

ABSTRACT

PEREZ, JAIME MAURICIO. Application of Target Costing Principles in Publically Funded Green Buildings. (Under the direction of Dr. Min Liu).

The purpose of this research is to propose a Target Costing principles-based frame work for publically funded Green Buildings. Target Costing, a concept from manufacturing, includes a variety of principles and techniques, all of which have the same ultimate goal: to control costs and to increase value to bring the most satisfaction to the end users. This study investigates the current practice when programming and designing the Hunt Library, a LEED-Silver certified and publically funded building at North Carolina State University (NCSU), and proposes some improvements to this practice based upon the fundamentals of Target Costing. The feasibility of the proposed framework was examined in this research through interviews with key project participants, e.g., owner representatives, user groups, design team, and construction manager. The results from this research were gathered to create a Green Building specific Target Costing application framework which includes a flow chart, and a list of barriers and solutions.

Application of Target Costing Principles in Publically Funded Green Buildings

by
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A thesis submitted to the Graduate Faculty of
North Carolina State University
in partial fulfillment of the
requirements for the Degree of
Master of Science

Civil Engineering

Raleigh, North Carolina

May, 2009

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DEDICATION

A Dios, quien ha sido mi principal guía, y me ha dado la fuerza necesaria para salir adelante y lograr alcanzar esta meta.

To God, who has been my core guide and has provided me with the necessary strength to go forward in order to achieve this goal.

A mis padres, Jaime y Cumandá, quienes desde el cielo han guiado siempre mis pasos.

To my parents, Jaime and Cumandá, who from heaven have guided and looked over each of my steps.

A mis hermanos, Héctor, Clemen, Tanya y Lorena, quienes constantemente me han brindado su amor y apoyo incondicional.

To my brother Héctor and my sisters Clemen, Tanya, and Lorena who have constantly provided love and unconditional support.

BIOGRAPHY

Jaime Pérez was born August 31st 1978 to Jaime O. Pérez and Cumandá Hinojosa in Otavalo, Ecuador. He spent his youth living with his family. He attended a “Católica” Elementary School before graduating from “Sánchez y Cifuentes” High School in 1996. After this, he enrolled in an exchange student program that led him to Moline, Illinois where he lived with an American family for a year to experience the American culture. Later in 1997, Jaime moved to Quito, to begin life as a student at Pontificia Universidad Católica del Ecuador, where he obtained his degree of Civil Engineer in 2003.

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ACKNOWLEDGEMENTS

I would like to thank Dr. Min Liu, as co-chair of my advisory committee. Without their guidance and tangible contribution the completion of this work could not have been possible.

I would like to acknowledge both Dr. Michael Leming, and Dr. David Johnston for serving as member in my committee. I extend my gratitude to Roberto Nunez for his friendship and longtime support during my academic studies. Also, I want to thank Dan for his help while writing this study.

I am grateful to the Fulbright Program and the Department of Civil, Construction, and Environmental Engineering at NC State University for the financial support that made possible this wonderful life and academic experience.

I would like to thank the people involved in programming and design of the Hunt Library for their invaluable advice and support, especially Carolyn Axtman for letting me participate in the process and for providing the data needed for this study. Their diligence has led to a timely and polished release of this work. Thank you very much.

Finally, I would like to thank Gabby for finding entertaining the stories on this research, my friends for their moral support throughout all this time at school, and all the people who in one way or another provided crucial support necessary to bring this work to fruition.

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Chapter 1. **Introduction**

1.1 **Need**

Robust, cost effective and easily implemented decision making tools such as Target Costing can be useful in assisting the owner, the design professional, and the contractor while producing publically funded green buildings. Green Building, defined by USGBC as the practice of increasing building efficiency and reducing building impacts on the environment, is intended to provide a practical response to environmental concerns. In a market-driven construction industry, owners often abandon Green Building due to increased initial costs even when life cycle costs are expected to be reduced (Kibert, 2008).

1.2 **Background**

Target Costing was originally used by Japanese automobile companies in new product development to help balance the lowest cost and the required utility. It attempts to reduce the costs of future products to target levels mutually established by both the designer and the supplier. This process requires creativity, commitment, and opened working relationships. Target Costing has proven to be highly successful in reducing costs and increasing values in the automotive and manufacturing industries (Cooper & Slagmulder, 1997). In the construction industry, however, the implementation of Target Costing is less than a decade old. No clear evidence of applications of Target Costing in Green Building was found.

Kibert (2008) noted that Green Building is based on principles that can be traced back to the end of the nineteenth century when designers foresaw the need for an ecological change in the

construction industry. The Green Building movement became more widely accepted in the early 1990's (Kibert, 2008). Yudelso (2008) states that Green Building developed as a trend derived from better understanding of how buildings are using up resources, affecting people, and polluting the environment. In addition, Green Building emerged as part of a solution to global issues relative to climate change, human health, and indoor air quality.

LEED stands for Leadership in Energy and Environmental Design, and is a rating system created by the United States Green Building Council (USGBC). This rating system has become the most commonly tool to assess green buildings.

1.3 Objectives

This study focuses on developing a Target Costing application that can be implemented buildings designed to reduce environmental costs and footprint, and are owned by publically funded institutions. This research had the following objectives:

1. Determine current state of knowledge and level of application, if any, to the use of Target Costing in Construction.
2. Identify the current practice used in a real and traditional Green Building delivery process during its initial stages that is, programming and schematic design in publically funded institutions.
3. Develop a framework for applying Target Costing in construction of buildings with reduced environmental impact, owned and operated by a publically funded institution.
4. Evaluate and revise as necessary the proposed framework by analyzing the potential application to a real project in a publically funded institution.

1.4 **Benefits**

The benefit that can be attained from this research is the knowledge to assist in understanding how Target Costing should be integrated with Green Building, and how the proposed integration will bring the most benefit for this sector in terms of controlling costs and adding value.

Chapter 2. Literature Review

In this chapter, aspects of Target Costing and Green Building will be reviewed.

2.1 Target Costing

“Target Costing” (TC) was conceived as a tool to not only control costs but also produce products ensuring that the buyers receive the most value for what they are purchasing and at the same time creating a desirable profit for the maker.

2.1.1 Definition

Various authors have defined Target Costing based upon their field of studies, as a result a significant number of definitions can be found in the literature. The definitions that are most relevant to this study come from the Manufacturing industry. These definitions are chronologically described below.

Sakurai (1989) mentioned that Target Costing is a way to reduce cost throughout the various stages of a products development and that this is taking place among some Japanese industries such as automobile, electronics and manufacturing.

Kato (1993) suggested that Target Costing developed as a result of re-evaluating the just-in-time production system, which was used in Japanese industries in 1960's. In this sense, he argued that Target Costing is not a cost system but rather a system which focuses on costs of a product over its entire life and seeks to discover how these costs can be lowered when planning and designing.

Tanaka (1993) defined Target Costing as a collaborative process from designers and managers in order to accomplish a goal. The goal is the product's target cost.

According to Ansari *et al.*, (1997) Target Costing is a management tool that helps obtain a profit when costs are controlled at the beginning of the product development process by incorporating the input of all downstream participants. Similarly, Cooper & Slagmulder (1997) defined Target Costing as an approach in which the market, the quality, and the functionality are considered when costing a product that will generate a profit.

It is imperative to note that all given definitions are adapted from the manufacturing industry. A definition of Target Costing seen from a Construction Industry point of view will be provided in Section 2.1.6.

2.1.2 Historical Background

The literature shows evidence that 'Target Costing', or 'Genka Kikaku' in Japanese, is definitely not new, at least not new to Japanese industries. Times and dates vary from one author to another. An effort has been made to obtain a chronological depiction of the main events.

Cooper & Slagmulder (1997) reported that Toyota coined Target Costing in 1959, while Tanaka (1993) argued that Target Costing was first developed in 1965. All agree that Toyota is the source of the concept.

Since its foundation in 1937, Toyota has worked on finding a new and innovative system for reducing costs in an effective manner. They realized cost estimation was not good enough, and the need for a new cost control technique had arisen. The first Toyota product to take advantage of this system was the "one thousand-dollar vehicle" in the mid 1960's. Nevertheless, the dispute mentioned in the previous paragraph when Target Costing came out is may be due to when the concept was first developed or in practice.

Mass production from Japanese industries was required to supply customer demands in 1960's. Customers became more selective in the goods they were consuming. Mass production did not offer the ability to differentiate products as much as desired. Because of this, many problems had to be solved to effectively respond to the demands of the market. Target Costing (TC) was implemented in some industries such as Atsugi Motor Parts, a Nissan Motor subsidiary, in 1976 and Daihatsu at a later date. Both companies adapted TC to effectively respond to a changing market, in which the customers identify valuable products at reasonable prices (Sakurai, 1989).

Kato (1993) reported that more than 80% of the major companies in assembly-oriented industries were already using Target Costing in Japan. In turn, Cooper & Slagmulder (1997) noted that these major companies included Nissan Motor Company, Ltd., Toyota Motor Corporation, Komatsu, Ltd., Olympus, Ltd.; Sony Corporation, Topcon Corporation, and Isuzu Motors, Ltd.

2.1.3 Principles

Target Costing is based on basic straight forward principles; all these principles must be followed to have success. Ansari *et al.*, (1997) described the following six principles:

1. Price Led Costing
2. Focus on Customers
3. Focus on Design
4. Cross Functional Teams
5. Life-Cycle Orientation
6. Value – Chain Involvement

The first principle, price led costing, basically captures the idea of the price setting the costs, contrary to traditional costing procedures in which the costs set the price. Therefore,

$$C = P - \pi$$

Where

C = target cost

P = competitive market price

π = target profit

The second principle, focus on customers, is used to ensure customer input is considered when setting the price. Customers will neither buy a product that does not meet their needs nor pay more for a product that is not valuable to them. In addition, the product has to generate profit in order to be produced.

The third principle, focus on design, shows the commitment of costs throughout the product development cycle. In other words, the earlier the product and process are designed, the more influence they have on costs. Figure 2.1 depicts a typical plot comparing committed costs to incurred costs.

The fourth principle, cross functional teams, recognizes that the people that make possible Target Costing should encompass the different areas needed such as engineering, production, sales, marketing, materials, cost, service and support. In addition, outside participants, such as suppliers,

customers, dealers, distributors, providers, and recyclers must be also included in the design process at the early stages of the product development cycle.

The fifth principle, life-cycle orientation, considers not only the cost of manufacturing the product but also the costs the product will incur over its entire existence. In this sense, the final user benefits from this because the costs of ownership are minimized and the producer also benefits because the costs of development are reduced as well.

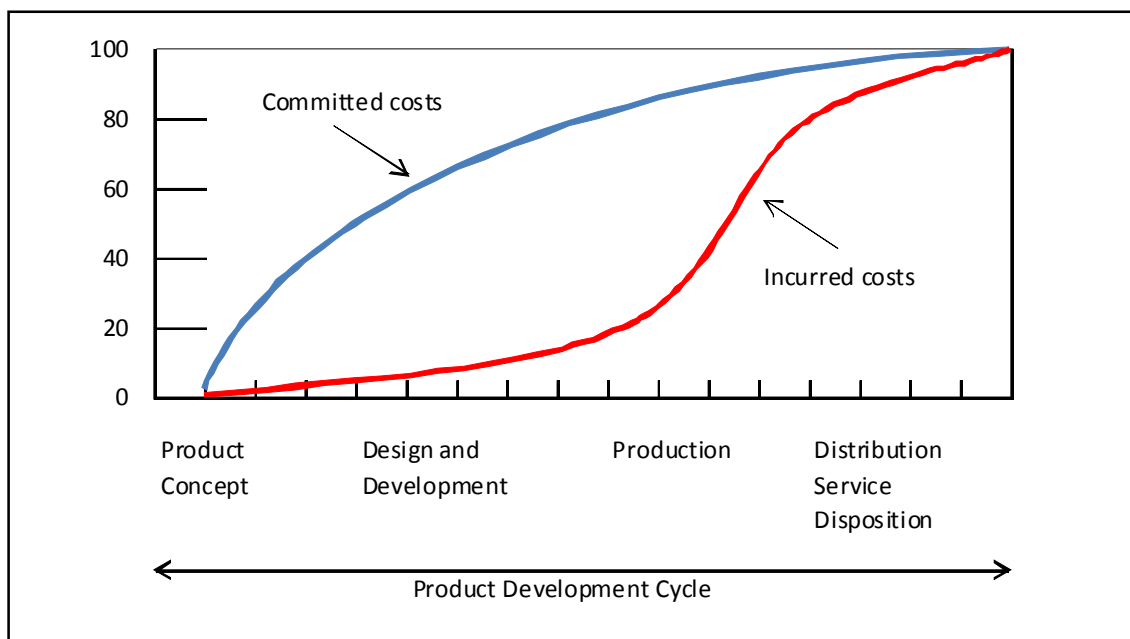


Figure 2.1 Comparison of Committed and Incurred Cost (Adapted from Ansari *et al.*, 1997)

Finally, the last principle, value-chain involvement, discusses the manner in which an established relationship among all participants achieves cost reduction. This relationship is seen in the long-term and has to be beneficial to both parties.

2.1.4 Process

The Target Costing process varies from one firm to another and from one author to another. For example, Sakurai, (1989); Kato, (1993); Tanaka, (1993); Ansari *et al.*, (1997) and Cooper & Slagmulder, (1997) have different numbers of phases and sections to represent the Target Costing process. These variations are no significant to the purpose of this research. The process followed in this study is that proposed by Cooper & Slagmulder (1997), consisting of three main sections.

Figure 2.2 depicts the process and its structure.

- Market-Driven Costing
- Product-Level Target Costing
- Component-Level Target Costing

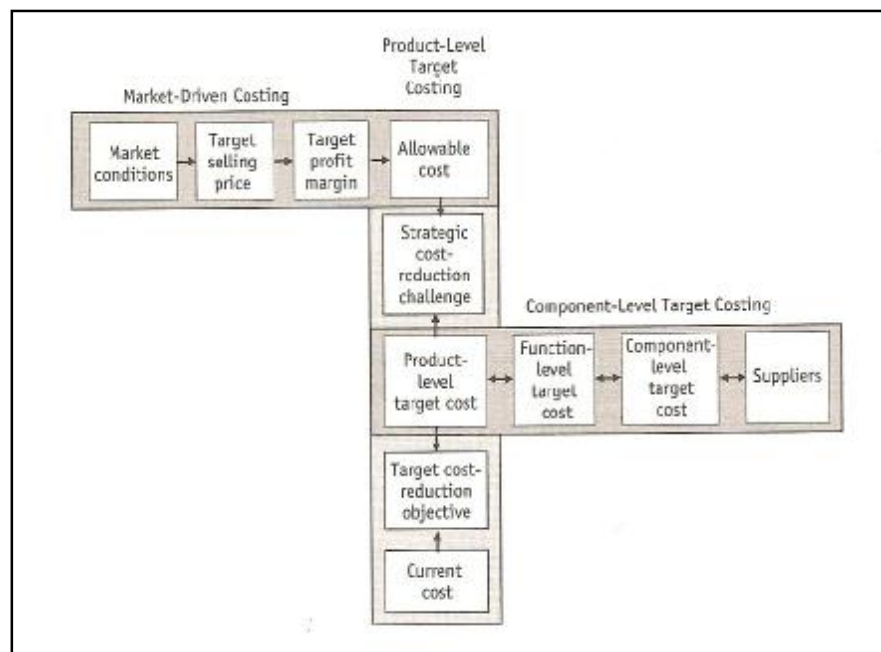


Figure 2.2 The Target Costing Process (Cooper & Slagmulder, 1997)

The three components are explained in more detail following the findings of Cooper & Slagmulder (1997).

2.1.4.1 Market-Driven Costing

In this section, the term “allowable cost” is introduced. This term represents the cost at which the product must be produced in order to generate the profit desired by the producer. It is important to note that this cost is not based on the capabilities of the firm but on the customer expectations and market conditions. Equation 2.2 shows how allowable cost is determined.

$$\text{Allowable Cost} = \text{Target Selling price} - \text{Target Profit Margin}$$

The Target selling price is what the final customer is willing or able to pay for a product meeting his/her expectations under the current market conditions. The factors of functionality and quality must be part of the analysis when determining this price. Figure 2.3 exhibits the relationship of these factors.

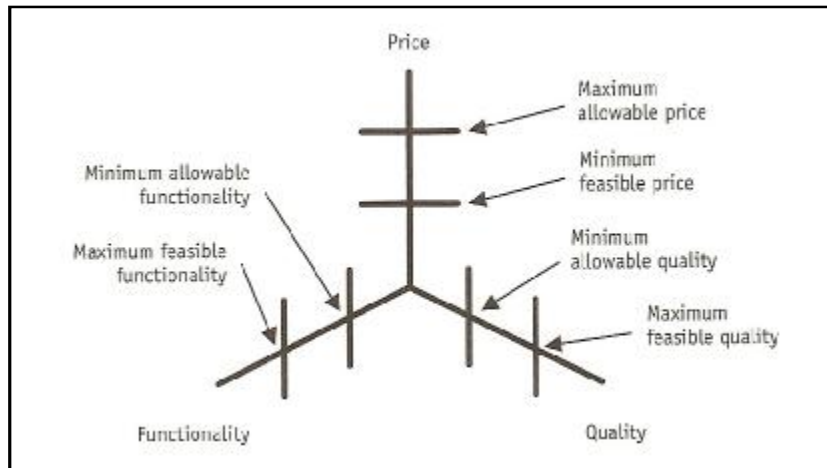


Figure 2.3 The Survival Triplet for a Product (Cooper & Slagmulder, 1997)

Target Profit Margin is what the firm or company expects to obtain after selling its product at the target selling price. The price should be aligned not only with the firm profit plan but also with the product historical profit, if any. There are two requirements when setting the target profits margin: (1) it must be realistic and (2) it must compensate the life-cycle costs of the product. Figure 2.4 shows the relationships between these factors.

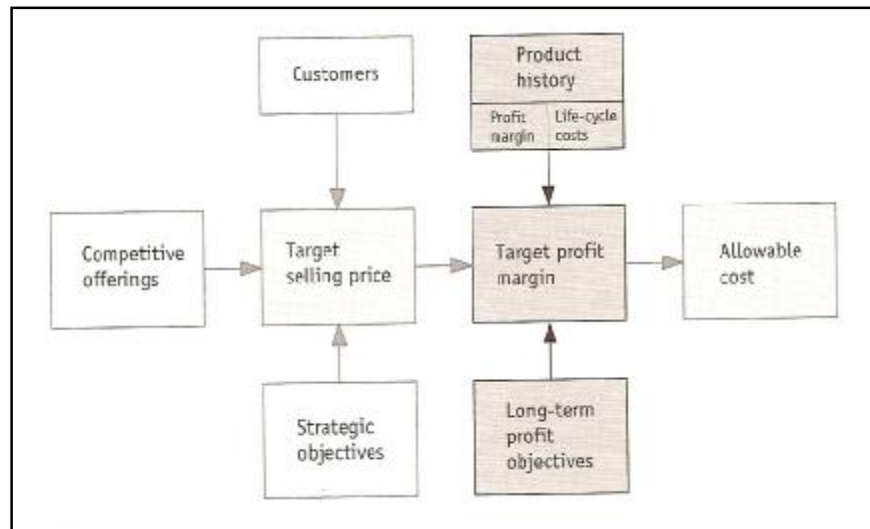


Figure 2.4 Setting the Target Profit Margin (Cooper & Slagmulder, 1997)

In a Target Costing process, firms generally struggle to meet the allowable cost because this cost is set by the customer rather than the actual cost; as a result a target cost is needed. The target cost will be located anywhere within the gap between the allowable cost and the actual cost, preferably closer to the allowable cost. The actual cost is also known as the current cost.

2.1.4.2 Product-Level Target Costing

Based on the firm's capabilities and level of confidence on achieving its goal, the Target Cost can be equal to or greater than the allowable cost. On the other hand, the current cost is defined as the

cost at which the product would be produced without using any cost control technique or engineering improvement. Figure 2.5 shows the three costs: current, allowable and target cost.

