WORKS!

~The particulars

1. Each building will have designated collection containers for wet trash and food waste.
 - a. These containers will be located in hallways, classrooms and kitchen/kitchenettes.
 - b. The containers in these areas will be lined with **black** trash bags.
 - c. These **black** trash bags will be collected nightly by the SMU custodial staff and placed in the University Park dumpsters to be hauled to landfills.
 - d. In some locations where UP dumpsters are not located, SMU staff will collect the trash bags and take them to the landfills.
2. All other trashcans will be for the collection of recyclable material.
 - a. These trashcans will be lined with **clear** plastic bags only.

- b. The **clear** bags from these trashcans will be collected nightly by the SMU custodial staff and placed in recycling collection areas.
- c. These **clear** bags will then be collected daily by the SMU staff and taken to a local recycling plant.

Progress is possible with your participation-

The proposed program will be successful if we all do our part. Single stream recycling is a point-of-use recycling program, so it will be our responsibility to ensure its success. If you have any questions concerning single stream recycling call Robert Taylor at 8-2028. For disposal of large amounts of cardboard please break down the boxes then contact the work order desk (no charge) at 8-3494.

Thanks for all your efforts in helping us help the environment!

Resources

Campus Use of
Grounds

Contact Us

FAQ

Feedback

Landscape

Performance
Assessment

Policies and
Procedures

Recycling

Response
Priorities

Services

Who Pays?



More than 12,000 tons per hour of chilling capacity is available, but an average of only 5,000 tons is used through the hot summer months due to efficient operations.



Recycling at SMU



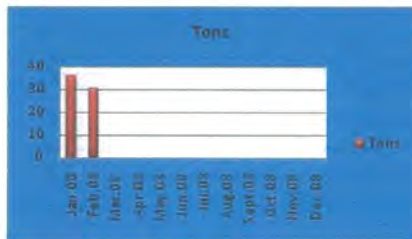
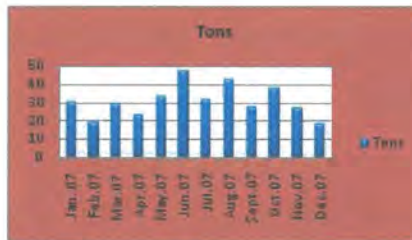
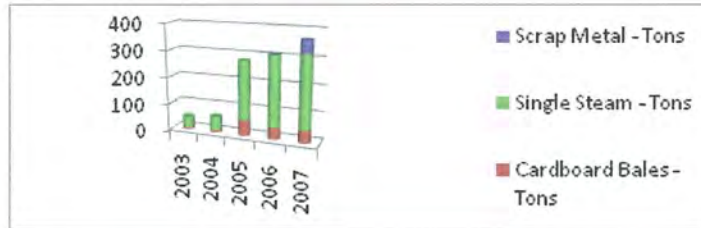
Single Stream Recycling

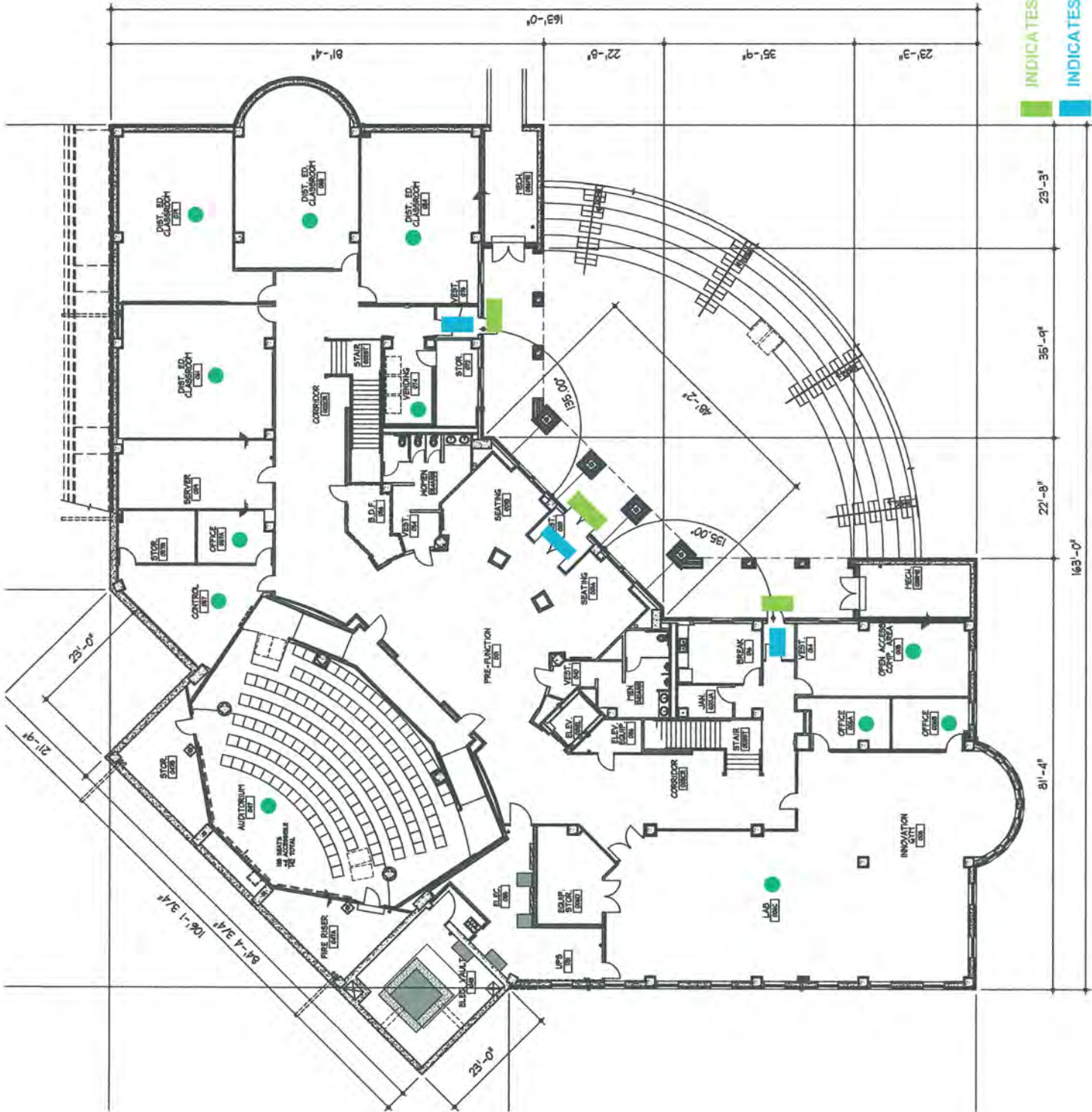
Americans throw away enough writing and office paper annually to build a wall 12 feet high from Los Angeles to New York City.