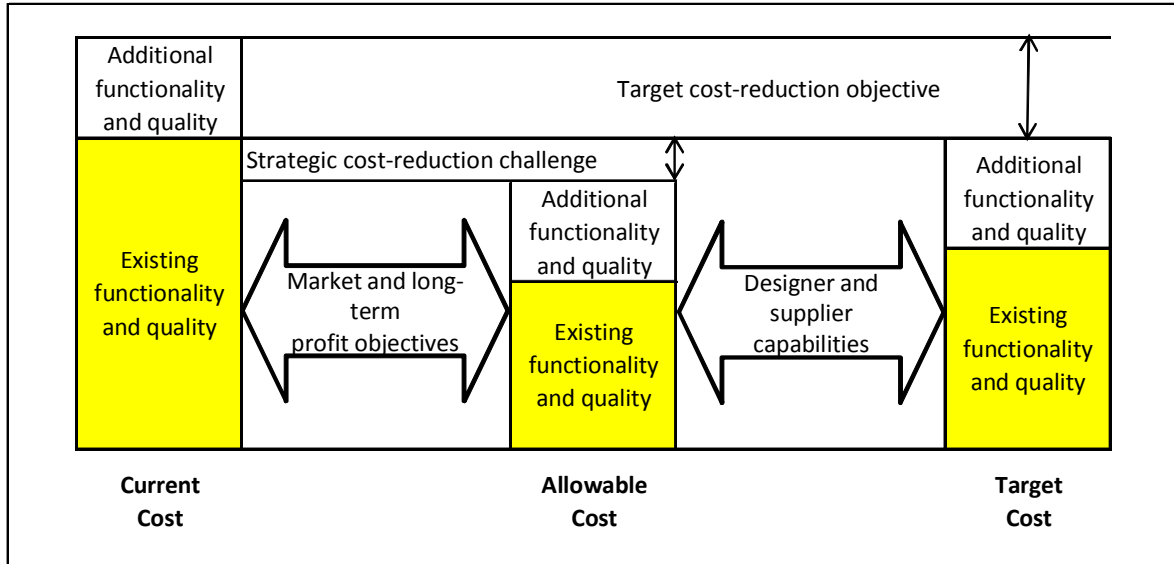


Figure 2.5 Costs in a Target Costing Process (After Cooper & Slagmulder, 1997)

By looking at the figure above, differences among these costs can be observed. The Target cost - reduction Objective is determined by subtracting the target cost from the current cost, and is what the firm believes can be achieved by eliminating certain costs from the product. The process of how these costs are eliminated can be termed “Value Engineering” (VE) explained in more detail in Section 2.1.4.2.1.

The difference between Target Costing and Allowable Cost is termed “The Strategic cost-reduction challenge” and can be defined as what the firm believes cannot be achieved by applying Value Engineering. In other words, it is a way to recognize that it is not always possible to close the gap between what the user wants and what the producer can offer.

2.1.4.2.1 Value Engineering

Sakurai (1989) defined Value Engineering as method of designing a product from different perspectives but always with the purpose of reducing costs and giving the customer what he/she wants.

Value Engineering is the central part of the Target Costing process, without it Target Costing would not be possible (Monden, 1995). Kato (1993) considers VE to be one of the most powerful tools available.

The Target Costing process focuses on reducing costs without sacrificing functionality and quality, and, as such requires a significant effort from the designers. A reduction in cost without a reduction in functionality is called Value Engineering (Ansari *et al.*, 1997).

Value Engineering is a structured approach to analyze each factor affecting the target cost and to predict how each of those factors add or reduce quality and reliability (Cooper & Slagmulder, 1997).

Monden (1995) reported the Japanese Value Engineering Association definition of VE as:

“Organized effort to implement functional analysis of products and/or services to reliably achieve all required functions at the lowest possible life cycle cost”

Gould (2005) defines VE in construction as a tool best applied early in the designing/building of the project. VE should consider all the elements relative to costs and benefits to provide value to a project owner.

This study defines Value Engineering as a multi-disciplinary process used by a team including owners, designers, and suppliers to develop innovative, creative alternatives that may become a product that meets the expectations of producers and users.

Target Costing is an extremely powerful tool, but is human-based and therefore, depends on human intelligence and creativeness. Target Costing can create a sense of defeat and lack of interest when targets are not being met as originally anticipated (Kato, 1993). Kato also noted that Target Costing could neglect environmental issues which are an important part of this study.

2.1.4.3 Component-Level Target Costing

Using the process proposed by Cooper & Slagmulder (1997), once a product is engineered, the next step is to examine its components. Figure 2.6 shows a hypothetical breakdown of product components.

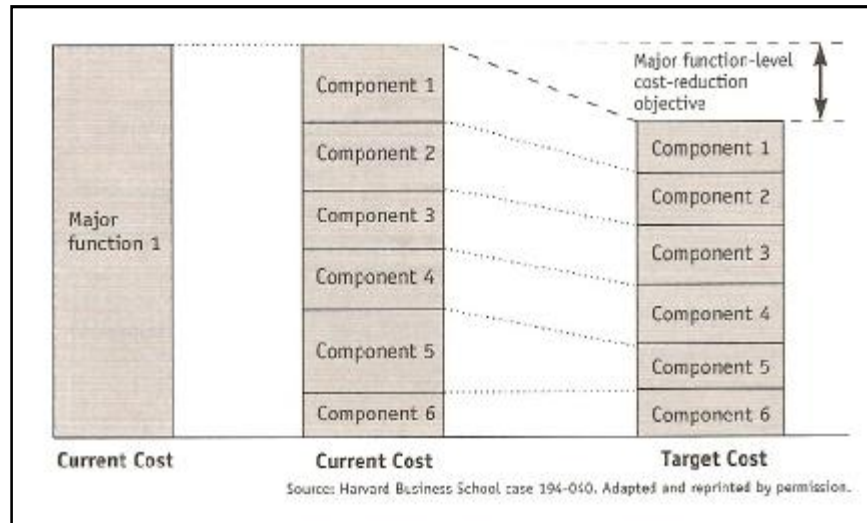


Figure 2.6 Nissan Motor Company, Ltd.: Decomposing the Target Costs of Major Functions to the Component Level, (Cooper & Slagmulder, 1997)

In construction, a significant percentage of the parts are obtained from suppliers as second, third, or fourth tier subcontractors. In almost all practical cases, the input from suppliers is vital to the process, because their knowledge is more specific and can bring new ideas to the development of value engineering. Economic incentives are offered when Value Engineering is put in place. Bringing downstream players upstream is another important characteristic of Target Costing.

The components largely determine the final product, but the construction process itself is also important. Suppliers must be carefully selected. The following criteria are recommended by Cooper & Slagmulder (1997) when choosing from available suppliers.

- Competiveness of their bids
- Reputation
- Degree of Innovation

As mentioned earlier, the Target Costing process varies and so does the relative importance of the three sections – market-driven costing, product-level Target Costing, and component-level Target Costing – within the process.

2.1.5 Organization and Participants

The process organization, the roles the participants play, and the evaluation criteria must be clearly communicated so that there is a coherent sequence to follow, responsibilities are properly assigned, and all participants understand both goals and motives. The creation of an effective cross-functional organization among top management and all participants is important (Ansari *et al.*, 1997).

Typically, there are four major teams in a manufacturing process: the business planning team, the product team, the design team, and the product manufacturing team. Smaller teams can also be part of the organization depending on how the firm is structured (Ansari *et al.*, 1997). A proposed composition and output of teams is shown in Figure 2.7.

Team	Membership	Major Team Output
Business planning team	Senior executives from all major functions including program managers	Long-term strategic plan, core competencies and key technologies, product strategy and plans, deployment plan
Product team	Product team program manager, sales and marketing (including international), product planning, manufacturing; cost analyst, procurement, key suppliers	Product level profit plans, product concept, product feasibility, value engineering (VE), cost targets, capacity and investments plan
Design team	Design engineering, prototype development, product planning, manufacturing, cost analyst, procurement, key suppliers, service and support, sales/marketing/distribution, recycling	Product concept, VE, detailed product and process design, validated product and process
Product manufacturing team	Design engineering, plant manufacturing, quality control, cost analysis, procurement, key suppliers, service and support, sales/marketing/distribution	Production plan, capacity requirements, final make/buy decisions, training on new processes, supplier management, continuous improvement

Figure 2.7 Composition and Output of Teams (Ansari *et al.*, 1997)

An effective integration of areas of expertise is vital to cross-functional team operations.

Participants are expected to interact with people from different backgrounds and expertise without losing their functional distinctiveness.

2.1.6 Research in the Context of the Construction Industry

The Construction Industry accounts between 4% and 5% of U.S Gross Domestic Product, reaching an important status in today's economy (Howell & Barefoot, 2008). Construction practitioners and scholars have noted that changes in current practice could improve cost delivery products. Nicolini *et al.*, (2000) discussed the need for this change in the UK construction. They noted that (1) Construction costs in the UK are higher than costs in USA and on Japan (WS Atkins, 2004); (2) Excessive waste is generated because of reworking to fix details that were not considered in the original design (Latham, 1994); and (3) The cost of settling contract disputes which, in 1992, was £300 million resulting from adversarial relationships between owners, designer, builders and suppliers (Barker, 1993).

The existing construction oriented literature identifies some of the attempts to implement Target Costing within the construction industry. Nicolini *et al.*, (2000) reported the applicability of Target Costing in construction in two pilot projects. The authors claimed that current practices, the lack of effective cost-estimation systems from designer and contractors, and the lack of a strong market are barriers to implementation. The study claimed that construction firms generally did not make an effort to control costs except by obtaining lower bids from downstream players, which caused the addition of more contingency, and as a consequence of this, a higher price. The low-bid process prevented Target Costing from being fully implemented although; the gap between current best-practice cost and target cost was reduced by partial implementation.

Since Target Costing was first developed by Japanese automobile industries, it was expected that Japanese construction firms might be the first to adopt Target Costing to buildings. York *et al.*, (2005) analyzed a survey (SJVE, 2000), that reported that 15% of construction firms in Japan were

already using this approach and an additional 36% were willing to use it. TC was defined primarily as a cost management tool to help provide profit for builders and value for project owners. TC must be applied from the beginning to the end of the project and within a participative environment, to be effective.

York *et al.*, (2005) also reported on the findings of a survey built upon the responses from 40 Japanese construction firms that measured the performance of Target Costing implementation in three main areas: financial, operational and market. The results were encouraging. Top management, value engineering and effective cost estimation system were needed to support the TC process in order to have a successful implementation, however. The results showed that TC was seen more as an effective cost control tool than anything else. Table 2.1 lists the ranking of financial, operational, and market factors that were measured in the survey.

Table 2.1 Performance Results of TC Implementation (Adapted from York *et al.*, 2005)

Performance		Ranking	Average	Standard Deviation
Financial	Active Participation in Cost Reduction	1	4.11	0.66
	Decrease in purchase prices of raw materials	2	4.03	0.80
	Decrease in construction costs	3	3.87	0.79
Operational	Waste elimination on the construction site	4	3.86	0.67
	Improvement in interdepartmental coordination	5	3.63	0.72
	Technological innovation	6	3.57	0.69
Market	Satisfying customer needs	7	3.78	0.63
	Timely introduction of new products	8	3.65	0.72
	Improvement in quality and functionality	9	3.62	0.76
	Realization of product concepts	10	3.42	0.87

From the analysis of the existing implementation of Target Costing in the Japanese construction industry, none of the averages appear to be statistically significantly different. Some significant inputs can be utilized in order to justify the proposed framework. First, cost is acknowledged to be more important than any other aspect, even more important than quality and time. The focus on cost by using TC was reported to be not older than seven years by 2005. Second, there is certainly some cost reduction when using TC, mainly due to the early interaction between participants and value engineering ideas that are brought into the process, which also keeps quality and time on track. Third, it was also concluded from the survey results that a robust implementation seems difficult without the commitment of the top management, the presence of Value Engineering and Cost Estimation Systems (York *et al.*, 2005).

Previous studies (Sakurai, 1989; Kato, 1993; Tanaka, 1993; Ansari *et al.*, 1997; Cooper & Slagmulder, 1997; Nicolini *et al.*, 2000; York *et al.*, 2005) concurred that, in order to have Target Costing fully implemented; a superior and accurate life cycle cost estimation system is required by the architect/engineer. To better address this necessity, Pennanen *et al.*, (2005) developed an application whose primary function is to calculate life cycle costs of a project based on the room and the quantitative requirements for those rooms beginning at the 'Programming.' Programming is the initial stage where wants, needs and constraints should be identified (before design). It is worth noting that once functional criteria are controlled quantitatively, their costs can be then fixed. Non-quantitative criteria (soft values), e.g. pleasantness, beauty, are still immeasurable. As a consequence of putting in place the application, its proponents claimed that the model has proven to be successful in several projects, achieving cost reduction up to 15% without sacrificing quality.

The application reduces the complexity of the whole system by having each design component meeting only one functional requirement; this is opposed to the concept used in Integrated Design Process in Green Building that will be explained in Section 2.2.5.1.

On the other hand, the term 'Project Definition' was introduced by Ballard (2000) as a synonymous for 'Programming', a common terminology used in construction to designate the first stage of a traditional delivery process. Thus, Project Definition is the first phase of a project delivery process that attempted to make use of 'Lean principles' for construction, this process is known as 'Lean Project Delivery System'.

According to Ballard (2000), one of main aspects supporting this 'Lean Project Delivery System' is that "costing and project duration estimating will be integrated with the production of the project definition, rather than being done after the definition is produced." Because of this, Ballard(2006) suggested redefining Project Definition so that Target Costing would be the main driver. Figure 2.8 shows how this system is organized in terms of phases and modules. It is imperative to note that the system has been already modified from its original to fit the adoption of Target Costing.

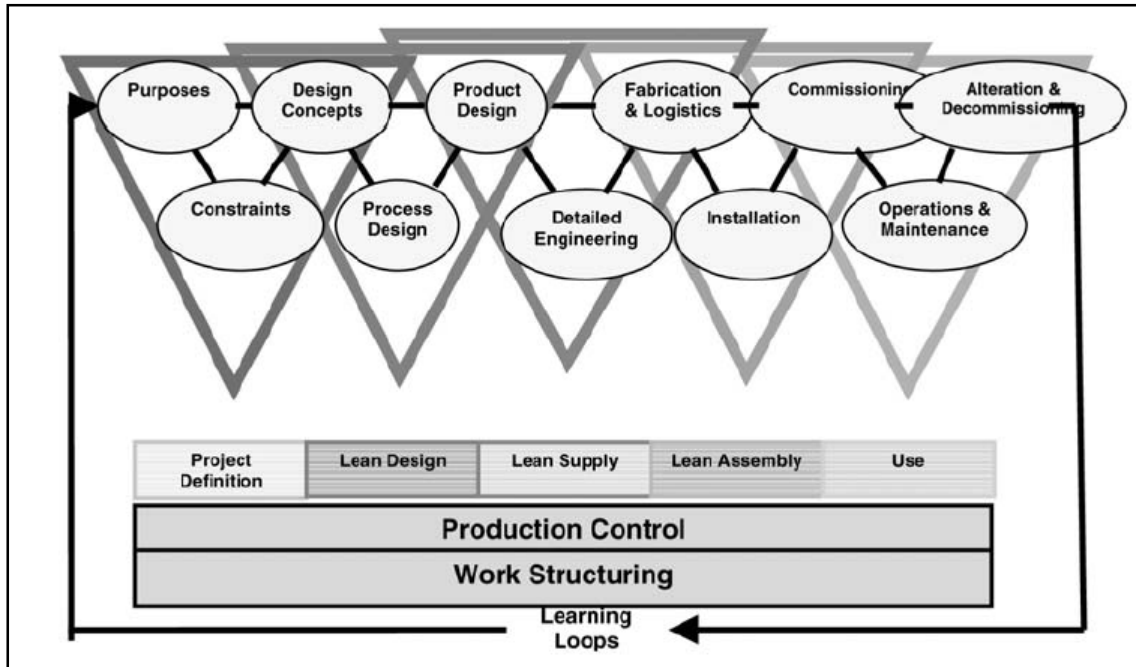


Figure 2.8 Lean Project Delivery System (Ballard, 2006)

Now, that Target Costing has been precisely described, a conceptual model is presented to permit a target cost to be integrated and accomplished at this phase of the project (Ballard G. , 2006). The model was based upon the principles explained in Section 2.1.3 but the application aimed a typical construction project. The model emphasized following a recommended sequence of steps and training participants, who in the end are responsible for the success of the project. In addition, the purpose of the model is to provide a logical sequence of actions such that if followed, decisions regarding whether to fund the project can be made, and target costs and scopes can be set. Figure 2.9 indicates the step to follow to achieve a target cost in the project definition stage.

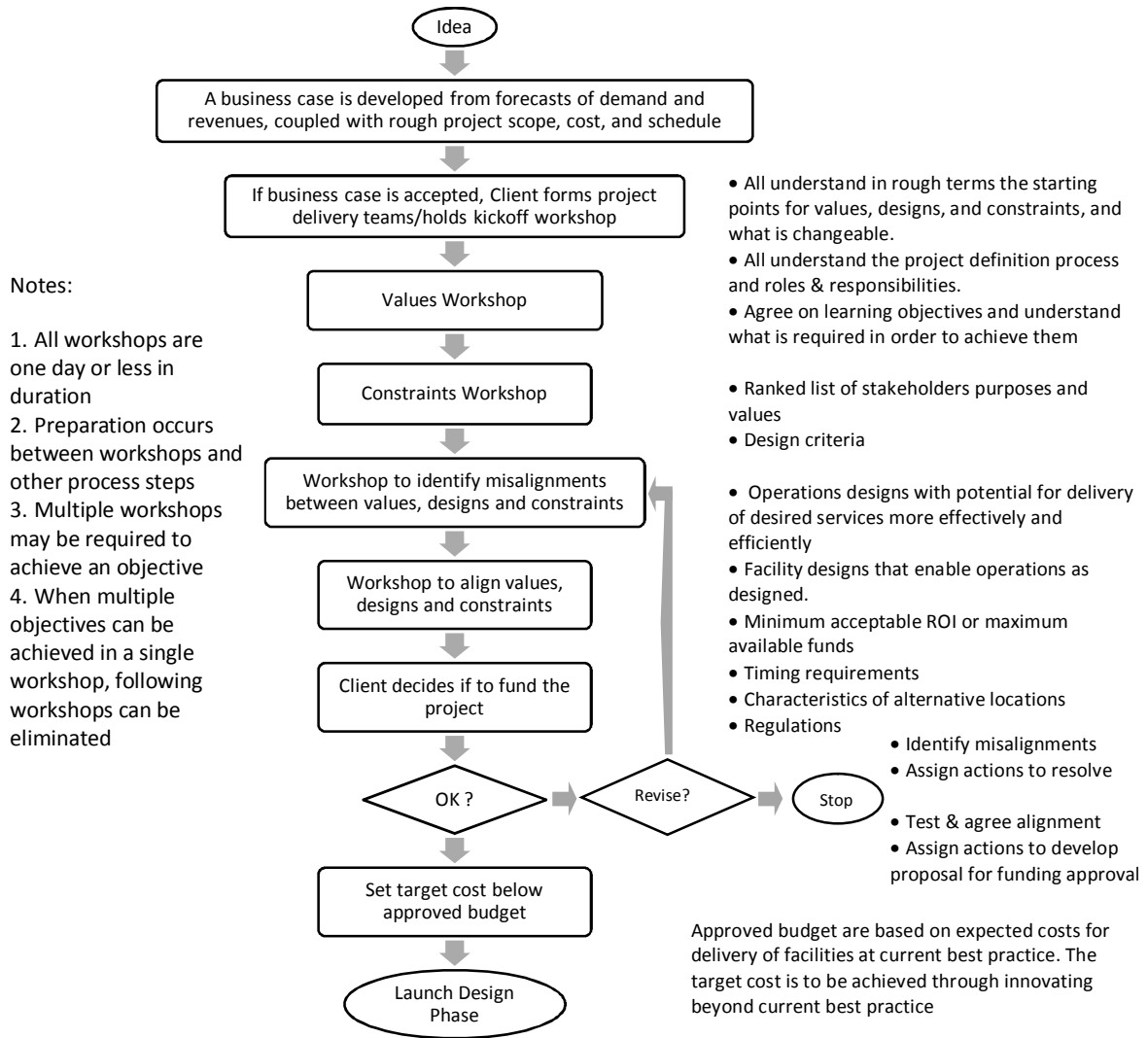


Figure 2.9 Project Definition Process (Ballard G. , 2006)

From the graph, a target cost must be set before launching design, in order to do so, it is necessary to implement an accurate cost estimation system to determine expected costs directly from the customer’s needs. Pennanen & Ballard, (2008) presented a method which allows obtaining the target cost for construction projects as indicated by the theory for product development from manufacturing. There are some requirements that must be present when the application is in place, however. Thus, a list of these requirements was proposed.

- Target Cost must be based on customer's function(s) and performance
- Client involvement must be at defining features such as functionality, quality, and value
- Target Cost must be market-driven
- Cross functional team work must be promoted at all times
- Target cost must be attainable, definitely not too low to prevent it from overrunning.
- Target cost must not be too high such that creativeness is possible
- Target cost must be broken down into components
- Effective estimates should be at hand

Once these prerequisites are met, a Target Costing process for the Programming or Project Definition phase for a traditional construction project is described. The process itself contains nine steps that are to be followed; some of the steps call for iterations, which could eventually increase the amount of work.

Finally, additional literature (Ballard & Reiser, 2004; Robert & Granja, 2006; Simões, Takinami, & Hirota, 2008) are mentioned to show the current status of the Target Costing approach for the Construction Industry, particularly for conventional construction.

2.2 **Green Building**

The development of Green Building, up to its current status, has occurred based on the awareness of how the construction industry is adversely affecting not only human kind but the whole planet in terms of preservation. For the purpose of this study, it is essential to understand the main drivers as well as the fundamentals of Green Building. The information provided will be helpful to support the proposed integration with Target Costing.

2.2.1 Rationale

“Green Building” has become one of the most important topics in the last decade due to the increasing environmental, economic, and health and community concerns. How to address these concerns have become the primary reasons for Green Building’s emergence.

Kibert (2008) reported three reasons considered as the key drivers for Green Building. First, sustainable construction will help minimize the impact of construction on the environment; lower the rate of resource consumption by recycling and reusing; and discover new alternatives of renewable energy. Second, economics are improved because costs are evaluated under a life-cycle cost analysis. Although initial costs might sometimes be more expensive, these can be recovered over a relatively short period of time. Lastly, the health of people who inhabit buildings, Kibert (2008) also reported on a study (World Health Organization, 1984) which suggests that as many as 30 percent of new and remodeled buildings in the world cause complaints relative to indoor air quality. Moreover, the causes for sicknesses such as sick building syndrome are to a certain extent neglected by traditional construction. All the elements mentioned above are part of the theoretical foundation of Green Building.

The USGBC has made the information listed below accessible to the public, such that an environmental consciousness can be realized at all levels people-wise. At the USGBC website (www.usgbc.org), it is indicated that in the United States alone, buildings account for:

- 72% of electricity consumption
- 39% of energy use
- 38% of all carbon dioxide (CO₂) emissions

- 40% of raw materials use
- 30% of waste output (136 million tons annually)
- 14% of potable water consumption.

When the concerns mentioned at the beginning of this section are addressed, they are seen as benefits. Although, today, a large number of benefits derived from Green Building have been identified, this number is continuously increasing due to the extensive research being done by public and private organizations in discovering the potentials of Green Building.

The United States Green Building Council at its website has completed an effort to list a group of benefits into three main categories derived from the concerns mentioned in the previous paragraph.

Environmental benefits:

- Enhance and protect ecosystems and biodiversity
- Improve air and water quality
- Reduce solid waste
- Conserve natural resources

Economic benefits:

- Reduce operating costs
- Enhance asset value and profits
- Improve employee productivity and satisfaction
- Optimize life-cycle economic performance

Health and community benefits:

- Improve air, thermal, and acoustic environments
- Enhance occupant comfort and health
- Minimize strain on local infrastructure
- Contribute to overall quality of life

In sum, there are good reasons for Green Building to continue being developed and researched.

2.2.2 Definition

Due to the evolution of the topic, definitions are continuously being updated and changed. A rigorous selection has been made in order to include those which are most complete and most updated for research purposes.

Kibert (2008) noted that the term Green Building is generally used when a structure - referring to a building – has features related to quality and characteristics derived from the implementation of ‘sustainable principles’. In this sense, many authors have agreed “Sustainability” relates to ecological, social and economic issues. Kibert also noted that, from the vast amount of terms being used by researchers and practitioners of Green Building, the expression “High-Performance Building” has become somehow a widely accepted synonym for Green Building. Presently, the two terms are used interchangeably.

Correspondingly, the research committee of the United States Green Building Council (USGBC) took the definition from ‘The Federal Commitment to Green Building: Experiences and Expectation’, a

report done in 2003 by the Office of the Federal Environmental Executive that defined Green Building as:

“The practice of (1) increasing the efficiency with which buildings and their sites use energy, water, and materials, and (2) reducing building impacts on human health and the environment, through better siting, design, construction, operation, maintenance, and removal—the complete building life cycle.”

When a building or property is seen as something that does affect adversely neither the environment nor the human health, the term used to refer to it is known as “a Green Building.” By environment, use of less water and energy is expected and by human health, quality of life is not affected. Even though a building can meet sustainable requirements and be green, since 2007 people acknowledge a building as a Green Building when it has been certified by the LEED Green Building Rating System of the U.S Green Building Council (USGBC) (Yudelson, 2008). Rating Systems or Methods will be explained in Section 2.2.4

2.2.3 Historical Background

To better understand the current status of Green Building is essential to understand its origins. Because of this, the next two sections will cover a comprehensive review of the history of Green Building, first in the United States and second around the world.

2.2.3.1 Development in the United States

As noted earlier, the ideas and thoughts serving as the base of Green Building started developing at the end of the nineteenth century. Among the designers who contributed to this development are Fuller, Wright, Neutra, Mumford, Malcolm, and Lyle (Kibert, 2008).

There have been several remarkable events that triggered the Green Building movement. In 1970, both the first Earth day was celebrated and the U.S. Environmental Protection Agency was created. Interestingly, it is pointed out (Gottfried, 2004) that twenty years later, the celebration of the 20th anniversary of the Earth Day influenced the creation of U.S. Green Building Council.

The energy crisis of 1970's was another factor contributing to the development of the Green Building movement. As a result, the American government started promoting tax incentives and funding for research on new energy sources (Kibert, 2008).

During the 1980's, the awareness of ozone layer depletion and global warming became a major concern, this led to a worldwide immediate response. Consequently, the Montreal Protocol banned the use of chlorinated fluorocarbons to protect the ozone layer, and the United Nations' World Commission on Environment and Development , called Bruntland Commission, became the first to define 'Sustainable' to promote people' environmental consciousness.

In the decade of 1990's the trend continued growing. In 1992, the United Nation organized a conference on Environment and Development, which was held in Rio de Janeiro, later this happening became known as the 'Rio Conference.'

In United States, the U.S Green Building Council (USGBC) was founded in 1993 by a group of people who strongly believed in the construction industry being part of the environment rather than being a threat to the surroundings. Remarkably, it marked the beginning of what Kibert (2008) reported as the most successful environmental movement in the United States, and definitely the fastest-growing movement among those people who do not consider themselves as environmentalists.

Moreover, The USGBC was not alone on its task of promoting sustainable construction. Other well recognized organizations came into the play, these include: the Green Building Initiative (GBI), the U.S. environmental Protection Agency (EPA), the National Association of Home Builders (NAHB), the Department of Defense, and so on (Kibert, 2008; Yudelson, 2008).

By the end of the 90's, a worldwide agreement was signed by more than 170 countries, excluding United States. The agreement originated from the United Nations Framework Convention on Climate Change and regulated greenhouse gas emissions.

From the end of 1990's until today, there have been significant improvements in organizations, regulations, and communications seeking a better environment. All of these came as a result of the evolution of the Green Building movement throughout time.

2.2.3.2 International Development

The United States is not the only country focusing on 'Sustainability'. Around the world, there are an increasing number of countries adapting tools and techniques to have environmentally friendly buildings. Countries such as Canada, China, India, Australia, Spain, among others have been and are implementing extensive programs to achieve sustainable goals within the last decades. Presently, the World Green Building Council (WGBC) at its website has reported twelve countries as active member and eight as emerging members.

In 1998, delegates from Green Building Councils from different countries were having conversations to create a worldwide Green Building Council. It was not until 1999, however, that the WGBC was founded and later in 2002 was formalized (www.worldgbc.org). Each country has its own

environmental concerns and how they deal with them depends on many factors. Therefore, the WGBC provides the required guidelines so that countries can adapt them upon its needs.

It is now a widely accepted fact that the development of Green Building has challenged conventional construction in order to make buildings environmentally friendly.

2.2.4 Assessment Methods

How green is this building? This is the question that assessment methods answer because they provide the criteria (metrics) to measure how green a building is. Either they are called assessment or rating methods or systems, their primary function is to officially state the greenness of the structure.

In the United States, the predominant rating method is known as ‘Leadership in Energy and Environmental Design’ (LEED) created by the USGBC. The Green Building Initiative™, another American organization, promotes Green Globes as an alternative Rating Method (Kibert, 2008).

There is a Green Building Council for each country, as there is generally a rating method for each Green Building Council. Table 2.2 lists some of the rating methods currently adapted by country.

Table 2.2 Rating Methods by Country

Country	Rating System	
	Acronym	Expansion
U. K.	BREEAM	Building Research Establishment Environmental Assessment Method
Japan	CASBEE	Comprehensive Assessment for Building Environmental Efficiency
Australia		Green Star
International	GBTool	Green Building Tool

As noted earlier in Chapter 1, the purpose of this study is to document the building delivery process of a real construction project to support the proposed model. The project serving as a case study would get a LEED-Silver certification. Therefore, LEED as an assessment rating and the levels of certification are explained in more detail.

2.2.4.1 LEED – Leader in Energy and Environmental Design

The criteria consist of a point-based system, the more points, the greener the building. At its website, the USGBC has defined LEED as:

“a third-party certification program and the nationally accepted benchmark for the design, construction and operation of high performance Green Building”

In other words, LEED has become a standard which enables one to evaluate the features of a building from an environmental point of view.

Since 1994 until 1998, the basics of LEED were under development. The first version (LEED 1.0) was released in 1998 as a pilot version. Two years later, in 2000 a new version (LEED 2.0) was launched. Significant improvements were made based on the experience gained from the previous one (Kibert, 2008). LEED has been a learning experience for everyone and changes from time to time to respond to the market needs.

Although many people associate LEED with a single rating method, it is not. In point of fact, LEED is a set of rating methods, each for different types of buildings and at different stages of the building delivery process. Figure 2.10 shows the current rating systems and the phases in which they are applied.

HOMES		
NEIGHBORHOOD DEVELOPMENT (IN PILOT)		
COMMERCIAL INTERIORS		EXISTING BUILDINGS OPERATIONS & MAINTENANCE
CORE & SHELL		
NEW CONSTRUCTION		
SCHOOLS, HEALTHCARE, RETAIL		
DESIGN	CONSTRUCTION	OPERATIONS

Figure 2.10 Current LEED rating systems and their action phases. [After USGBC, retrieved: January 10, 2009 from www.usgbc.org]

As the number of points gets higher so does the level of certification. Within LEED, every system has its own number of points to be achieved. Because of this, buildings of the same type can be compared within the same system. On the other hand, the level of certification permits to compare structures from different systems (Yudelson, 2008).

The level of certification is based on the number of points; the number of points varies from one system to another, however. To better understand how the system works, the four levels of certification are explained in terms of percentages. Thus,

- Certified: The project is to achieve at least 40% of the points
- Silver: The project is to achieve at least 50% of the points
- Gold: The project is to achieve at least 60% of the points
- Platinum: The project is to achieve at least 80% of the points

Yudelson (2008) used an analogy to reporting that people are used to see labels on food products, on which the main information and what is important to the user are detailed. On the contrary, when people walk into a building, there is no information relevant to the place. The level of certification is awarded by providing an “Eco-Label” to be displayed at the entrance of the building showing its green attributes. Figure 2.11 shows an example of a typical eco-label, the awarded building was a Library seeking a LEED Silver certification.



Figure 2.11 Eco-Label for a Library Center in New York (www.usgbc.org)

Green Buildings are graded on basically six main categories: sustainable sites, water efficiency, energy and atmosphere, materials & resources, indoor environmental quality, and innovation & design process.

2.2.5 Process

Traditional or conventional building delivery processes are the terms relative to the delivery processes used on the vast majority of construction projects. Due to the familiarity of construction participants with these processes, they have been and are being used to deliver Green Buildings.

Construction management at risk is a building delivery method used in publically funded green buildings. In this method, the owner does much of the programming and designer selection alone in the preconstruction phase. Later, the construction manager is selected to help manage the construction process (Gould, 2005).

Construction participants, however, quickly realized that because of the distinct nature of the new goals and objectives to be achieved by Green Buildings, a different approach was needed to better manage these new challenges.

Within the process, the most important aspect is the thought that supports the process to deliver a high performance Green Building. Literature shows evidence of two terms used to describe this process, (1) Integrated Design Process (IDP), and (2) Whole Building Design Process (WBDP). The latter has a wider range, because it includes IDP as the first component and the people performing an IDP as the second component (Kibert, 2008). Nonetheless, both processes are based on the same principles and they both emphasize on collaboration and life-cycle performance. Moreover, the two terms are usually used interchangeably.

Zimmerman (2006), and Yudelson (2008) have claimed that Integrated Design Process (IDP) could be considered the most suitable process to better produce a High Performance Green Building. Alternatively, the expression “Whole Building Design” was originally conceived by the National

Institute of Building Science (NIBS) and has been acknowledged as the key aspect of a producing a Green Building. In addition, it has been adopted by a number of federal agencies, which has given it more widely recognition (Kibert, 2008).

For the purpose of this study and to make more explicit the concept (Integrated Design Process) and the performers of such process (Participants), the two aspects are explained separately in the subsequent sections.

2.2.5.1 Integrated Design (IDP)

In Green Building, participants are always looking for ways to attain the highest performance on green features at the lowest cost; one of the consequences is a new approach known as “Integrated Design Process” (IDP) which was developed in order to better address these needs.

Research done by Zimmerman (2006), Kibert(2008), and Yudelson(2008), argued that this process is one of the most preferred or recommended to produce Green Buildings. In addition, on a relative recent report(Langdon, 2007), Morris (2007) wrote that IDP is one of the most effective factors in delivery cost-efficient Green Buildings. Even though there is no attribution of IDP being the formal process. The assessment method mentioned in section 2.2.4, Green Globes, grants up to 20 points if IDP is used.

It is necessary to note that IDP was first conceived when designing energy-efficient commercial buildings in the early 1990’s by Natural Resources Canada’s C-2000 program and IDEAS Challenge. But, energy-efficient buildings are not anymore what they used to be in terms of energy, they have evolved from focusing on solely energy to focusing on sustainable attributes. This evolution has also caused the application of IDP to go from energy-efficient building to Green Building. The main

aspects of an Integrated Design Process are discussed briefly in the subsequent sections of this chapter. Aspects such as definition, elements, implications, and participants are presented in order to develop a clear understanding of the process.

2.2.5.1.1 Definition

In a report (Larsson, 2002) on a National Workshop held in Toronto, Canada in October 2001, a definition of the IDP was presented based on (1) discussions developed at the workshop, and (2) afterward inputs by email from participants. Hence, IDP was defined as a collaborative approach to produce high performance buildings meeting the fundamentals of Sustainability. This process analyzes the building over its entire life, from programming through design, construction, commissioning, delivery to the owner to occupancy, which allows owner and stakeholders to better recognize what is wanted in terms of functionality, quality, price and sustainable features.

It is vital to understand that the term 'stakeholder' has been introduced to represent any person who has an interest in the project.

Similarly, IDP has been defined at the website of the U.S. Department of Energy as a design process that takes into account conventional features and also features that at first are not seen as related. This permits us to recognize what is valuable and to obtain the most benefit. The process cannot be developed without having the appropriate team on board. Participants from different disciplines play an important role by means of bringing ideas that help achieve better performance at lower costs.

2.2.5.1.2 Elements

Conversely, Zimmerman (2006) argued that because there are a considerable number of definitions, it is imperative to recognize the elements that should be part of an Integrated Design Process, rather than the definition itself. Although none of these elements are new, how they are intended and what they emphasize on is the gist of the process. The basic elements that an effective IDP should include are the following:

- *Goal-driven*, being sustainable the key aspect
- *Facilitated* by someone who is responsible for producing the building
- *Structured* so that a rational order is followed
- *Clear decision-making* for people to understand the reasons why something is done
- *Inclusive*, no one, who has an interest in the project, should be neglected from the process.
- *Collaborative*, so that people work as a team rather than individually.
- *Holistic or Systemic Thinking* so that synergy is obtained.
- *Whole-building budget setting* so that trade-offs are based on economical benefits
- *Iterative*, continuous improvement from previous decisions
- *Non-traditional expertise*, which permits to identify issues not identified conventionally.

These elements should carefully be included in the process so that a successful implementation of an IDP is attained when producing Green Buildings. IDP functions when each and every element is accomplished, and a successful result is not possible when elements are neglected or partially considered.

2.2.5.1.3 Effects based upon time implementation

There is a consensus among practitioners of IDP on the fact that the earlier IDP is put in place the more the benefits that can be obtained for the project. The same thought is realized in the Target Costing process, where cost is the main benefit. The fact that the ability to influence costs is higher at the beginning of any construction process has been evidenced by many studies on project management and it can somehow be considered common knowledge. Figure 2.12 shows the effects on costs and savings through the different stages of the process.

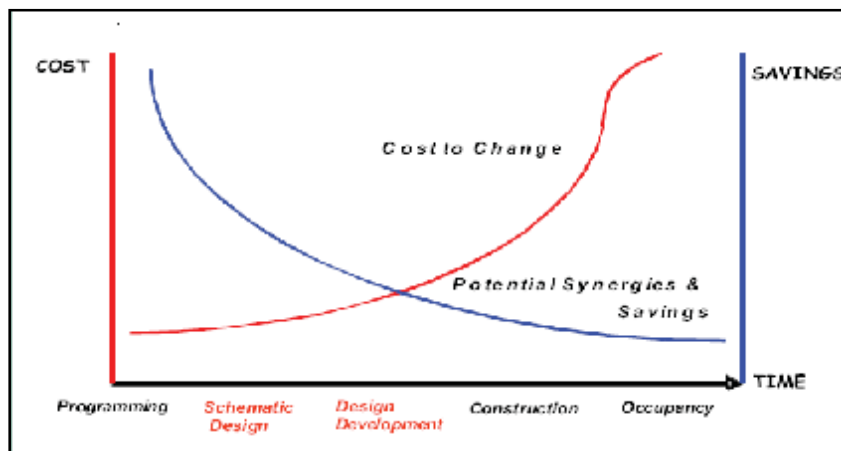


Figure 2.12 Effect on Costs and Savings over time through the process

Similarly, the maximum benefits are achieved if an IDP is established even before the start of the design process. Because IDP came out as a result of producing high-performance Green Buildings, which are different from traditional buildings, IDP differs from a conventional design process in terms of when the design team is brought in, and what decisions should be made throughout the different stages of the project. The IDP must start much earlier so that key aspects and goals are

defined as soon as possible. Figure 2.13, adapted from Interface Engineering, Inc. shows how the opportunities of IDP decrease over time (Kibert, 2008).

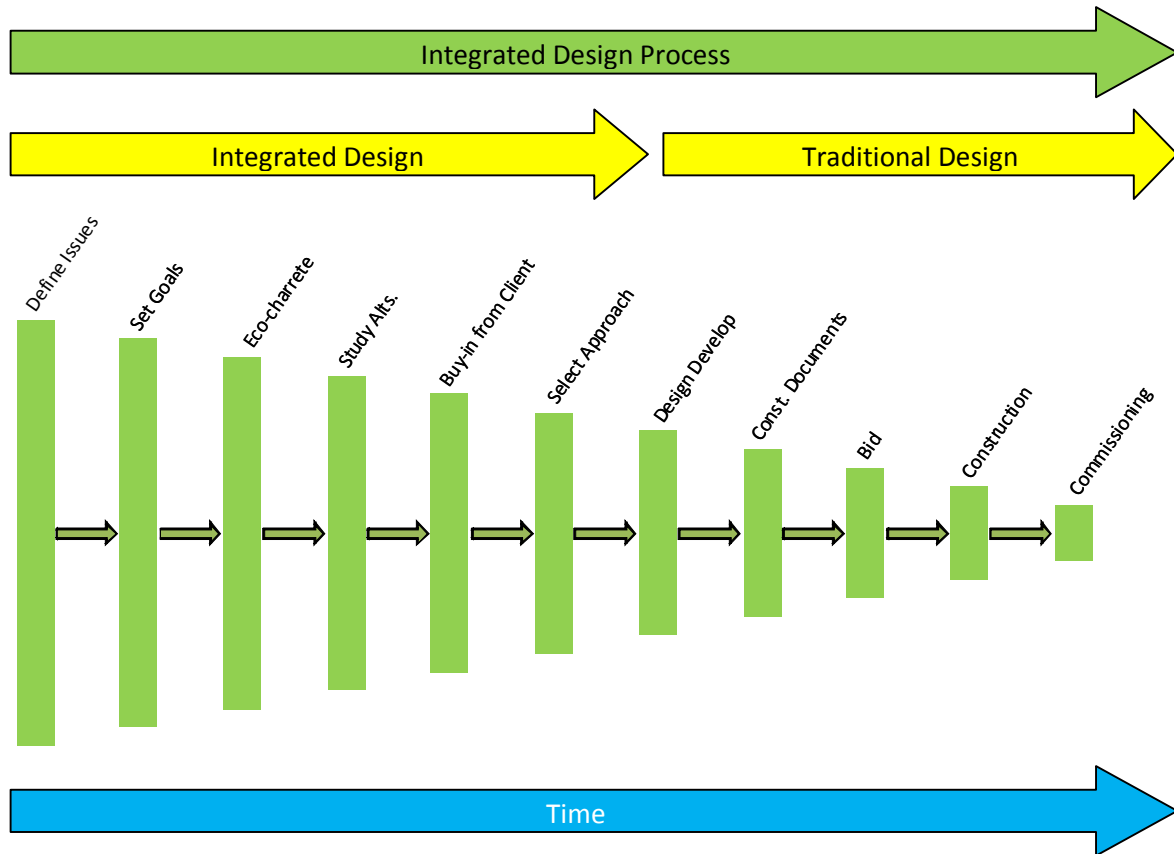


Figure 2.13 Integrated Design vs. Traditional Design

2.2.5.1.4 Participants

As previously noted in Section 2.2.5.1.2, one of main elements of an Integrated Design Process is to be “*Inclusive*”, which refers to who should be involved in the process. In some traditional construction delivery processes some participants are not heavily involved, e.g. users. Conversely, because IDP draws from the experience and knowledge of all stakeholders (Kibert, 2008) the only

manner to obtain this experience and this knowledge is by actually having all stakeholders participate in the process.