US businesses consume an estimated 21 million tons of paper every year, the equivalent of approximately 350 million trees.

Every Ton of Recycled Paper saves 17 trees, 4,100KWH of Energy, 7,000 gallons of water, 3 cubic yards of Landfill, and reduces air pollution by 60 pounds.

See the problem? What's the Answer? **The 3 R's**



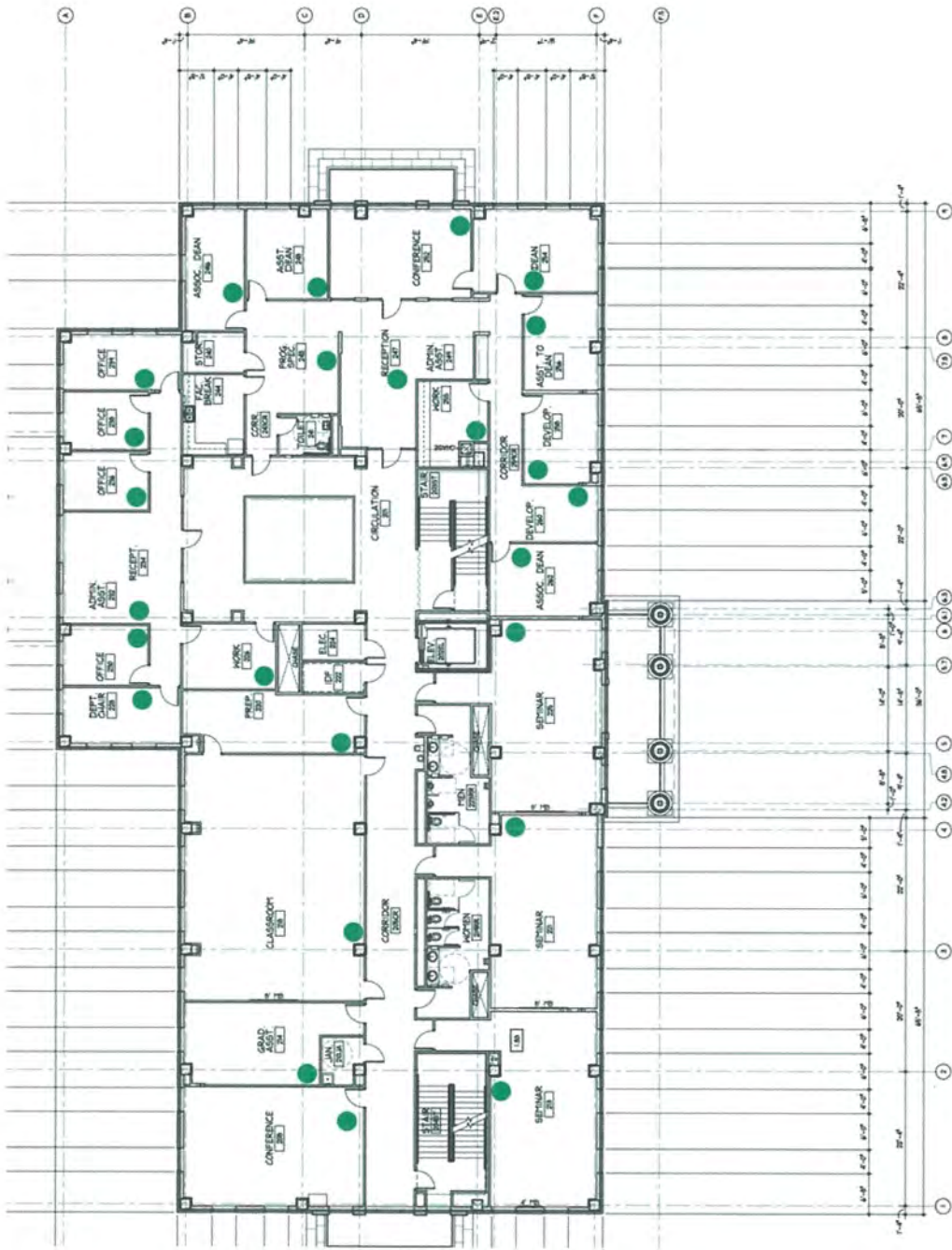


INDICATES EXTERIOR MAT
 INDICATES INTERIOR MAT

INDICATES RECYCLE
 CONTAINER

1 GARDEN LEVEL FLOOR PLAN
 N.T.S.





● INDICATES RECYCLE CONTAINER

APPENDIX I

PERMISSIONS

Kim Rich
2517 Rochdale Street
Garland, TX 75040
Phone: 972.530.2978
Cell: 214.274.5077

July 28, 2009

Dr. R. Gerald Turner, President
Southern Methodist University
PO Box 750100
Dallas, TX 75275

Dear Dr. Turner,

Please allow me to introduce myself; I am a doctoral student at the University of Missouri, Columbia. I am working on my doctoral degree in Environmental Design through the Architectural Studies department. My dissertation topic has to do with LEED Certified Buildings and the processes involved in designing LEED Buildings. It has been brought to my attention, there are several LEED building projects on Southern Methodist University's campus: Embrey, which is completed; Caruth Hall, which is in the construction phase; the Simmons building, which will break ground soon; Prothro Hall, which is finishing up; and Student Housing at the SMU-in-Taos, New Mexico, is also finishing up. Since all of these buildings are in different phases of completion, they would make a great case study. I understand that SMU is a private university therefore, I request authorization to study these buildings through the programming and design process of each as it pertains to LEED.

In addition to learning more about how these buildings are programmed, designed, and built, I hope to develop a strategy that would help streamline the LEED process to save money and time on future LEED projects. In order to develop this strategy, I will need to interview willing participants involved with these projects as well as visit the sites, review documentation, and take and review photos made of each site. The interviews would be conducted on a voluntary basis and can be completely anonymously if desired.

Through the University of Missouri, I will follow the protocol established by the Initial Review Board for these types of studies for participant permission. Southern Methodist University may have access to my research at any time during this process.

I truly feel that everyone will benefit from this type of study. If granted permission, I can get started right away with the formal written permission forms. At SMU's request, I will submit my proposal of study once it is approved by my lead professor, Dr. Benyamin Schwarz.