Correspondingly, the number of participants is not limited to the number of people from a traditional design team, which includes: architects and engineers. As noted earlier when defining the IDP, some areas that originally seem unrelated to the project are identified. This identification is simply possible by enhancing the initial design team up to a team integrated by all stakeholders, which sometimes is referred (Kibert, 2008) as an “Integrated Design Team.”

It is important when IDP is implemented during the process, and so is when participants are brought in. Zimmerman (2006) reported that there are usually two dozen actors involved in the design and construction of every building, however, it is not recommended to have everyone in the room at all time on every issue. The core group should include:

- Building owner or owner’s representative
- The design facilitator
- A cost consultant
- An energy simulator
- A General Contractor or Contract Manager, if the procurement method permits it

In addition, there are some other people who can be brought as needed:

- User group’s representative
- Facilities manager
- Specialists in specific technologies

- Non-traditional expertise e.g. a day lighting modeler, an appraiser, a site ecologists, etc

Another element mentioned in section 2.2.5.1.2, is “*Collaborative*”. A key feature of IDP is that everyone is part of an environment of collaboration where there must be a commitment to meet the goals and objectives of the projects. The architect is not seen anymore as the sole practitioner responsible. The architect, indeed, is a co-learner in the process.

2.2.6 Costs

Chapter 1 identified that the increased initial cost associated with Green Buildings can often lead owners to stop pursuing them. Kibert (2008), and Yudelson (2008) claimed that understanding building economics and the incremental cost of Green Buildings, correspondingly, is essential, because it will shape the development of Green Building despite of the benefits already discussed in Section 2.2.1.

Construction costs are considered “hard” and benefits, on the contrary, are considered “soft” (Yudelson, 2008). Because of this, a rational analysis balancing out costs and benefits should be done in order to make clear these two aspects to project owners seeking Green Buildings.

Throughout the years, cost studies on Green Building have attempted to answer the question: What does Green really Cost? Although, the question is quite simple, there is no agreement on how much should be added to the budget neither on the existence of such extra cost on achieving reasonable levels of sustainability in Green Building (Langdon, 2007). The cost studies supporting relevant facts to demonstrate the cost or no extra cost of being green are discussed below. Because the case study, being researched by this thesis, is a Library facility seeking a LEED-silver certification, primarily cost studies on LEED-seeking and library buildings have been selected.

One of the first cost studies found in the Literature of Green Building that has become popular to refer to when researching the costs of Green Buildings was done by Kats (2003), for the State of California. The study reported on several aspects such as cost perception, cost quantification and time implications.

First, the perception that Green Buildings are more expensive than conventional buildings is illustrated by pointing an article in the New York Times with the title “Not Building Green is called a Matter of Economics”, in which it is mentioned that the initial extra cost is not worth it. No numerical analysis was presented to support this statement, however.

Second, the study showed evidence on 33 Green Buildings whose costs were locked and compared to conventional designs for those same buildings. Surprisingly, the weighted average premium was 1.84%, (See Figure 2.14) which was suggested to be lower than the perception at that time. The extra costs were related with architectural and engineering design time, modeling costs and most importantly with the time used to put in place IDP. It was also acknowledged that institution of the IDP earlier in the process helped to lower the cost of the finished project.

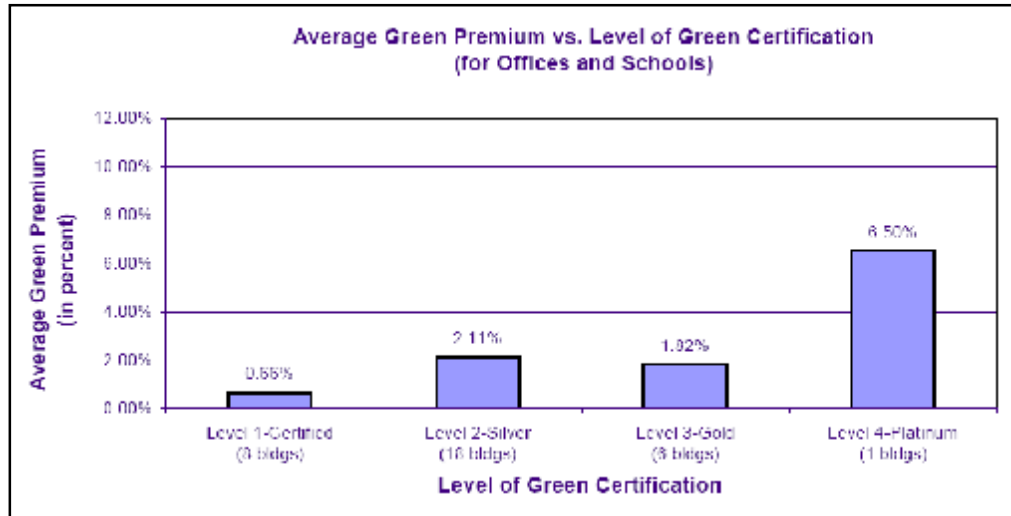


Figure 2.14 Average Green Premium vs. level of LEED certification (Kats, 2003).

Last, regarding time implications, the study also displayed data, from the 18 LEED-silver projects depicted on Figure 2.14, on the green premium average in terms of year of completion. From this, it can be theorized that cost of green design has dropped in last few years. This is mainly attributed to an increase design experience over time. Figure 2.15 shows this trend.

Year of Completion	Average Green Cost Premium
1997-1998	2.20%
1999-2000	2.49%
2001-2002	1.40%
2003-2004	2.21%
Avg. of 18 Silver buildings	2.11%

Figure 2.15 Year of Completion vs. Average Green Cost Premium

On the contrary, a cost study (Langdon, 2004) which became popular among Green Building practitioners that is based on 94 different building projects from different types, found that project costs were not determined by the level of certification sought, rather by other conventional factors such as goals, construction type and the local economy. The additional conclusions drawn from this study indicated that there is not significant evidence to suggest that Green Buildings cost more per square foot than traditional buildings; because of the uniqueness of each building, the results should be only used as information, not for prediction.

In sum, when comparing green and non-Green Buildings side by side in terms of cost per square foot there was no conclusive evidence indicating green is more expensive, the costs were somewhat mixed.

Another cost study, prepared for the U.S. General Services Administration in 2004, reported on two projects types: (1) new construction, and (2) modernization. In both cases, it realized an extra cost to achieve the LEED certification level required. Although the results are not the same as the ones found in Kats (2003), they do support the conclusion that extra costs are required to meet certain levels of LEED certification. Table 2.3 shows the results of this study.

Table 2.3 Green Cost Premiums based on the level of LEED certification (Steven Winter Associates, Inc, 2004).

Level of LEED certification	Range of Green Cost Premiums (% of total construction cost)	
	Building Type	
	New Construction	Office Modernization
Certified	-0.4% to 1.0%	1.4% to 2.1%
Silver	-0.0% to 4.4%	3.1% to 4.2%
Gold	1.4% to 8.1%	7.8% to 8.2%

As of January 2009, the most recent report on Green Building costs is found in 2007 literature which depicts an updated version of an earlier report (Langdon, 2004) previously referred at the beginning of this section. In this report (Langdon, 2007) because of the growing market of Green Building, the sample size had been increased from 94 up to 221 buildings, demonstrating that Green Buildings are still being built. Again, a comparison between LEED-seeking and non-LEED buildings supports the fact that

“...there is no significant difference in average cost for Green Buildings as compared to non-Green Buildings.”

Comparisons among buildings within the same type were done; Figure 2.16 shows only the comparison including libraries, which consists of a total number of 57 projects between libraries achieving certain level of LEED and non-LEED Libraries. From the graph it is possible to see that cost can be high or low regardless of the level of LEED achieved or not achieved by the building. In addition, this graph will demonstrate if the construction cost of the case study falls into the existing range.

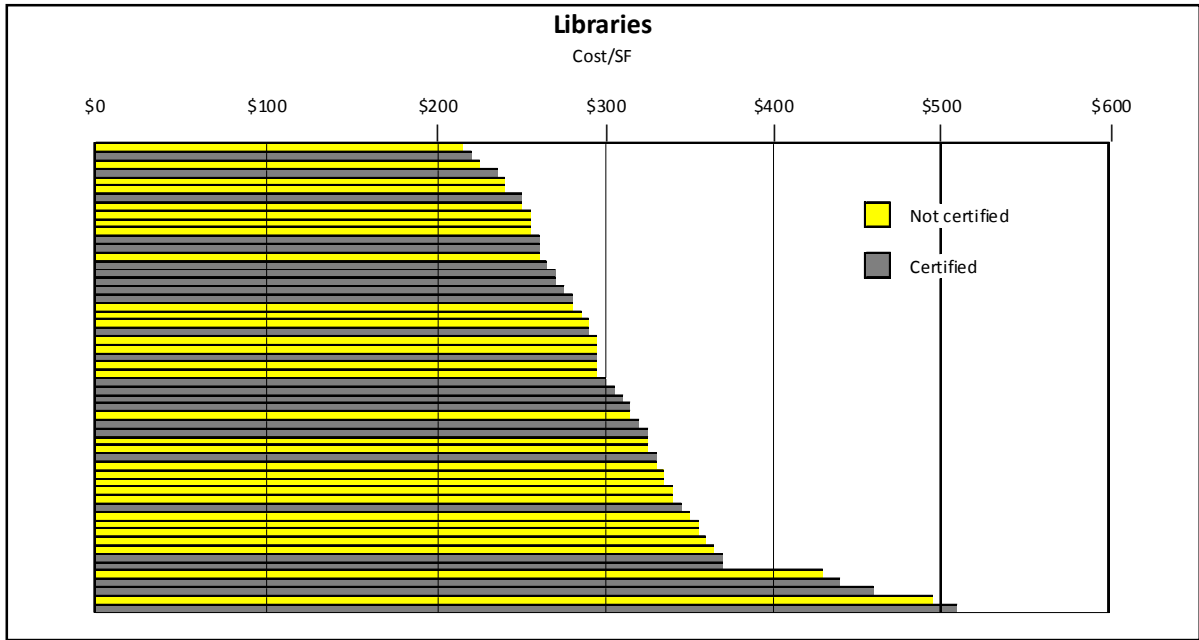


Figure 2.16 Comparison between libraries construction costs for LEED certified buildings and non-LEED certified buildings (Langdon, 2007).

The most important thing to be considered based on what is proposed by this study is the fact that Sustainability should be part of the project; it should not be seen as something extra that can be taken in and out depending on the money availability. Despite sustainability has come a long way, it is still seen as a “below-the-line item,” (Langdon, 2007).

Chapter 3. **Methodology**

This study was conducted in five phases to accomplish the objectives of the research listed in Section 1.3.

3.1 **Research Design**

The research was qualitative, and in this sense, Goforth (2007) pointed to a study (Creswell, 2003) which suggests that a qualitative approach is

One in which the research is based primarily upon constructivist perspectives or participatory perspectives or both. In this approach, the researcher collects open-ended or emerging data in order to identify developing themes within the data, as was done in this research. Qualitative research uses strategies of inquiry such as interviews.

The five phases are the following. Phase I, was a comprehensive review of the current body of the knowledge of Target Costing, first in manufacturing, and then in construction. Phase II, was the action research of a project.

Phase III was developed based on the knowledge obtained in Phase I and Phase II. Phase III created two flow charts: the first shows the current practice, and the second includes modifications on the current practice that can be useful for a Target Costing application.

Phase IV included a series of interviews consisting of two parts: a questionnaire and a matrix evaluation form. The questionnaire was developed to obtain feedback and opinions of primary decision makers on findings and observations derived in this study. A matrix evaluation form was also developed in order to assess the level of participants' involvement. The researcher had key

project participants both answer the questions and fill out the matrix evaluation form. Finally, Phase V collected the feedback acquired from Phase IV and made use of these responses to propose a framework for future use. Figure 3.1 depicts a flow chart showing the research design.

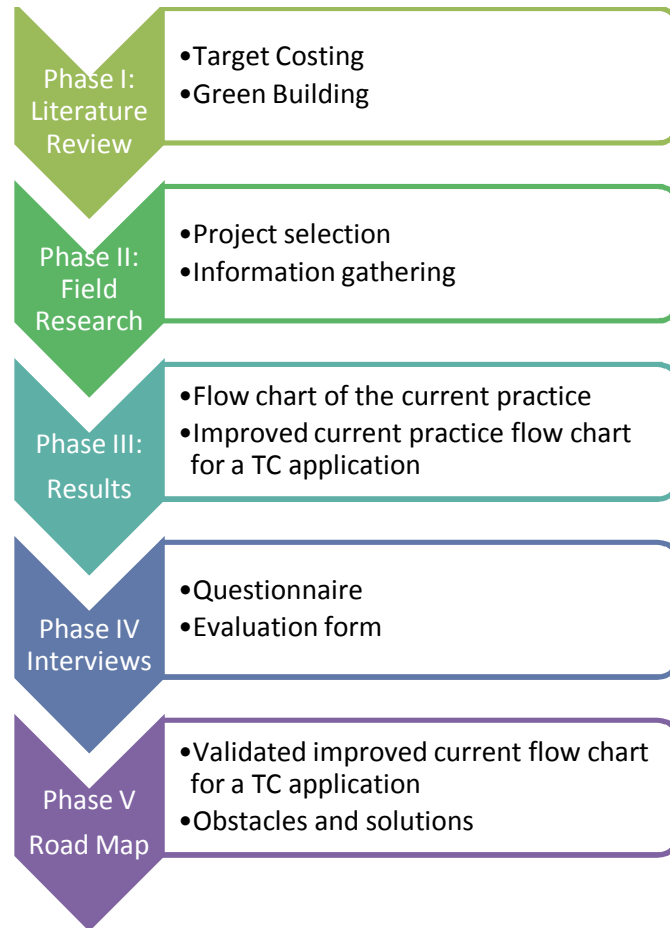


Figure 3.1 Research Design

3.1.1 Phase I: Literature Review on Target Costing and Green Building

In order to address objectives one and two listed in section 1.3, this study provides an understanding of Target Costing and how the application of its principles has gradually evolved and migrated from Manufacturing to Construction, and within the latter more specifically Conventional

Construction. On the other hand, Green Building, a relatively brand new construction practice, is presented to identify the new challenges, requirements, and goals that this new approach must meet. The objectives were accomplished by an exhaustive revision of different sources.

- Textbooks, trade journals, and scholarly journals related to Construction Management, Cost Control in Construction, Lean Construction, Lean Manufacturing, and Green Building.
- Websites relative to Green Building.
- Seminars relative to Green Building, Construction Project Management, and Sustainability.

A detailed list of the sources the researcher benefited from is presented in the list of references.

3.1.2 Phase II: Field Research

Field research refers to the work the researcher plans to carry out on a real project. A structured approach had to be followed to fully achieve objective number three mentioned in Section 1.3.

Therefore, the researcher organized this phase into two main activities: select a project and gather information relative to it.

3.1.2.1 Project Selection

Phase II placed emphasis on finding a project that was seeking any level of green certification and that was currently at its initial stages, as project definition (master plan, programming) or design (schematic design, design development).

The intended approach of the researcher was to look for a project with the required characteristics in order to achieve certain level of project involvement such that research objectives can be met.

There were two main options, the first option was to find a project within North Carolina State University (NCSU), and the second one was any local project in Raleigh, NC. The first option would be the most convenient because the researcher would develop his study taking advantages of working with a research oriented institution. Furthermore, the fact that a facility or renovation at NCSU be part of a research is consistent with the NCSU mission statement (NCSU-Mission, 2001):

The mission of North Carolina State University is to serve its students and the people of North Carolina as a doctoral/research-extensive, land-grant University.

To verify the existence and feasibility of a project meeting the research needs, networking, online searches and information searches on current local projects were accomplished.

Several steps were followed. First, the Project Manager (PM), as the representative of the project owner, was contacted to schedule a meeting. Second, the researcher along with the committee members attended the scheduled meeting to present the needs, objectives, and benefits of the research and asked for collaboration. The presence of the committee members made this request more formal. Third, once collaboration with the research had been granted, the PM required coordinating all the general project and personnel needs during the research; furthermore, the PM established the proper access to relevant information, allow attendance the meetings, and set the channels of communication between the interviewer and the possible interviewees.

3.1.2.2 Information Gathering

Once the Project Manager had authorized the involvement of the researcher in the project, the researcher attended to the meetings that were considered relevant to the purpose of this research. Attending the relevant meetings took place between September of 2008 and March of 2009.

Attending the project meetings helped carry out observations. These observations allowed the researcher gaining a fully understanding of some characteristics of the project that were important to this study. Some of these characteristics included aspects related to stakeholder values, space distribution, cost control, value engineering, achievement of green certification, and life-cycle cost among others. Furthermore, identification of key participants as possible interviewees was possible; these key participants matched the recommendation done by the PM regarding what people would be most suitable to be interviewed.

Additionally, due to the significant amount of information relative to the project and the time constraint, much of the material came from project reports and minutes of meetings that were provided by the Project Manager. Personal notes were also used. All this helped support the findings and results described in Chapter 4.

3.1.3 Phase III: Initial Results

Once information gathering was finished, it was expected to make available enough information for the researcher to identify the relevant aspects. The information coming from the literature review and from the field work provided the method to recognize similarities and differences between the current best practices and the Target Costing process in the Construction Industry and the recommended Green Building process (IDP).

First, a flow chart of the current practice was drawn focusing on aspects that are interest of this study. This flow chart is a visual way to represent the actual process so that weak, strong and improvement-needed areas in the process are easier to recognize.

Second, an improved flow chart of the current practice was also drawn. It included elements for a Target Costing application.

3.1.4 Phase IV: Interviews

By looking at the flow chart from Phase III, the researcher needed to obtain feedback not only on his personal observations but on ways to improve cost control. Interview questions were developed by using interview design approaches found in similar studies (Goforth, 2007; Robert & Granja, 2006). Previous matrix-based assessment forms on determining participants' involvement (Ramkrishnan et al., 2007; Robert & Granja, 2006) were used to build the new forms.

The results required direct contribution from project participants. Because of this, interviews were needed. Figure 3.2 depicts the conceptual framework (Creswell, 2003) that was followed in which open-ended interviews were conducted; notes and observations from the interviews were compiled in order to verify certain assumptions and to validate what was proposed earlier. In addition, the feasibility of the proposed framework map will be also verified through interviews.

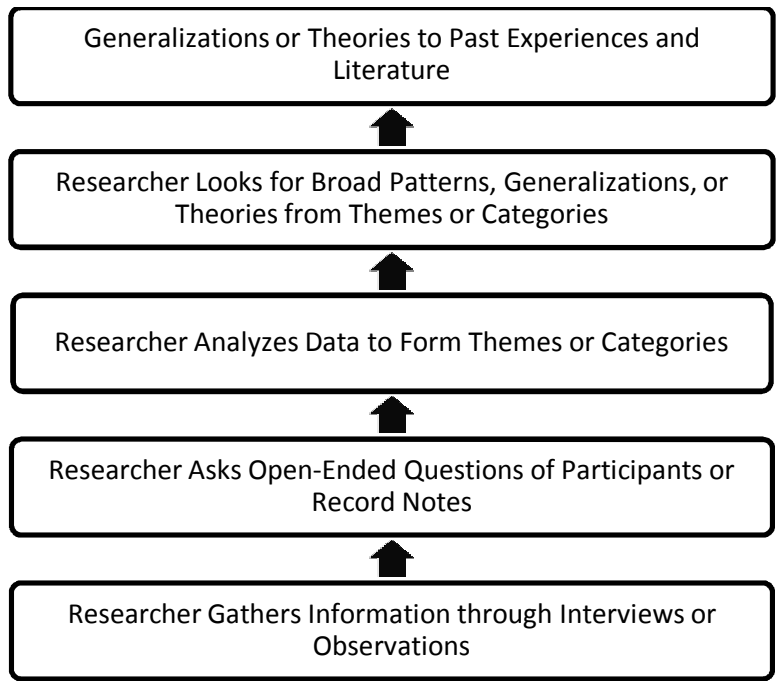


Figure 3.2 The Inductive Logic of a Qualitative Research Study (Creswell, 2003).

The questions were aimed to validate what observed and what is proposed. The project interviews revealed the important aspects of the actual process being used by the project owner, design team and contractor. This information determined what techniques and tools are already in place. In addition, it helped determine how much of these tools are already aligned with the Target Costing process and with IDP.

This part of the study consisted of open-ended interviews and questionnaires, related to the project, with a number of people. How many and who was determined by the people’s availability and the expertise and knowledge on the project. This knowledge should include the ability to understand the entire delivery process from the beginning to the end and from top to down, and to provide helpful insight.

Previous studies (Goforth, 2007; Ramkrishnan, Roper, & Castro-Lacouture, 2007; Robert & Granja, 2006; York, Kim, & Yoshikawa, 2005) have used similar approaches to collect feedback from project participants.

3.1.5 Phase V: Framework

Based upon the results from all the previous phases, best practice recommendation framework for implementing Target Costing principles in publically funded Green Buildings was established and presented in Chapter 5. The framework consists of two parts: a recommended flow chart and a list of the barriers faced by the construction participants interviewed and suggested solutions to these barriers.

Chapter 4. **Analysis and Results**

4.1 **Introduction**

Qualitative data gathered in Phase I, II, III and IV of the research are analyzed and presented as results in this chapter. Recall from the previous chapter, Phase I covered an exploration of theoretical sources, Phase II covered the field work, Phase III generated preliminary results, and Phase IV provided validation.

4.2 **Phase II: Field Research**

Recall from Research Design, a series of steps were needed to carry out this phase. Therefore, finding and selecting a project that would meet the research needs was critical to continue the research. Information gathering followed the project selection.

4.2.1 **Project Selection**

By searching the NCSU website, an article was found at a webpage (NCSU-Sustainability, 2008) recognizing how new constructions are accountable for resource consumption and how the built environment is the best way to promote sustainability. Thus:

NC State understands this impact and has committed all new construction to be LEED-Silver which will help tie sustainable design into our University Construction Guidelines for new construction and renovation projects.

The Office of the University Architect will continue to lead planning efforts, creating a campus environment that supports learning, living, and communication, including sustainability initiatives that are in-line with the Campus Master Plan and Centennial Master Plan. The Physical Environment Committee also has a role in ensuring modifications to campus buildings; landscaping and transportation are in line with the master plans.

Based on the article, it was clear to the researcher there would be some upcoming University projects that will be seeking a LEED-Silver certification; although the timing of these happenings was unknown. Next, people who were likely to be aware of this statement were to be contacted. Personnel from the Department of Civil, Construction, and Environmental Engineering, Office of Sustainability, Solar Center, and College of Design were reached. After talking to them, an architect from the division of Capital Project Management (CPM) was determined to be the most appropriate contact person.

Following the procedure proposed on research design, the mentioned architect was contacted to schedule a meeting. The researcher and two committee members attended the meeting to present the objectives, needs, and benefits of this study and to ask the architect for collaboration. The architect suggested that the new library on Centennial Campus – Phase I, better known as the James B. Hunt Jr. Library (Hunt Library) would be an appropriate project to work with because such facility will seek a LEED-Silver certification. Table 4.1 shows the dates when these events took place.

Table 4.1 Initial Events and Dates

Event	Date
Awareness that all NCSU new constructions will be LEED-Silver	August 25, 2008
First contact with the Architect from Capital Project Management at NCSU	September 18, 2008
First meeting with the Architect from Capital Project Management at NCSU	September 24, 2008

Also from Project Selection previously described in section 3.1.2.1, the project had to be at its early stages, either programming or design. Figure 4.1 shows the project schedule and the period of time field research was performed.

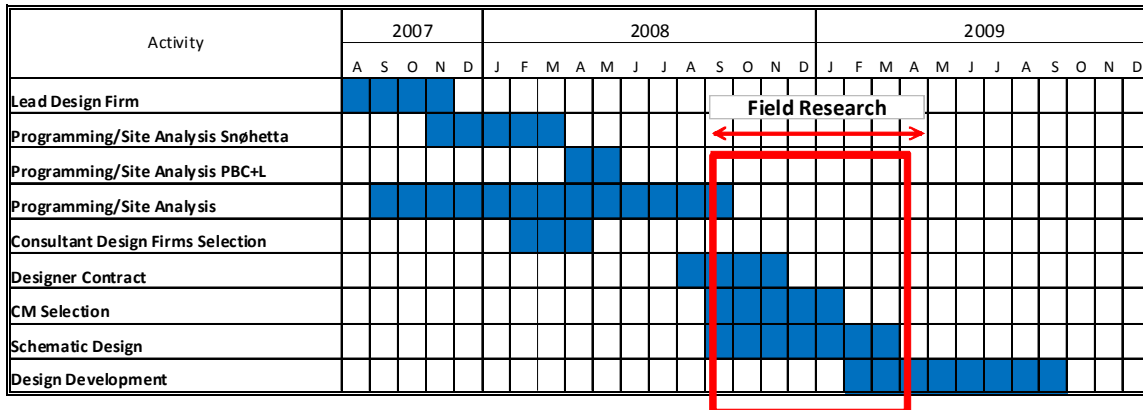


Figure 4.1 Hunt Library Schedule – Programming & Design

By comparing the dates from Table 4.1 with the schedule shown in Figure 4.1, it could be determined the project was at the end of programming and at the beginning of schematic design, therefore it was appropriate for research. As a result the Hunt Library was selected as the project

on which field research will be done. Figure 4.2 shows an image of the Hunt Library as of April, 2009.



Figure 4.2 Image of the Hunt Library at NCSU, as of April 2009.

The project is expected to break ground in early 2010, and be finished at the end of 2012.

4.2.2 Information Gathering

Project reports, minutes of meetings, and personal notes from the attended meetings were the main sources of information for the project.

4.2.2.1 Project Reports

Project reports provided a summary of the main aspects of the project initial phases. Moreover, useful information about the facts supporting the decision-making process during these phases was also presented. There was not clear evidence on when the project was first conceived, however, the origins of the project were traced back to 2002. There were three main project reports that

were produced chronologically and the researcher had access to: the NCSU Library Master Plan, the Programming & Pre-Design, and the Schematic Design report.

4.2.2.1.1 NCSU Library Master Plan

NC State University hired Meyer, Scherer & Rockcastle, an architectural firm based in Minneapolis, MN and Hyattsville, MD with 27 years of experience to develop the Library Master Plan as part of the 10 year Capital Program. This study was executed in June 2002 and specifically recommended that the Library System at NCSU should meet the following business case:

- Monographs: 3.3 million
- Bound Volume Equivalent (BVE): 3.7 million (58% growth in print collections)
- Total Individual and Collaborative Seats: 7,269 (students, faculty, staff and partners)
- Current capacity: 1,490 seats
- Total increase: 5,879 seats
- Approximate total space: 893,250 sf. (Hill, Centennial, and Branches)
- Current space: 434,000 sf.
- Increase: 459,250 sf.

Proposed space distribution:

- D. H. Hill Library—with 413,000 sf.
- Centennial Campus—with 405,000 sf.
- Branch facilities and off-site storage for the remainder of 75,250 sf.

From the information listed, the need and the space allocation for an improved library system was realized.

Table 4.2 lists the four phases proposed by the NCSU Library Master Plan to cover the recommended scope; in addition, the cost of each phase is also suggested. These costs are considered allowable costs.

Table 4.2 Library Master Plan’s Phases

Phase #	Description	Cost (\$M)	Start (Year)	Finish (Year)
1	D.H. Hill Library East Wing Renovation	8.75	2002	2005
2	Centennial Campus Library - Phase I	70.75	2005	2008
3	D. H. Hill Library Renovation and Addition	82.75	2006	2010
4	Centennial Campus Library - Phase II	N/A	N/A	N/A

When the study was completed, phase 2 referred to the Centennial Campus Library – Phase I, but currently the project is known as the James B. Hunt Jr. Library. To avoid confusion the researcher will use the short name, Hunt Library. To keep consistency with the terms annotated on reports, these names for the building could be used interchangeably throughout this document.

The Hunt Library will:

- Reduce the accreditation square footage deficit by 202,000 sf.
- Provide 1,450 study seats
- Provide space for 871,000 volumes

- Serve the specific needs of the Centennial Campus

The Planning Process Approach used for this project consisted of two main parts:

1. The First part helped gather information through visioning workshops and detailed discussions among planning committees, library staff and students. The goals of these workshops were:
 - a. To listen and to learn from the on-campus users.
 - b. To promote a friendly environment so that the design team could get a better understanding of the library role: better serve the alumni, staff, faculty and students.
2. The Second part used the data from the first one in generating collection, study and staff needs for the future. In addition, space needs were also discussed in regard to University collection, staff and future library uses.

A key aspect of this planning approach was to include, if not all, at least most of the people who had an interest in the project. Following is a list of stakeholder groups attending the workshops:

- Design Team: 9
- Management Council: 14
- Vice Chancellors and Deans: 8 + 8
- Faculty and Staff: 13
- General Faculty and Staff Senate: 7
- General Faculty: 10
- University Library Committee: 5
- Students: 14

By looking at the list, 88 people from 8 groups representing the owner, user, and designer were identified. On the other hand, there was not documentation indicating the level of involvement, if any, from participants such as suppliers, designers, and people with experience on Green Building, i.e., LEED-Accredited Professional.

According to Meyers *et al.*, (2002) the future spaces needed, which include collection, study and staff, were generated based upon the current conditions. Rates of growth of library user population and collections were applied to these conditions in order to define the spaces required in the future. It was also estimated that the new library on Centennial Campus will house 61.5% of the Library collections. Phase 2 should include the construction of the Centennial Campus Library - Phase I (Hunt Library). At a later time, this will be expanded to 404,600 square feet in Phase 4 of the Library Master Plan. Location of this facility should be on the Academic Oval, maximizing its presence in the academic heart of the Centennial Campus. Figure 4.3 shows the scope of work and original proposed budget for the construction of the Hunt Library as well as the breakdown of its main components and their costs.

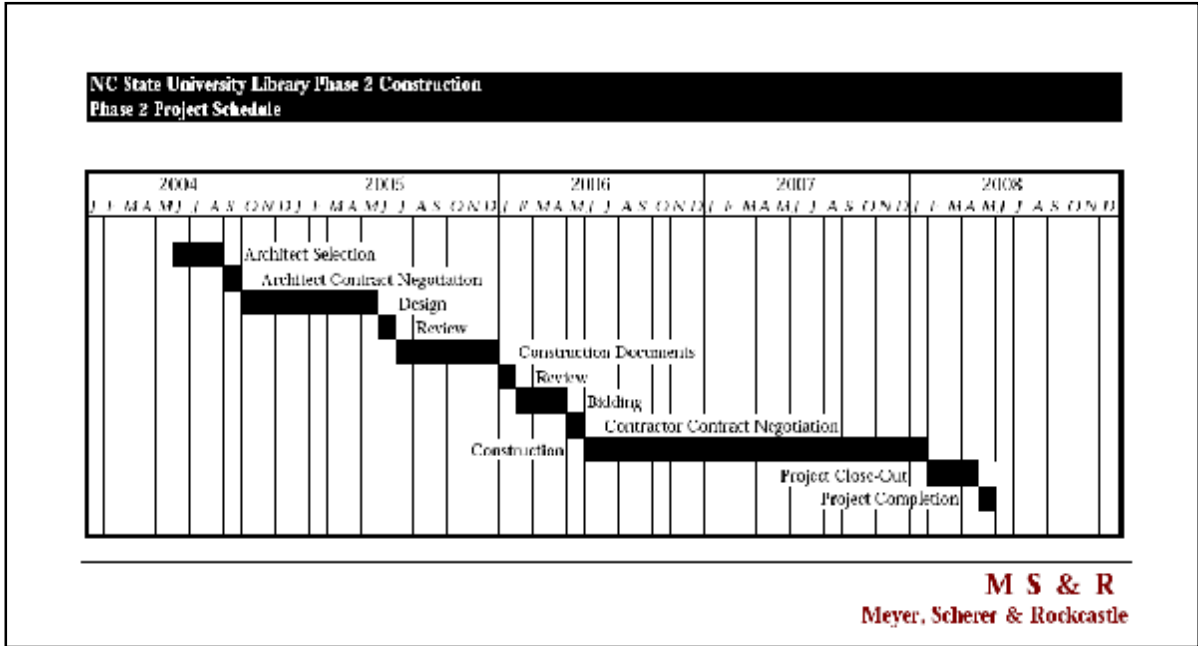


Figure 4.4 Initial Project Schedule – Hunt Library (Adapted from Meyers *et al.*, 2002)

There were visioning sessions organized by the consultant and held in September and November 2001, which helped determine users' needs by asking one single question to different user groups. Table 4.3 lists the user groups and the question each of them was asked.

Table 4.3 Users and Question Asked

Date	User group	Question
9/27/01	Science and Technology Faculty Staff	If a major donor selected you to direct how to spend \$100 million on the library, what would you do?
9/27/01	Management Council Charette	If a major donor met you at a party and wanted to give you \$100 million to build the finest library on the planet, what would you do?
9/27/01	Student Charette	How can the Library increase service to students?

Although, there was a single question, the participants were asked to categorize their answer into five areas:

- Collections
- Space
- People
- Services
- Equipment

Furthermore, the sessions contained meetings where questions were posed for open discussion.

The questions asked to the different users groups are listed below.

- What defines a great University?

- What role does the Library play in the determination of a world class University?
- What past predictions have come true or not?
- What is the essential core of intellectual inquiry?
- Collection/Space/Services/People/Equipment
- Why do anything?
- Can NCSU continue to compete? What is needed for this to happen?

The first session was held on November 6, 2001 and had the following users organized into the following groups.

- Vice Chancellors/Deans Group A
- University Library Committee
- Vice Chancellors/Deans - Group B
- Design Team

Three weeks later, on November 27 2001, another session was held and had the two following groups:

- General Faculty and Staff Senate Charette 1
- General Faculty and Staff Senate Charette 2

The report (Meyer et al., 2002) contains a complete and detailed summary of respondents and their answers.

4.2.2.1.2 Programming & Pre-Design Report

Based on the results from the library Master Plan report, in July 2007 the North Carolina General Assembly appropriates \$17 million in planning funds for the Hunt Library, with an anticipated project budget of \$114 million.

There was a Kick-off Meeting prior to the start of the design process, consistent with the Integrated Design Process for Green Building. A typical kick-off meeting agenda includes:

- General Introduction
- Design Team history/experience (Lead Designer)
- Review of Project Scope Statement
- Funding Available (Project Manager)
- Design Process (Project Manager)
- Project Schedule (Project Manager)
- Identification of User Groups for Programming (User Representatives)
- Ex Officio members particular concerns

It was expected that other departmental representatives would assume the role of stakeholder as the project progresses.

According to the information obtained from the written procedures, and that serve as guidelines for formal capital projects at NC State University, the objective of programming and site analysis is to provide a method for ensuring that all University stakeholders are included. Stakeholders might include representatives from:

- Users Group
- Office the University Architect
- Environmental Health and Safety
- Facilities Operations
- Transportation
- Others

How these individuals interact, express their interest and get involved will vary based upon the project type, location, scope and other factors.

Recall from Table 4.1, the actual involvement of the researcher in the project took place at the end of September 2008. Programming & Site Analysis was carried out between September 2007 and September 2008. Because of this, it was not possible for the researcher to be directly involved during this process. The final report on Programming & Pre-Design phase contained the necessary information to evaluate the process that was followed during this phase.

This report summarizes input the Design Team has received from the Building Committee and User Groups during the Programming & Pre-Design phase. Their feedback helps formulate the criteria for the architectural design and will be a helpful guide for the Design Team during these subsequent phases. Table 4.4 lists the participating companies that worked on the report and their area of expertise.

Table 4.4 Participating Companies and Their Expertise

Company Name	Function / Expertise
Buro Happold	Sustainability
Davis Langdon	Cost Consultant
DEGW	Programming
PBC+L	Executive Architect
Snøhetta	Designer

The report was delivered on August 8, 2008 and reviewed on October 24, 2008. The Programming and Pre-design phase began in January, 2008 and was completed in August, 2008.

The “program” was developed by having a series of workshops, in which the participants were users and stakeholders. The summary of the program is as follows:

- Overall Gross Area: 207,353 sf.
- Overall Net Area: 139,495 sf.

The cost of the project had been studied through the programming process and is estimated as:

- Project Budget: \$107,700,000
- Construction Budget \$70,500,000 (Management Team, \$325/sf.)
- Construction Budget \$76,700,000 (Design Team, \$355/sf.)

The construction cost per square feet was estimated by two different sources:

- 1) NCSU Capital Project Management, and
- 2) Design Team Cost Consultant, Davis Langdon

The Association for the Advancement of Cost Engineering noted that the accuracy of design estimates varies depending on the phase the project is in, the technological complexity, appropriate reference information, and inclusion of an appropriate contingency (Humphreys, 2005). Ranges are shown in the table below.

Table 4.5 Accuracy of Estimates (Adapted from Humphreys, 2005)

Phase	% of Design Completed	% of Estimate Variation
Concept	0% – 2%	-50% → +100%
Feasibility	1% – 5%	-30% → +50%
Authorization	10% – 40%	-20% → +30%
Control	30%– 70%	-15% → +20%
Engineer’s Estimate	50% – 100%	-10% → +15%

Recall from Figure 2.16, construction costs of non-LEED Libraries and LEED Libraries range approximately from \$235/sf. to \$500/sf. Therefore, the estimated construction costs for this project are within range. However, none of these LEED libraries sought a LEED-Silver certification, the level of certification sought by the Hunt Library.

The “program” was used to establish the parameters needed for the architectural design. In addition, the main objective is to clearly identify and reconcile user needs with the available funds for construction, and to define an appropriate cost level which meets the level of ambition NC State

has for this project. Developing a room program and cost model was the outcome of this process. The alignment of cost, quantity, and quality before the design phases begin will help ensure a responsible use of resources.

The space distribution was determined to be as follows:

1) Library	63.1%
2) Institute of Emerging Issues (IEI)	17.2%
3) Chancellor's Spaces	4.9%

The result obtained from this process was the identification of six main themes for the Hunt Library:

1. Create signature, iconic building for Centennial Campus.
2. House three different occupant groups: the library, IEI, and Chancellor's spaces.
3. Have a diverse user base.
4. Provide a spectrum of users' space that blends more common with specialized functions and offers users choices as to where and how they work.
5. Provide versatility as a key aspect.
6. Promote interaction and collaboration among students, faculty, staff, and affiliates while balancing the need for global connectivity with local focus.

Another important outcome of this report was on Sustainability. How Sustainability will affect the new library was a major concern, especially when the new library must meet both Senate Bill 668 and LEED-Silver requirements. Indeed, the legislature forces state, university, and community

college buildings to follow Senate Bill 668 regulations to promote the conservation of energy and water use in state. Because sustainability goals of Senate Bill 668 are already high, the potential of achieving a LEED-Silver certification is likely. Although, the targets vary from one regulation to another, the most restrictive ones will be sought. Figure 4.5 shows the areas of Senate Bill 668 focus.

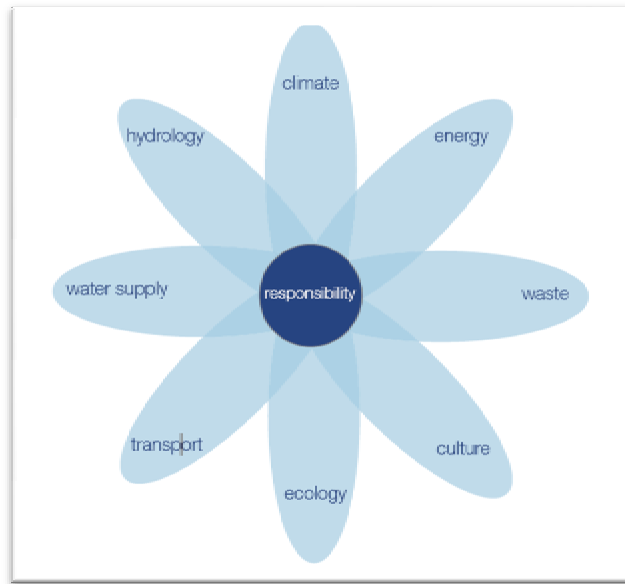


Figure 4.5 Concentration areas of Senate Bill 668

Sustainability was driven by two components. Components whose achievement is enforced by the law are known as hard drivers, whereas components whose achievement is voluntarily are considered soft drivers. Some of the hard drivers are:

1. North Carolina Senate Bill 668

- LEED NC Silver certification required.
- 30% energy efficiency below ASHRAE 90.1-2004.
- 20% potable water reduction below baseline.

- 50% water reduction of outdoor potable water or harvested groundwater over baseline.
- Other requirements: commissioning, metering, occupancy sensors, low flow fixtures, e-star rated appliances and office equipment, post construction M&V, local products and manufacturers.

2. Economically Rational Paybacks

- Cost savings associated with energy efficiencies that pay for additional investment.
- Reduced demand on grid that generates subsidies from local utilities.
- Reduced potable water consumption savings that pay for impending water consumption regulations.
- Sensitivity to local drought issues; anticipation of potential supply limits.

And some of the soft drivers are:

1. Quality of Life and Indoor Spaces

- High indoor quality from fresh air, views and plants.
- Natural daylight and views to outdoors improve alertness, attention span and retention.
- Temperature and humidity control for books and records.
- Insurances from potential future regulations.

2. Campus Initiatives

- Water Conservation Challenge – A UNC-CH vs. NCS competition to conserve water.

- Institute for Emerging Issues – Issue for 2008 is Energy.
- WolfPack Environmental Student Association (WESA).
- Positive press for green design through media coverage.

The owner, the users, and the environment will benefit from the accomplishment of each of the drivers mentioned. Some of these benefits were fully described in the report (DEGW; PBC+L; Snohetta; Langdon; Happold, Buro, 2008). A list of them can be found below.

- Reduce impacts of natural resource consumption.
- Compete in water conservation challenge.
- Reduce cost from water and energy use reduction.
- Enhance occupant comfort and health.
- Minimize strain on local infrastructures and improve quality of life.
- Support local industries and economy.

Finally, Cost Management is vital for the success of the project especially in times when economies are slow; therefore, the report (DEGW; PBC+L; Snohetta; Langdon; Happold, Buro, 2008) states that the primary objective of cost management during this phase is to ensure that the University's needs and aspirations for this building are in alignment with the available funds and site options.