Thank you for your time and consideration.

Sincerely,

Kim Rich



SMU

Office of Planning, Design, and Construction

August 13 2009

Ms. Kim Rich
2517 Rochdale Street
Garland, Texas 75040

**RE: Permission to perform Case Study for LEED Buildings
Southern Methodist University**

Dear Ms. Rich,

Your letter dated July 28, 2009, to Dr. R. Gerald Turner, President of Southern Methodist University, has been forwarded to my attention for consideration. As such, we are pleased to grant you permission to pursue the case study you have outlined in your letter. You may begin coordination of your efforts by contacting Jay Meister and Trisha Mehis, Senior Project Managers in the Office of Planning, Design, and Construction. As with any institution, the University has policies and procedures in place which are expected to be adhered to while on campus. Any questions you may have regarding this or any other matters should be directed to our office.

We, also, understand the University may have access to your research at any time during the process. We would greatly appreciate receiving a copy of your final study, as well.

We look forward to assisting you in this endeavor. Should you have any questions, please do not hesitate to contact me directly.

Respectfully,

SOUTHERN METHODIST UNIVERSITY

Philip A. Jabour, AIA
Executive Director
Office of Planning, Design, and Construction

cc: Chris Casey, SMU
Trisha Mehis, SMU/PDC
Jay Meister, SMU/PDC



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Title: CARUTTE HALL

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Request to Publish Authorized by: Cynthia Thomas
Title: Librarian Date: 12-10-10

APPENDIX J

CODING MATRICES

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VITA

Kim Rich is pursuing her Doctorate of Philosophy in Environmental Design at the University of Missouri, Columbia. She obtained a Bachelors of Fine Arts degree in Interior Design at the University of West Georgia and a Masters of Fine Arts in Interior Design at Florida State University, Tallahassee. While attending college over the years she managed her own business in Interior Design. Her experiences have grown to include teaching for the Art Institute of Dallas and for the Art Institute of Pittsburgh, Online division for over six years. In addition, she has worked for several prominent designers in the Dallas, Texas area. Career wise, she plans to continue her occupation within the industry of design, and to perhaps, teach again to share her knowledge and experience. In addition, continue her research in environmental design.