The consultant emphasized the fact that approximately 85% of a building's cost is the direct result of the amount and quality of programmable space it contains. Consequently, any change at this phase will significantly affect how the project meets the budget. In addition, a good program will help prevent "Value Engineering" from being accountable for bringing the costs down in the subsequent design phases.

A state-of-the-art feature of the new library is the use of an Automated Retrieval System (ARS) for storage of the library volumes. One of the main advantages of the ARS is that it reduces the space and the cost of storing the library volumes by up to a third the space and cost of traditional open or compact shelving systems (HKSYSTEMS, 2008).

In terms of spaces, the initial program or “wish list” was reduced by approximately 50% to meet the construction budget. For example, the IEI Forum Event space was completely eliminated, the Library reduced its staff space and all users agreed to share common meeting rooms.

Information about soft costs was provided by Skanska, the contractor of a new nearby building, to Davis Langdon, the cost consulting company. Because of this, the cost model was refined based upon data from local contractors. The budget for Hunt Library, including the library, IEI and Chancellor’s Rooms, site preparation, external finish works, utility expansion, and a parking deck, is \$126,000,000, excluding future expansion.

4.2.2.1.3 Schematic Design

The Schematic Design (SD) phase took place from September 9, 2008 to January 30, 2009 and was necessary in order to implement the scope defined in the Library Master Plan and in the Programming & Pre-Design phase. In addition, SD ensured that all University stakeholders were included in the process. Stakeholders include representatives from the User Group, the Office of the University Architect, Environmental Health and Safety, Facilities Operations, Transportation, and others. Therefore, the Executive Architect developed a strategy for the schematic design process. Below are listed the strategy items that are relevant to this study.

- A kick off meeting to review comments from previous phases.

- A series of workshops to work with stakeholders for meeting the program.
- A series of meetings with the architectural team, consultants, and University participants to discuss about project requirements and alternative selection.
- An iterative process of meetings and workshops with the design team and university representatives to work on concepts, explorations, examinations and decisions.
- A series of meetings with the University's facilities staff to define coordination issues, schedule, and budget.
- A set of comparisons of building systems options: foundations, structural, mechanical, glazing, etc. to be considered in the Life Cycle Cost Analysis (LCCA).
- A preliminary evaluation to meet the requirements of Senate Bill 668 and LEED-Silver certification.
- A set of schematic drawings, and narratives for discussion with the owner.
- A schematic design opinion of probable construction costs.

A report (PBC+L, et al., 2009) that is a summary of the happenings and results of Schematic Design phase for the Hunt Library was submitted at the end of January 2009. The report was an effort of the contributors listed below.

Table 4.6 Report Contributors

Contributor / Firm	Function / Expertise
DEGW	Programming
PBC+L	Executive Architect
Snøhetta	Designer
ColeJenest & Stone	Site
ARUP	Structural Engineer
Stewart	Structural Engineer
AEI	PME Engineer
Davis Langdon	Cost Consultant

The report focused on ten areas: architectural, structural, plumbing, HVAC, electrical, civil, landscape, day lighting analysis, sustainability strategies, and energy model with life cycle cost analysis.

Eight of the areas mentioned in the previous paragraph are usually found in conventional buildings. The two remaining areas, sustainability strategies and the energy model with life cycle costs, are relevant for this study.

First, regarding sustainability, the Hunt Library will integrate appropriate sustainable design strategies that are sensitive to local resource constraints, available infrastructure and user needs.

The Hunt Library must meet two major requirements that were already mentioned in the report on Programming and Pre-design (DEGW; PBC+L; Snohetta; Langdon; Happold, Buro, 2008). These two initiatives are:

- 1) The Chancellor has directed that all new construction on NCSU campuses shall earn at a minimum a LEED-Silver rating.
- 2) The NC Legislature has passed Senate Bill 668 which requires 30% energy efficiency beyond ASHRAE 90.1 – 2004 baseline; 20% potable water reduction beyond baseline, and 50% water reduction of outdoor potable water over baseline.

Early in the process, LEED v2.2 was going to be sought. However, at this point in time LEED v3 seems to better take into account regional aspects (USGBC-LEED, 2009). Therefore, the Hunt Library will be registered under the LEED v3. Although, this new rating system includes the same categories as mentioned in Section 2.2.4.1, some of the items have become pre-requisites and others have been added (USGBC-LEED, 2009).

Second, Building energy consumption and Life Cycle Cost Analysis (LCCA) was performed in order to obtain conclusions from results that may have limited resolution as compared with a similar analysis in later phases of the project. This practice is consistent with the fifth principle of Target Costing and with the Integrated Design Process used in Green Building. The conclusions from LCCA brought up more questions that will require further investigation.

4.2.2.2 Minutes of Meetings

The project reports such as the Library Master Plan 2002 and Programming & Pre-design 2008 provided useful information about events that occurred earlier in the project and in which the

researcher was not involved. Conversely, the Schematic Design report included data obtained during the same period of time as the research activity was done. Nevertheless, detailed and specific information was also found in the minutes of meetings which depict official records of the proceedings. Table 4.7 shows the list of meetings of which the researcher was informed.

Table 4.7 List of Meetings

#	Date	Subject	Start Time	Duration (hours)	Minute	Attended	Personal Notes
1	Sep 29, 2008	Building Committee Meeting	8:30 AM	4:30	☒		
2	Sep 30, 2008	Building Committee Meeting Re-Cap	3:00 PM	2:00	☒		
3	Oct 21, 2008	Building Committee Meeting	1:00 PM	2:00	☒		
4	Nov 5, 2008	LEED certification-Delegated	8:00 AM	2:00		☒	☒
5	Nov 6, 2009	Leadership Meeting	3:30 PM	1:30	☒		
6	Nov 17, 2008	Site, Building Space Allocations-Delegated	12:15 PM	1:15	☒	☒	☒
7	Nov 17, 2008	LEED certification effort-Delegated	1:30 PM	4:00	☒	☒	☒
8	Nov 18, 2009	Leadership Overview	12:00 PM	2:30	☒		
9	Nov 19, 2009	Building Committee Meeting	2:00 PM	2:00	☒		
10	Dec 5, 2008	Chancellor's Spaces Group	9:30 AM	1:30	☒		
11	Dec 12, 2008	Building Committee Meeting	2:00 PM	2:00	☒		
12	Jan 15, 2009	NC Department of Insurance - Project Overview	10:00 AM	2:00	☒	☒	☒
13	Jan 15, 2009	SD Project Review Meeting	12:15 PM	1:00	☒	☒	☒
14	Jan 15, 2009	Oval Master Plan	1:15 PM	2:00	☒	☒	☒
15	Jan 21, 2009	Students' ideas on the project	4:30 PM	1:00	☒	☒	☒
16	Jan 22, 2009	Oval Grading and Storm Master Plan	2:00 PM	2:00	☒	☒	☒
17	Feb 11, 2009	Scope Reduction Strategies-Delegated	8:15 AM	2:00	☒	☒	☒
18	Feb 16, 2009	SD Comment Review Meeting - MEP-Delegated	1:00 PM	1:30			
19	Feb 16, 2009	SD Comment Review Meeting - Utilities/Site-Delegated	2:30 PM	1:30			
20	Feb 16, 2009	SD Comment Review Meeting - Architectural-Delegated	4:00 PM	1:00			
21	Feb 17, 2009	Security Meeting-Delegated	10:00 AM	1:30	☒		
22	Feb 18, 2009	SD Comment Review Meeting-Delegated	8:30 AM	3:30		☒	☒
23	Feb 19, 2009	Auditorium Space-Delegated	2:30 PM	1:30	☒	☒	☒
24	Mar 2, 2009	Meeting with University Dining-Delegated	2:30 PM	1:30			
25	Mar 4, 2009	Cost Reconciliation Meeting-Delegated	1:00 PM	4:00		☒	☒
26	Mar 5, 2009	Cost Reconciliation Follow-Up Meeting-Delegated	9:00 AM	2:00		☒	☒
		Totals		53:15	17	13	13

The table indicates the meetings the researcher was able to attend, to obtain the corresponding minutes, and notes taken during such meetings. Even though all the meetings listed might have had minutes, not all the minutes were obtained. In addition, by comparing the dates the meetings were held to the schedule in Figure 4.1, it is possible to verify the first 15 occurred during Schematic Design and the rest during Design Development.

The minutes provided a detailed summary of key aspects needed for this research. Several pronouncements relative to how stakeholders' values were included in the program, how LEED-Silver certification is sought, and how costs are controlled were found.

Despite the fact important findings were obtained from the minutes, the results are presented in Section 4.2.2.4, which is an integration of the information derived from minutes and the information obtained from the researcher personal notes on the meetings.

4.2.2.3 Personal Notes on Meetings

While attending the meetings, the researcher used the note taking technique. Ridley (2008) presented the main reasons to take notes while reading or interviewing.

- To identify the main aspects.
- To aid recall.
- To use in later research and writing.
- To help concentration.
- To make connections between different topics.
- To arrange information for later writing.

A summary of personal notes and information obtained from attending the meeting is presented.

The two sources were combined in order to avoid duplicity.

4.2.2.4 Summary of Minutes of Meetings and Personal Notes

Phase II addressed the following research objective from Section 1.3. Current practice used in Green Building was identified and analyzed through project reports, minutes of meetings, and personal notes from the meetings attended.

Specific information coming from minutes of meetings and personal notes according to Table 4.7 is presented in the next paragraphs. There are a significant number of project participants. Because of this, the researcher gathered them together into five groups as shown in Table 4.8.

Table 4.8 Project Participants by Group

Owner	Users	Design Team	CMR	Suppliers
NCSU-Office of the University Architect (OUA)	Library	Designer	Construction Manager	ARS Supplier
NCSU-Capital Project Management (CPM)	Institute of Emerging Issues (IEI)	Executive Architect		
NCSU-Facilities Operations	Chancellor's space	Programmer		
		Cost Consultant		
		Site & Landscape Architect		
		Structural Engineer		
		Structural Engineer		
		PME Engineer		

Overall there is a logical, coherent process being followed to achieve the stakeholders' needs and aspirations throughout the schematic design phase. The documents serving as guidelines are, indeed, followed by the representatives of the University and by the design team. These documents include the narratives of each phase so that participants can read and understand the needed inputs and the expected outcomes.

The users' voice is heard at all times, representatives of users are invited to the meetings in which decisions are made regarding the scope and performance of the building. It appears everyone is heard and everyone has something to contribute to the design. The workshops held at the beginning of SD captured most of the users' ideas. These ideas facilitated the building design sketches. The integration of the building with the already built environment and with future buildings was also taken into consideration.

Regarding space distribution, the design team reviewed along with the project users the proposed distribution of the space within the building. An important space that needed special discussion was the location of the ARS due to the area and the volume that it will occupy in the building. Areas for each floor were discussed along with the services hosted by these areas.

There were two main options to define the scheme of the building and spaces. Massing studies and perspectives were considered when selecting the appropriate scheme. In addition, the Office of the University Architect emphasized consideration of University commitments to aspects such as accessibility. IEI pointed out that due to the nature of this iconic and signature building, an impressive entrance is required for important visitors.

In meeting #7, the design team addressed some of the users' concerns by presenting the development of the project spaces and surrounding site issues, massing studies and interior perspectives.

In meeting #8, a preliminary layout of library staff space allocation was presented. There were discussions on elements such as digital library features, information technology,

research/collections, access and delivery services, technical services, administration, and common meetings areas.

In meeting #9, the design team was working to reduce the footprint into more efficient layout, they predicted that program goals would be met and no programmatic cuts were expected at that time.

In meeting #10, there was a discussion on the allocation of individual versus collaborative work spaces of the chancellor's spaces. The design team through the programmer prepared a work sheet to visually show the program allocation. The programmer noted that the trend is to have more collaborative work spaces rather than individual ones. In turn, the existing University standards promote individual work spaces.

In meeting #11, another Schematic Design workshop was held to present an update of the project development. The aspects discussed were the same as the ones discussed in the previous workshops, showing the process is iterative and seeking continuous improvement. More details and specifics were identified as the process went on.

Regarding Sustainability goals, a series of meetings were held in October 2008 to review LEED strategies. The design team produced a "LEED Activity Checklist" which took an initial look at the points that were relatively easy to achieve, and at the points that might be achievable by adjusting the building program, University standards, and materials.

It is vital to mention that seeking the LEED points seems to be made through a process that is integral to the design of the building. The design team often met with the University representatives to determine how the LEED elements could be integrated into the building. The

University (project owner) began the process of appointing a commissioning agent to be part of the design team.

In meeting #7, the Project Manager emphasized the items necessary to achieve LEED-Silver certification and identified the University policies and standards that must be modified to meet these goals. A representative of the University Facilities Operation suggested that the Hunt Library should be designed with solidly performing systems that can be maintained and will perform efficiently over time. The existing LEED checklist was reviewed to determine the NCSU team members that will be the contacts for each point, and also will be responsible for determining the additional staff needed to make decisions about the discussion points, distributing information material, and advising the design team on issues. It was expected LEED points will be sought based on benefit/cost analysis rather than cost only. But, the points that did not add extra costs would be sought first. The designer stated that a good practice is to aim 10% more points than the ones required because some of the points might not be counted as expected.

Facilities Operations also emphasized that Life Cycle Cost Analysis should be completed early in the design process to be in accordance with Senate Bill 668, which states that LCCA should be part of SD Submittal.

Although unlikely, the design team will try to obtain an LEED-innovation point for the use of the ARS. Examples of other libraries around the country seeking a LEED-Silver certification were mentioned. A representative of one of the users proposed a potential vision statement should be developed by the owner for making the Hunt Library LEED certified. At the end, a future meeting was planned to have a LEED discussion with the university stakeholders.

From the process followed to achieve the LEED points, it appears that integration among key elements and key participants was not fully established. Elements are seen rather independent.

In meeting #14, discussions on how the building should be integrated with the existing and future buildings took place. Furthermore, a representative of the Office of University Architect made some recommendations to the design team, specifically to the Civil/Site Engineering and Landscape Architecture in regards how the owner was expecting the building to blend in with the environment.

Constructability also played an important role. In meeting #13, when reviewing the schematic drawings, the design team recognized the consistent relationship between structural elements for constructability and costs. Some cost concerns were raised to pay attention to program area. Small distances between some columns and slab edge were seen as a potential constructability problem. In addition, the structure for some areas had not been resolved at this time. Future library expansions were also discussed to avoid impediments from being placed in a location that will affect future expansions.

Regarding cost control, some meetings were important when discussing on costs. Thus, in meeting #16, scope reduction was discussed. At that date, the designer recognized the fact that there was not an estimate construction cost; in addition, the designer mentioned that the current gross area was approximately at 218,000 sf., 13,000 sf. over the target area of 205,000 sf. Because of this, an implicit linear relationship between costs and area was assumed. Since the current gross area was over the target area a flag to check costs was raised. Three options to control costs were proposed:

- To use simpler materials
- To re-evaluate the net area
- To utilize creative schedule and creative construction

On the other hand, the owner reminded the design team not to cut the program to meet the target cost. In turn, the designer was focusing on design reductions i.e., overall building size, size of the atrium, and excess gross. The purpose was to properly align the scope with the available funding before moving on to design development.

In meeting #24 and #25, cost reconciliation was the main focus. There were two cost estimates; they both were based on the schematic design drawings, narratives and request for information. One estimate was prepared by the design team, specifically by the independent cost consultant hired by the design team, and the other estimate came from the Construction Management at Risk (CMR). The CMR was officially brought in the process in January, 2009 almost in the end of the Schematic Design phase. The CMR was selected because of its experience in a nearby building.

The objective of the meeting was to take the independent estimate done by the Cost Consultant and the CMR estimate and bring them together so that a baseline could be established to begin to work. The purpose was to have an idea of what the budget is based on the project information available at this point. There was a difference of 20% between the two estimates.

By having the Cost consultant and the CMR together and bringing their knowledge collectively, it was expected to come out with an estimate that represented a good benchmark to begin to look at the options in order to get dollars down where they need to be. This meeting is considered as the first step in the iterative process of controlling costs.

Since the CMR was already working in a nearby University building (EB III), they used that knowledge to price some of the work; it was understood, however, the Hunt Library is a unique building.

The plan for the CMR and the Cost Consultant was to go over the main components of the estimate, for example, Civil, Mechanical, Electrical, and so forth. In order for the two estimates to be compared, items were moved from one category to another so that the scope was equal and could be reconciled. Then it was evaluated the areas where deltas had been seen, some of these deltas could be quantities, unit prices or the actual definition of the scope.

By using the combined knowledge and expertise from both group participants, they tried to decide what the correct answer was, then to make the adjustments to both estimates to represent the particular scope of work. A spreadsheet was used so that as adjustments were made it was possible to see how the totals were affected by these changes. A real-time status of what was being done to the estimates was the result.

The majority of the deltas between the two estimates fell in a few categories. By targeting those and understanding the assumptions made by both sides, and by deciding on how to approach and how it will be for the design moving forward; it was expected to resolve a big portion of actual difference. The entire process resulted in both estimates changing.

At the end of meeting, the estimate was still higher than the funding available for construction, scope reduction was required. The PM asked for a list of scope reduction options and their relative savings from the design team. This information was later distributed to the pertinent stakeholder (those whose interests would be affected by the proposed reductions).

The results from Phase I and II made possible to draw a flow chart of the current practice. This flow chart is presented in the next section.

4.3 Phase III: Initial Results

Once the current practice was clear understood, the researcher created a flow chart to show the actual process to deliver the Hunt Library building. A flowchart is defined as a visual or graphical representation of a process, using suitably annotated geometric figures connected by flow lines for the purpose of designing or documenting a process (SE_VOCAB, 2009). Flowcharts are used in analyzing, designing, documenting or managing a process in various fields such as Construction.

4.3.1 Flow Chart of the Current Practice

The purpose of the flow chart was to depict the actual process being followed while doing programming and design of the Hunt Library. Relevant aspects to this study such as stakeholders' values, cost control and Green Building were emphasized and are shown below.

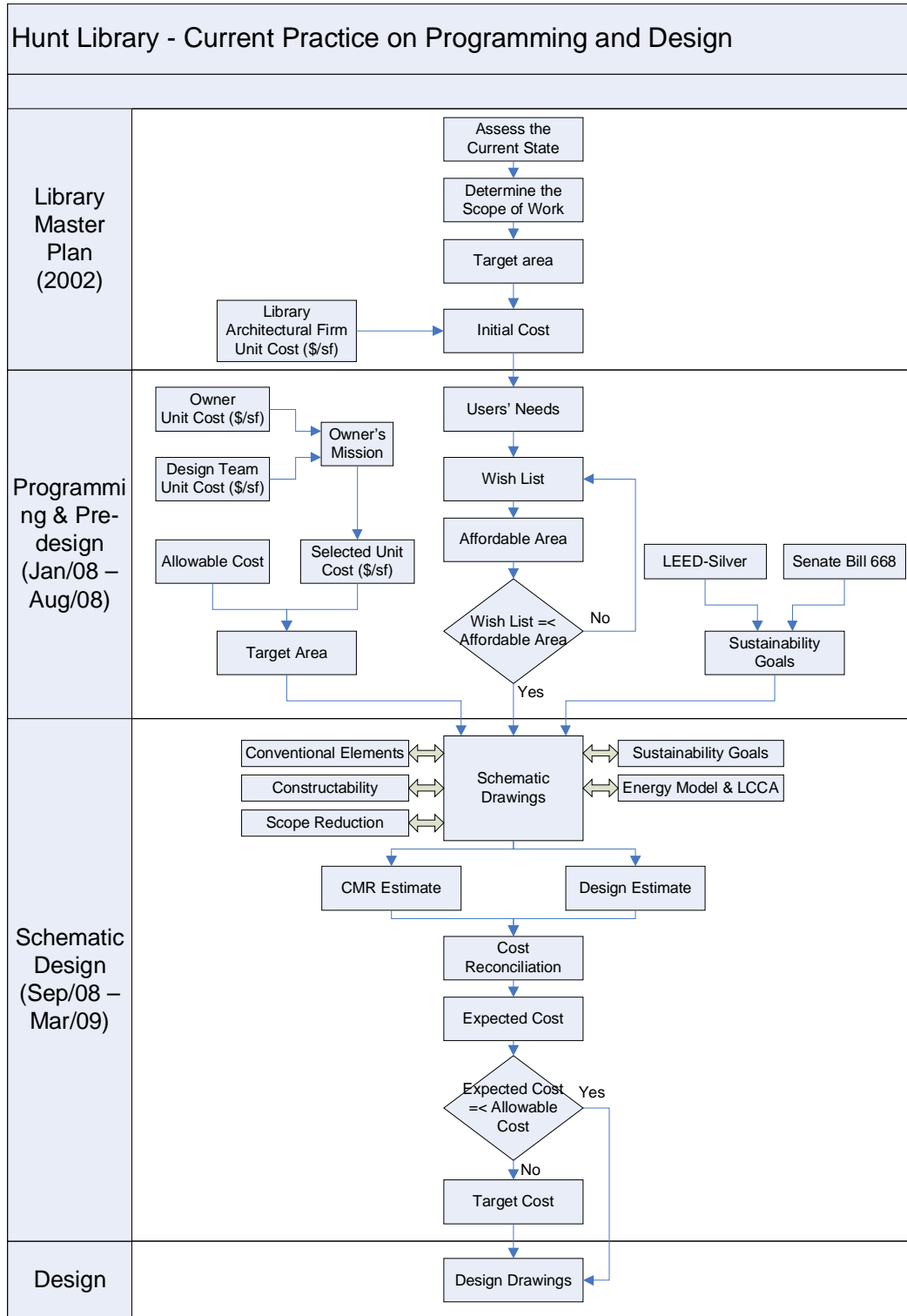


Figure 4.6 Hunt Library - Flow Chart of the Current Practice on Programming & Pre-design

4.3.2 Proposed Flow Chart

Based on the process used to produce the Hunt Library, a flow chart was proposed. The proposed flow chart includes elements so that Target Costing principles and Integrated Design Process from Green Building are integrated. Whether the new elements are feasible in Construction was validated through interviewing project participants.

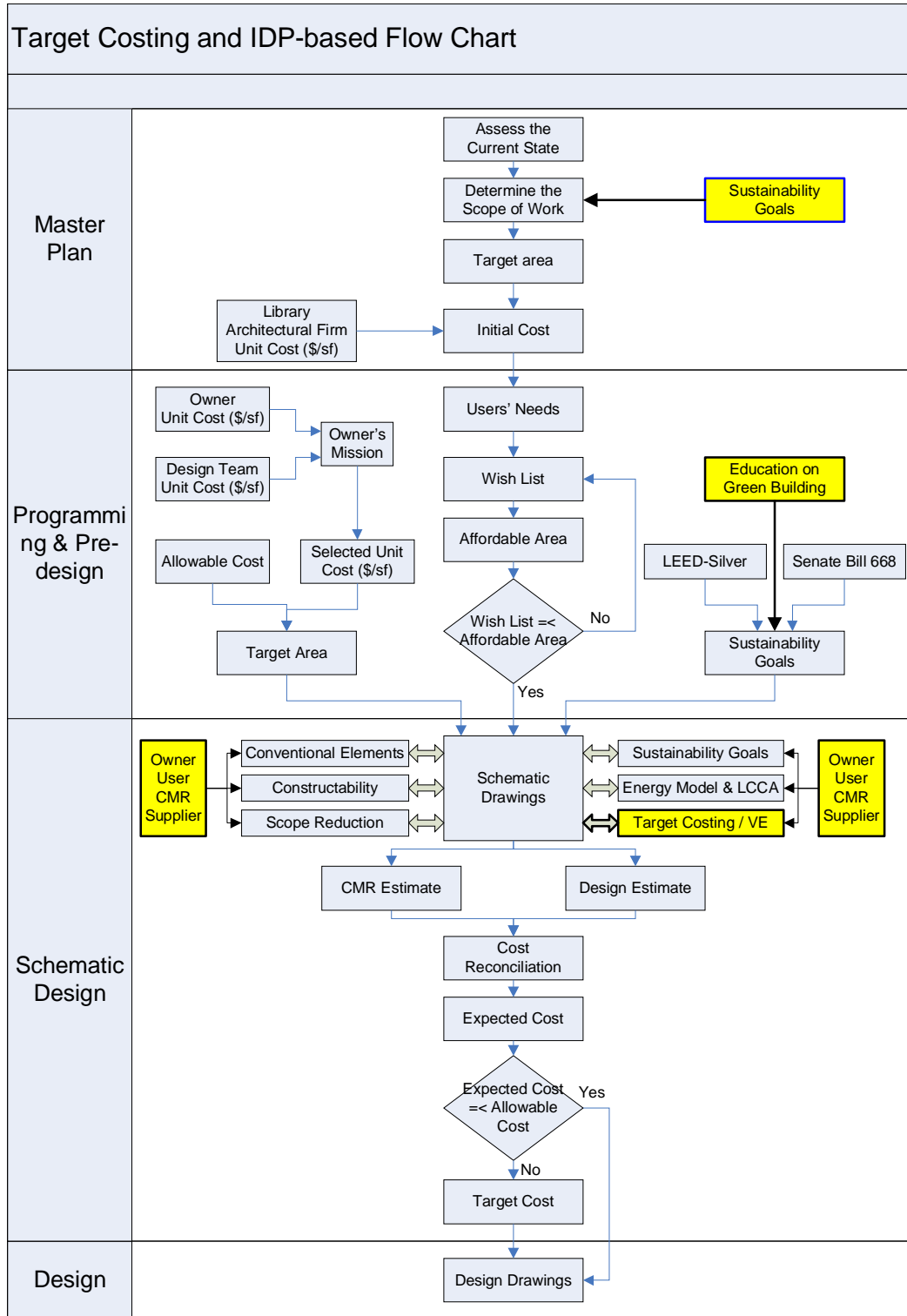


Figure 4.7 Proposed Flow Chart

4.4 Phase IV: Interviews

Interviews were needed in order to accomplish objective five listed in Chapter 1. Recall from section 3.1.4, prospective interviewees were chosen based upon their knowledge on aspects such as stakeholders' values, needs and aspirations, cost control, and Green Building. Time availability was also an issue when contacting them, however. As requested by the Project Manager, any participation the design team offers must not be at a cost to the project; besides the PM needed to review all the material relative to the interview. All the people selected for the interviews were in agreement with PM. Table 4.9 lists the interviewees. Numbers were used rather than names. Additional information was presented to understand the participant role in the project.

Table 4.9 List of Interviewees

Interviewee	Representative of	Organization	Department	Position
Interviewee 1	Owner	NCSU	Office of the University Architect	University Architect
Interviewee 2	Owner	NCSU	Capital Project Management	Project Manager
Interviewee 3	Owner	NCSU	Capital Project Management	Assistant PM
Interviewee 4	Users	NCSU	Libraries	Vice Provost & Director of Libraries
Interviewee 5	Users	NCSU	Chancellors Spaces	Associate Dean for Academic Affairs
Interviewee 6	Designer	Snøhetta	Design	Project Manager for the Designer
Interviewee 7	Designer	PBC+L	Design	Project Director
Interviewee 8	Designer	PBC+L	Design	Assistant Project Director
Interviewee 9	CMR	Skanska	Construction	Project Executive

4.4.1 Questionnaire

Eleven questions were proposed in order to capture participants' feedback not only on the researcher's observations and but on the researcher's ideas to improve cost control. Table 4.10 shows the rationale of the questions based on the aspects the researcher focused on.

Table 4.10 Interview questions and their rationale

Part	Purpose	Aspect	Question
Stakeholders values, needs, and aspirations	To obtain feedback on observations	Users' needs and aspirations	1. During the Programming & Pre-Design Phase that began in January 2008 and was completed in August 2008, were the stakeholders' values properly determined and prioritized? Explain how this could be improved
		Space Distribution	2. One of the purposes of The Programming & Pre-Design phase was to find the appropriate space distribution. Is the current space distribution in agreement with each project user, i.e., Library, IEL, and Chancellor's space? Please explain
Approach to balance scope - price	To obtain feedback on ways to improve	Cost Estimation System	3. In Schematic Design, cost estimates are done after schematic drawings are ready. Would the implementation of a cost estimation system from the beginning of Schematic Design facilitate to control costs? Please explain
		Value Engineering	4. Throughout the entire Schematic Design process. Would it be beneficial and feasible to use Value Engineering such that decision-making is based on the costs associated to these decisions? Please explain
		Cost Control	5. In Schematic Design, reducing scope seems to help reduce costs. Would you consider that better ways cost control techniques should be in place rather than reducing scope? Please explain
		Design to a Target Cost	6. At the end of Schematic Design and beginning of Design Development, costs reconciliation meetings were held to reconcile quantities takeoff and unit costs. If the final budget is over the target, then target costs for main budget components are realized. Would it be feasible to apply this process not only for the main components but for the entire project?

Table 4.10 Continued

		Cross functional teams	7. Would it be beneficial and feasible for controlling costs to include the expertise from the Construction Manager at Risk (CM@R) and the supplier (HK Systems) of the Automated Retrieval System earlier in the process? Let's say during Programming & Pre-design?
Green Building	To obtain feedback on observations	Cost vs. Benefit/Cost	8. At the beginning of Schematic Design some meetings were held to analyze the process in order to achieve the LEED-Silver certification. Should this process be based upon costs only or benefit/cost analysis? Discuss
	To obtain feedback on ways to improve	Holistic Approach	9. LEED-Silver requirements were not considered earlier in the process because the North Carolina Construction Guideline did not require their accomplishment until 2008. Have the Senate Bill 668 and LEED-Silver requirements been properly integrated into the Building delivery process? Discuss
		Extra item in the budget	10. Literature on Green Building claims that there is no extra cost added to meet a LEED certification. Is the LEED-Silver certification seen as an extra item in the Budget? Discuss
		Inclusive & Collaboration	11. Aspects such as "inclusive (everyone is heard)" and "collaboration (active roles)" are important to meet sustainability goals. Have these two aspects been properly considered? Discuss

4.4.2 Evaluation Form

A matrix was also created in order to evaluate the level of involvement of each participant. The matrix consisted of two parts; the first part was an individual evaluation on detailed aspects and, the second part was a group evaluation on general aspects. The given answers depended on the participant's personal opinion. Figure 4.8 shows the matrix evaluation form.

MATRIX TO ASSESS THE LEVEL OF PARTICIPANTS' INVOLVEMENT IN THE JAMES B. HUNT LIBRARY

Instructions

- * Find the two tables to be filled: Individual Evaluation (right), and Group Evaluation (below)
- * Please use the numbers in the Filling Criteria Table (below) to rate participants' involvement
- * Please refer to the Terminology Table (below Filling Criteria Table) if necessary
- * Answers are subject to interviewee's personal opinion

Filling Criteria	
Rating Number	Participant is:
3	Highly involved in project meetings and brings valuable contribution
2	Normally involved in project meetings and brings important or valuable contribution
1	Not very involved and brings comments rather than contributions
N/A	Not Applicable / Participant's involvement was not effective at that time

Terminology	
Abbreviation	Expansion
OUA	NCSU - Office of University Architect
CPM	NCSU - Capital Project Management
FO	NCSU - Facilities Operations
IEI	Institute of Emerging Issues
CMR	Construction Management at Risk

Individual Evaluation		
Phase	Survey Item	Rating
D e f i n i t i o n	Library Master Plan, 2002	/
	Assess the current state	
	Develop criteria to guide development	
	Planning Diagrams	
	Scope of Work	
	Budget	
P r o g r a m m i n g	Programming & Pre-design, 2008	/
	User Needs	
	Room Program	
	Cost Model	
	Sustainability Goals: LEED - Senate Bill	
	Pre-design	
D e s i g n	Schematic Design, 2008-09	/
	User Needs	
	Sustainability Goals: LEED - Senate Bill	
	Life Cycle Cost	
	Constructability	
Cost Reconciliation		

Group Evaluation													
Phase	Survey Item	Facilities Reps			Users			Design Team				CMR	Supplier
		OUA	CPM	FO	Library	IEI	Chancellor	Designer (Snøhetta)	Executive Architect (PBC + L)	Programmer (DEGW)	Cost (Davis Langdon)	Skanska	HK Systems
Definition	Library Master Plan, 2002												
	Programming & Pre-design, 2008												
Design	Schematic Design, 2008-09												

Figure 4.8 Evaluation Form

4.4.3 Questionnaire Results

From the interviews, a complete version of the answers to the questionnaire can be found in Appendix. The researcher used the interview technique mentioned in Section 3.1.4 to summarize the responses on the three main topics i.e., Stakeholders' values, Cost Control (Target Costing), and Green Building. A summary of the answers classified by topic first, and then by question is presented.

4.4.3.1 Stakeholders' values

The first two questions addressed aspects relative to stakeholders' values, needs, and aspirations. These aspects were considered at the beginning because of their communality between Target Costing and Green Building.

Q1. During the Programming & Pre-Design Phase that began in January 2008 and was completed in August 2008, were the stakeholders' values properly determined and prioritized? Explain how this could be improved.

The owner's representatives, the design team, and the CMR all agree on the fact that the stakeholders' values were properly determined and prioritized and not much improvement could be done in the process. Users believe that communication was an issue because it was difficult to plan meetings due to everyone's busy schedules.

Q2. One of the purposes of The Programming & Pre-Design phase was to find the appropriate space distribution. Is the current space distribution in agreement with each project user, i.e., Library, IEI, and Chancellor's space? Please explain.

Although, the building has shrunk, the owner's representatives, the design team, and the CMR believe that space allocation is in agreement with each project user. Someone said: "If we manage to disappoint every user group in equal amount then we are doing our job properly". Users seem to be satisfied with the current space.

4.4.3.2 Ways to improve Cost Control (Target Costing)

From question #3 to question # 7, the main focus was to capture the participant's feedback on ways to improve cost control.

Q3. In Schematic Design, cost estimates are done after schematic drawings are ready. Would the implementation of a cost estimation system from the beginning of Schematic Design facilitate to control costs? Please explain.

The owner's representatives, the design team, and the CMR believe that the implementation of a cost estimation system from the beginning of Schematic Design is not fully feasible because of the lack of information relative to the building at that time. From their point of view, a cost estimation system would limit the process of exploration during Schematic Design, and the use of time would not be effective. The users did not have an input because they did not feel knowledgeable about costs.

Q4. Throughout the entire Schematic Design process. Would it be beneficial and feasible to use Value Engineering such that decision-making is based on the costs associated to these decisions? Please explain.

Most of the participants answered, yes, Value Engineering would be beneficial to use. The concept of value varied depending of the respondent. VE was believed to be in place during

SD, but not in a robust way. Participants concurred that Value Engineering could be done earlier in SD, rather than waiting until the end to estimate costs.

Q5. In Schematic Design, reducing scope seems to help reduce costs. Would you consider that better ways cost control techniques should be in place rather than reducing scope? Please explain.

Participants from all groups believed that reducing the scope of the project was the preferred option used to cut costs. Owner's representatives and designers made clear that the Hunt Library is a signature building which means very high qualities, high performance, and high level of finishes are expected. As a result, space had to be sacrificed. In turn, the CMR stated that reducing space would ultimately be the last resource to achieve the goal of meeting a budget. In all cases, focusing on building systems is believed to be a good option to control costs, and to make the building more efficient.

Q6. At the end of Schematic Design and beginning of Design Development, costs reconciliation meetings were held to reconcile quantities takeoff and unit costs. If the final budget is over the target, then target costs for main budget components are realized. Would it be feasible to apply this process not only for the main components but for the entire project? Please explain.

Even though, most of participants think that the process should be broken down as much as possible to look at all the pieces and parts of it, they also think that it is not an efficient use of

effort and time. Smaller items will be pursued if what wanted is not being achieved by just focusing on the larger items.

Q7. Would it be beneficial and feasible for controlling costs to include the expertise from the Construction Manager at Risk (CM@R) and the supplier (HK Systems) of the Automated Retrieval System earlier in the process? Let's say during Programming & Pre-design?.

Most of the respondents agree that it would be very beneficial to have the expertise from the CMR (Skanska) and from the supplier (HK Systems) earlier in the process. Specifically, it was believed that having the supplier's input since Programming & Pre-design would have brought valuable information for the designers to work with. One of the users think that the building could be different and its odd shape mainly because this lack of information. It was mentioned, however, the supplier did not want to provide information until being under contract. On the other hand, having a discussion between the CMR and the cost consultant for the design team earlier, during the time the target cost was set; would have brought valuable input because of their knowledge of the local market.

4.4.3.3 Green Building

The last part of the questionnaire consisted of four questions to obtain the participant's feedback on aspects related to Green Building.

Q8. At the beginning of Schematic Design some meetings were held to analyze the process in order to achieve the LEED-Silver certification. Should this process be based upon costs only or benefit/cost analysis? Discuss.

Most of the participants suppose that by going after the LEED-Silver certification the benefits are already given; therefore looking at cost is what makes sense. The fact that the LEED system is new was seen as a justification for not knowing the benefits. Within the LEED system, there are categories; these have not been discussed much for the Hunt Library. Users felt neither the costs nor the benefits have been discussed with them, even though they will be people using the building at all times.

Q9. LEED-Silver requirements were not considered earlier in the process because the North Carolina Construction Guideline did not require their accomplishment until 2008. Have the Senate Bill 668 and LEED-Silver requirements been properly integrated into the Building delivery process? Discuss.

Owner's representatives and designers said that the integration of Senate Bill 668 and LEED-Silver requirements has not happened so far, but it will. They also said that the Hunt Library is one of the first projects out of the box, therefore they are learning as they go. It will get better over time. One person from Capital Project Management brought up the fact that there were a few meetings at the beginning of SD and there has not been much talk since then. It appears only the designers know where they are in terms of achieving these requirements.

Q10. Literature on Green Building claims that there is no extra cost added to meet a LEED certification. Is the LEED-Silver certification seen as an extra item in the Budget? Discuss.

Most of the participants believe there is an extra upfront cost added to meet a LEED certification. They all realize there is more work from part of all groups, and time means costs. Nevertheless, this cost is not seen as an extra line item in the budget, but sure it is an extra cost that is integrated in the total project cost. One of the owner's representatives believes a LEED-Silver certification adds between 3% and 5%, leaning more toward the highest percentage.

Q11. Aspects such as “inclusive (everyone is heard)” and “collaboration (active roles)” are important to meet sustainability goals. Have these two aspects been properly considered? Discuss.

Overall, participants consider that these two aspects have been used effectively. One area that could be improved is the involvement of the mechanical/electrical design team and mechanical/electrical user's representative. This is where the biggest savings and biggest LEED points are imbedded. The process is considered very collaborative and inclusive whether or not you are talking about LEED. This is because the significant number of stakeholders in the project.

4.4.4 Evaluation Results

To better visualize the results, the cells containing the participants' responses were filled with colors. Figure 4.9 depicts the criteria used to associate colors with the level of involvement.

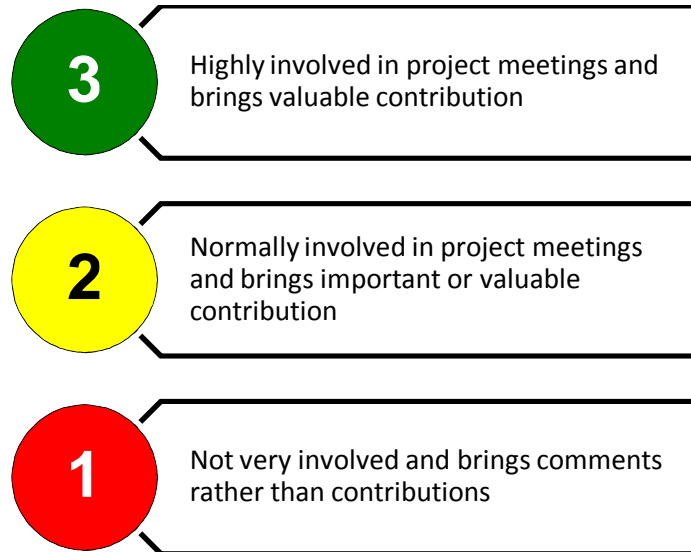


Figure 4.9 Level of Involvement and its corresponding color

The results from the evaluation forms were grouped together such that it was visually easy to identify the level of involvement by individual (Table 4.10), and by project phase i.e., Library Master Plan, Programming & Pre-design, and Schematic Design. See Table 4.12, Table 4.13, and Table 4.14, respectively.

Table 4.11 Individual Evaluation

MATRIX TO ASSESS THE LEVEL OF PARTICIPANTS' INVOLVEMENT IN THE JAMES B. HUNT LIBRARY

Self-Evaluation on Library Master Plan, 2002										
Phase	Evaluator	Facilities Reps			Users		Design Team			CMR
		OUA	CPM	CPM	Library	Chancellor's Spaces	Designer (Snøhetta)	Executive Architect (PBC + L)	Executive Architect (PBC + L)	Skanska
Library Master Plan, 2002	Assess the current state	3	N/A	N/A	3	N/A	N/A	N/A	N/A	N/A
	Develop criteria to guide development	2	N/A	N/A	3	N/A	N/A	N/A	N/A	N/A
	Planning Diagrams	2	N/A	N/A	3	N/A	N/A	N/A	N/A	N/A
	Scope of Work	2	N/A	N/A	2	N/A	N/A	N/A	N/A	N/A
	Budget	2	N/A	N/A	2	N/A	N/A	N/A	N/A	N/A
Programming & Pre-design, 2008	User Needs	1	3	1	2	3	3	2	1	N/A
	Room Program	N/A	2	2	3	3	2	2	1	N/A
	Cost Model	1	3	1	1	1	2	1	2	N/A
	Sustainability Goals: LEED - Senate Bill	2	3	2	1	1	1	3	3	N/A
	Predesign	2	3	2	3	3	3	3	1	N/A
Schematic Design, 2008-09	User Needs	1	2	2	2	3	3	2	2	1
	Sustainability Goals: LEED - Senate Bill	2	3	2	1	N/A	2	3	3	2
	Life Cycle Cost	1	2	1	1	N/A	1	1	1	1
	Constructability	2	3	N/A	1	N/A	3	3	1	3
	Cost Reconciliation	N/A	3	1	1	N/A	3	3	3	3

Table 4.12 Level of Participants' involvement during the Library Master Plan in 2002

Group Evaluation on Library Master Plan, 2002													
G r o u p	Evaluator	Facilities Reps			Users			Design Team				CMR	Supplier
		OUA	CPM	FO	Library	IEI	Chancellor's Spaces	Designer (Snøhetta)	Executive Architect (PBC + L)	Programmer (DEGW)	Cost (Davis Langdon)	Skanska	HK Systems
Facilities Reps	University Architect (OUA)	3	1	1	3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Project Manager (CPM)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Assistant Project Manager (CPM)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Users	Library Director	3	2	1	3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Chancellor's spaces rep	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Design Team	PM for the Designer	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Design Project Director	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Assistant Design Project Director	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
CMR	PM for the CMR	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 4.13 Level of Participants' involvement during Programming & Pre-design Phase

Group Evaluation on Programming & Pre-Design (Jan/08 - Aug/08)													
Group	Evaluator	Facilities Reps			Users			Design Team				CMR	Supplier
		OUA	CPM	FO	Library	IEI	Chancellor's Spaces	Designer (Snøhetta)	Executive Architect (PBC + L)	Programmer (DEGW)	Cost (Davis Langdon)	Skanska	HK Systems
Facilities Reps	University Architect (OUA)	3	3	1	3	3	3	3	2	3	1	1	N/A
	Project Manager (CPM)	1	3	1	3	3	2	3	2	3	1	N/A	N/A
	Assistant Project Manager (CPM)	3	3	2	3	3	2	3	3	3	1	N/A	N/A
Users	Library Director	3	3	1	3	3	2	3	3	3	3	N/A	N/A
	Chancellor's spaces rep	3	3	N/A	N/A	N/A	3	3	3	3	N/A	3	N/A
Design Team	PM for the Designer	3	3	2	3	3	1	3	3	3	2	N/A	1
	Design Project Director	2	3	1	3	3	3	3	2	3	2	N/A	1
	Assistant Design Project Director	2	2	N/A	3	3	2	3	2	3	3	N/A	1
CMR	PM for the CMR	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 4.14 Level of Participants' involvement during Schematic Design Phase

Group Evaluation on Schematic Design (Sep/08 - Mar/09)														
Group	Evaluator	Facilities Reps			Users			Design Team				CMR	Supplier	
		OUA	CPM	FO	Library	IEI	Chancellor's Spaces	Designer (Snøhetta)	Executive Architect (PBC + L)	Programmer (DEGW)	Cost (Davis Langdon)	Skanska	HK Systems	
Facilities Reps	University Architect (OUA)	2	3	2	3	3	2	3	3	1	1	2	1	
	Project Manager (CPM)	3	3	2	3	3	2	3	3	1	2	2	1	
	Assistant Project Manager (CPM)	3	3	2	3	3	2	3	3	1	2	3	1	
Users	Library Director	3	3	1	3	3	1	3	3	N/A	3	1	1	
	Chancellor's spaces rep	3	3	N/A	N/A	N/A	3	3	3	3	N/A	3	N/A	
Design Team	PM for the Designer	2	3	2	3	3	1	3	3	1	2	2	1	
	Design Project Director	3	3	1	3	3	3	3	3	2	2	3	2	
	Assistant Design Project Director	3	3	2	3	3	2	3	2	1	3	3	1	
CMR	PM for the CMR	2	3	1	3	3	1	3	2	N/A	2	2	1	

The tables contain categorical data. These categorical data are represented by arbitrary numbers; therefore it was possible to calculate an average by group. The averages helped to determine the central tendency, that is a descriptive measure to describe the center of the distribution of measurements and also how the measurements vary about the center of the distribution (Ott & Longnecker, 2001). The averages by groups are presented for Programming & Pre-Design in Table 4.15, and for Schematic Design in Table 4.16. No average was calculated for the Master Plan because almost all the cells contained N/A.

Table 4.15 Evaluation averages by groups on Programming & Pre-Design

LEVEL OF PARTICIPANTS' INVOLVEMENT IN THE JAMES B. HUNT LIBRARY					
Group Evaluation on Programming & Pre-Design (Jan/08 - Aug/08)					
Rated Evaluator	Facilities Reps	Users	Design Team	CMR	Supplier
Facilities Reps	2.2	2.8	2.3	1.0	N/A
Users	2.6	2.8	3.0	3.0	N/A
Design Team	2.3	2.7	2.7	N/A	1.0
CMR	N/A	N/A	N/A	N/A	N/A
Average	2.4	2.7	2.7	2.0	1.0

Table 4.16 Evaluation averages by groups on Schematic Design

LEVEL OF PARTICIPANTS' INVOLVEMENT IN THE JAMES B. HUNT LIBRARY					
Group Evaluation on Schematic Design (Sep/08 - Mar/09)					
Rated Evaluator	Facilities Reps	Users	Design Team	CMR	Supplier
Facilities Reps	2.6	2.7	2.2	2.3	1.0
Users	2.6	2.5	3.0	2.0	1.0
Design Team	2.4	2.7	2.3	2.7	1.3
CMR	2.0	2.3	2.3	2.0	1.0
Average	2.4	2.5	2.5	2.3	1.1

Chapter 5. Summary and Conclusions

By comparing the results of this investigation to the Target Costing process, a summary and conclusions are presented in Table 5.1

Table 5.1 Summary and Conclusion for each Target Costing principle.

Principle	Summary	Conclusion
Target Cost	A target cost was determined using the owner's funding limits. This target cost, however, was not checked during the process of programming or designing. The cost of meeting the LEED-Silver certification was integrated within the target cost.	Checking costs during the process of programming and pre-design can be of use to control costs in publically funded buildings. Costs could be identified and realized before they are incurred.
User focus	Users' traditional needs, e.g., level of quality, area, and functionality, seemed to be met. It appears, however, users were not well-informed about green requirements.	Having users educated and informed on green building aspects can be useful to better define sustainability needs.
Focus on design	Designing to a cost was not in place during SD due to the lack of information about the elements of the building. It is expected to happen in Design Development.	Designing each building component to a cost in earlier phases can help achieve the target cost.
Cross functional Teams	Owner, user, and designer were involved from the beginning of the process. The CMR came in late during SD, and the supplier after SD.	Having the input from the supplier and from the CMR earlier in the process can bring critical contribution to the design.
Life cycle cost reduction	An energy life-cycle cost model was done.	Performing a life-cycle cost reduction analysis on every building component can benefit the owner, because the costs of ownership are minimized.
Participants' involvement	The level of involvement from the owner, user, and designer was above normal. The CMR and the supplier's involvement were lower than the rest.	Increasing the level of involvement can bring joint problem-solving and joint decision-making rather than individual teams working on assignments.

5.1 Framework for Target Costing Implementation in publically funded Green Buildings

The framework includes a proposed flow chart and a list of barriers and solutions.

5.1.1 Flow chart

The flow chart shown in Figure 4.7 can be useful for a Target Costing implementation in publically funded Green Buildings.

5.1.2 Barriers / Solutions

Common themes of barriers were derived from the conducted interviews. These themes were compiled to create a listing of barriers and suggested solutions.

- Target Costing requires a change from the people, where they believe that a cost estimation system, providing feedback as schematic design is being developed; helps make project costs more predictable.

Solution: Inform people about a cost estimation system that could be useful to estimate costs while designing.

- People are often resistant to change especially if a particular process has worked relatively well for a long time

Education and training on Target Costing and Green Building.

- People often believe the main suppliers and the construction manager at risk should be brought in late in schematic design. Their input, however, may be more valuable beginning in programming rather than in design.

Solution: Finding means such that downstream players can be brought in upstream.

5.2 **Future Work**

From findings in this investigation, the following are recommended for consideration

1. Further research is needed to explore a cost estimation system to be used while programming and designing green buildings to realize costs before they happen.
2. Additional investigation is necessary to determine the best means to include project participants who are identified as not heavily involved during programming phase, i.e., contractor, and suppliers.
3. Further research is needed on later project phases in the Target Costing process: design development, and construction.

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APPENDIX

Table 1 Interviewed project participants

Interviewee	Representative of	Organization	Department	Position
Interviewee 1	Owner	NCSU	Office of the University Architect	University Architect
Interviewee 2	Owner	NCSU	Capital Project Management	Project Manager
Interviewee 3	Owner	NCSU	Capital Project Management	Assistant PM
Interviewee 4	User	NCSU	Libraries	Vice Provost & Director of Libraries
Interviewee 5	User	NCSU	Chancellors Spaces	Associate Dean for Academic Affairs
Interviewee 6	Designer	Snøhetta	Design	Project Manager for the Designer
Interviewee 7	Designer	PBC+L	Design	Project Director
Interviewee 8	Designer	PBC+L	Design	Assistant Project Director
Interviewee 9	CMR	Skanska	Construction	Project Executive

Questions

Stakeholder Values & Needs

- 1) During the Programming & Pre-Design Phase that began in January 2008 and was completed in August 2008, were the stakeholders' values properly determined and prioritized? Please explain how this could be improved.
- 2) One of the purposes of The Programming & Pre-Design phase was to find the appropriate space distribution. Is the current space distribution in a satisfactory level for each project user, i.e., Library, IEI, and Chancellor's space? Please explain.

Cost Control

- 3) In Schematic Design, cost estimates are done after schematic drawings are ready. Would the implementation of a cost estimation system from the beginning of Schematic Design facilitate to control costs? Please explain.
- 4) Throughout the entire Schematic Design process. Would it be beneficial and feasible to use Value Engineering such that decision-making is based on the costs associated to these decisions? Please explain.
- 5) In Schematic Design, reducing scope seems to help reduce costs. Would you consider that better ways of cost control techniques should be in place rather than reducing scope? Please explain.
- 6) At the end of Schematic Design and beginning of Design Development, costs reconciliation meetings were held to reconcile quantities takeoff and unit costs. If the final budget is over the

target, then target costs for main budget components are realized. Would it be feasible to apply this process not only for the main components but for the entire project? Please explain.

- 7) Would it be beneficial and feasible for controlling costs to include the expertise from the Construction Manager at Risk (CM@R) and the supplier (HK Systems) of the Automated Retrieval System earlier in the process? Let's say during Programming & Pre-design.?

Green Building

- 8) At the beginning of Schematic Design some meetings were held to analyze the process in order to achieve the LEED-Silver certification. Should this process be based upon costs only or benefit/cost analysis? Discuss.
- 9) LEED-Silver requirements were not considered earlier in the process because the North Carolina Construction Guideline did not require their accomplishment until 2008. Have the Senate Bill 668 and LEED-Silver requirements been properly integrated into Schematic Design? Discuss.
- 10) Literature on Green Building claims that there is no extra cost added to meet a LEED certification. Is the LEED-Silver certification seen as an extra item in the Budget? Discuss.
- 11) Aspects such as "inclusive (everyone is heard)" and "collaboration (active roles)" are important to meet sustainability goals. Have these two aspects been used effectively? Discuss.

Answers

Owner's Representative

NCSU – Office of University Architect

Architect

Stakeholder Values & Needs

- 1) Yes, the values and needs were determined and prioritized. There was extensive interaction with the major occupants of the building, i.e., the Library, IEI, the Chancellor's spaces and the Facilities Operations activities. However, some of sustainability issues were not fully clear at that time. As far as the occupancy of the building I don't believe it could be really improved.
- 2) Yes, the space allocation is in a satisfactory level. It seems consistent with early documentation that precedes January/2008. The biggest challenge is that the Library itself is a large proportion shared of the building and we use technology to help us solve some issues related to space (2 million volumes on shelving). The introduction of the Automated Retrieval System (ARS) enable us to consolidate the space for books and solve some cost issues but also creates opportunities for students' study spaces and seats in the Library.

Cost Control

- 3) Yes, a cost estimation system from the beginning of SD would help to control costs. We do that to a certain degree when we set a budget. The challenge is breaking a process down that is very creative into a methodology that allows you to have a real-time budget impact. It is usually

after a set of decisions that you pause and do an estimate. Having a CMR at this point would also help.

- 4) Yes, VE would be beneficial. The challenge is to know what the true value of something is. Everybody in the design process has a bias and identifying what the bias is important. VE is somehow done but not in a robust way. It would be good to have this tool as the process goes instead of having to come to a stop and gather all the decisions and then somehow price them, which is what we do now.
- 5) Absolutely, in fact one of my roles is to be the project contrarian, to challenge the assumptions, to make sure that all the possibilities are considered. Reducing the scope of the project is usually the first thing that happens. There are more options rather than cutting off square footage, even including challenging the person putting the estimate together because they might be too conservative guessing the other parameters.
- 6) I was not at the cost reconciliation meeting for this project, but typically they are very detailed and they are organized by major categories. The process should be as much as you can break it down so you can really look at all the pieces and parts of it. It should be applied to the entire project not just the main components.
- 7) Yes, it would help. There are two challenges working against that. One is that we didn't know much about the ARS during programming. The second challenge has to do with procurement. We usually have the architect know a little bit more about the building and then see what kind of CMR is needed.

Green Building

- 8) I am not sure. I suppose there would be some value knowing what the cost of that was, but a cost/benefit analysis justified the skeptics. In other words, the benefits are already given and no analysis is needed to justify the benefits, unless other certification such as Gold or Platinum is sought. Sustainability should never be on a cost only. LEED-Silver is mandated we need to be looking at the points that are affordable.
- 9) I do not know. Probably to some degree but not fully. So far there is an assignment of tasks I don't believe they are fully integrated yet. It seems we are not there because we don't have the experience.
- 10) The body of knowledge is expanding on what the cost to be green and to be LEED-Silver. In a way, by saying that we are going to do all LEED-Silver then there is no cost because that is what we are doing. The biggest challenge is that we are trying to measure one building against another, but every building is only built once. The model should change the assumptions every time. The data set is small.
- 11) Yes, they have been used effectively. Maybe one area that could be improved is the involvement of the mechanical/electrical design team and mechanical/electrical user's representative earlier. This area is important because is where you obtain the biggest savings and biggest LEED points.

MATRIX TO ASSESS THE LEVEL OF PARTICIPANTS' INVOLVEMENT IN THE JAMES B. HUNT LIBRARY

Instructions

- * Find the two tables to be filled: Individual Evaluation (right) , and Group Evaluation (below)
- * Please use the numbers in the Filling Criteria Table (below) to rate participants's involvement
- * Please refer to the Terminology Table (below Filling Criteria Table) if necessary
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Individual Evaluation		
Phase	Survey Item	Rating
D e f i n i t i o n	Library Master Plan, 2002	
	Assess the current state	3
	Develop criteria to guide development	2
	Planning Diagrams	2
	Scope of Work	2
	Budget	2
	Programmimg & Pre-design, 2008	
	User Needs	1
	Room Program	N/A
	Cost Model	1
Sustainability Goals: LEED - Senate Bill	2	
Pre-design	2	
D e s i g n	Schematic Design, 2008-09	
	User Needs	1
	Sustainability Goals: LEED - Senate Bill	2
	Life Cycle Cost	1
	Constructability	2
Cost Reconciliation	N/A	

Group Evaluation													
p h a s e	Survey Item	Facilities Reps			Users			Design Team				CMR	Supplier
		OUA	CPM	FO	Library	IEI	Chancellor's spaces	Designer (Snøhetta)	Executive Architect (PBC + L)	Programmer (DEGW)	Cost (Davis Langdon)		
Definition	Library Master Plan, 2002	3	1	1	3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Programmimg & Pre-design, 2008	3	3	1	3	3	3	3	2	3	1	1	N/A
Design	Schematic Design, 2008-09	2	3	2	3	3	2	3	3	1	1	2	1

Owner's Representative

NCSU - Capital Project Management (CPM)

Project Manager

Stakeholder Values & Needs

- 1) Yes, the Programming was unusually detailed and complex for the Hunt Library, with a specific library consultant on board that led all the user groups in a series of interactive workshops. The stakeholders' values and needs were indeed captured by producing ideas, bubble diagrams, adjacencies, among other techniques used in programming. It was an exemplary effort that couldn't be improved very much.
- 2) Users' request and budget are never resolved. Everyone wants more than the building can actually afford. Someone would say: "If we manage to disappoint every user group in equal amount then we are doing our job properly. It is inevitable to fulfill all the user groups' expectations; however, a good job is done if we can fulfill the most important needs and be fair about space allocation. Yes, the current space allocation is in a satisfactory level for each project user.

Cost Control

- 3) I don't think so. During SD, things are so fluid that you would spend so much effort maintaining any type of cost estimate model as things moved around. For example, the number of floors in the Hunt Library changed after SD was done, in response to the SD estimate provided by CMR.

A project needs to be developed up to a point, and then do a cost estimate and move forward from there. A cost estimate would not help much if brought sooner than SD.

- 4) SD is the probably first logical step in the process that you can start making those VE decisions. Because the design process is so fluid early on I don't see VE as an effective use of time. VE would be possible but probably not the most effective use of time and money for that effort.
- 5) There are 3 points: scope, quality and cost. You can control two of the three, but if you have a total cost you can spend and you want to have big building you will have to sacrifice quality of that building space. For the Hunt Library there is an expectation of certain level of quality of building, an iconic structure with nice and durable finishes in the public space in particular. In order to achieve what previously mentioned, a reduction in scope was needed.
- 6) The answer has to do with efficient use of effort and time. Smaller items will be chased if what wanted is not being achieved by just focusing on the larger items. However, it might not be after SD but after Design Development (DD) that chasing small items will occur. At this point it makes more sense to trying focus on the biggest yields.
- 7) No. If a project is too fluid in SD to really make an effective use of the CMR, then it is way to fluid. Part of programming is an exploratory aspect to list all the desires. There is not much defined that the CMR will be able to give you a price on. The CMR would not bring much to the process at the Programming time. As far as the supplier, it probably would have been useful to get some more definitive numbers from them, not only on costs but in regards to the size of the ARS. In this case, yes it would be good to get more information from the supplier. Unfortunately, the supplier was not willing to provide much information prior to being under contract.

Green Building

- 8) The actual LEED certification process is a benefit/cost analysis. You determine what point to go after based on the cost and at the same balancing the different parts of a LEED certification, for example allowing additional fresh air into the building to accommodate occupant comfort is going to take away from the energy efficiency of the skin of the building. It is more of a category analysis between the different areas within the LEED system itself. It is already a benefit/cost process.
- 9) Not yet. The Hunt Library is one of the first out of the box. However, our department is learning as we go and as we get a little bit further into the process we will do better at it. The majority of the staff is Accredited Professionals now.
- 10) There is two parts. First, certain amount of money is needed to register your building with LEED which is an additional cost. Second, I don't believe that accommodating green building practices and getting a LEED certification doesn't add an extra cost. In fact, I lean towards 5% to get the LEED-Silver certification. But again, it is a learning process to find out the real percentage in our buildings.
- 11) Yes, the two aspects have been used effectively. The workshops held at programming were very inclusive. Representatives of Facilities Operations, Environmental Health and Safety, Transportation are always included to discuss how the building is affected by their requirements or how the building is affecting some of their surrounding concerns. The process is very collaborative and inclusive whether or not you are talking about LEED. This is because the significant number of stakeholders in the project.

MATRIX TO ASSESS THE LEVEL OF PARTICIPANTS' INVOLVEMENT IN THE JAMES B. HUNT LIBRARY

Instructions

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Individual Evaluation		
Phase	Survey Item	Rating
D e f i n i t i o n	Library Master Plan, 2002	
	Assess the current state	N/A
	Develop criteria to guide development	N/A
	Planning Diagrams	N/A
	Scope of Work	N/A
	Budget	N/A
	Programmming & Pre-design, 2008	
	User Needs	3
	Room Program	2
	Cost Model	3
Sustainability Goals: LEED - Senate Bill	3	
Predesign	3	
D e s i g n	Schematic Design, 2008-09	
	User Needs	2
	Sustainability Goals: LEED - Senate Bill	3
	Life Cycle Cost	2
	Constructability	3
	Cost Reconciliation	3

Group Evaluation													
Phase	Survey Item	Facilities Reps			Users			Design Team				CMR	Supplier
		OUA	CPM	FO	Library	IEI	Chancellor's spaces	Designer (Snøhetta)	Executive Architect (PBC + L)	Programmer (DEGW)	Cost (Davis Langdon)	Skanska	HK Systems
Definition	Library Master Plan, 2002	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Programmming & Pre-design, 2008	1	3	1	3	3	2	3	2	3	1	N/A	N/A
Design	Schematic Design, 2008-09	3	3	2	3	3	2	3	3	1	2	2	1

Owner's Representative

NCSU - Capital Project Management (CPM)

Assistant Project Manager

Stakeholder Values & Needs

- 1) Yes, their values were determined regarding programming. It was determined early on what each group in the building needed and what they wanted. The problem was what they wanted was more than what the building could give them; cutting the scope further into SD could have been avoided by having these conversations in programming.
- 2) Yes, space allocation is in a satisfactory level, even though the project has shrunk. They are satisfied.

Cost Control

- 3) Yes, a cost estimation system from the beginning of SD would help a lot. If something is done earlier is better. A system like BIM (Building Information Modeling) where there is more integrated design up-front with the mechanical/electrical/plumbing people very early in the conceptual design then you can a cost estimate and it would help.
- 4) If they have an idea of the cost before the end of SD then yes VE could be done; instead of waiting until they have the cost at end of SD. This did not happened for this project, because VE came after the cost estimate was done.
- 5) If there are other techniques, yes it would be good to have them. I am not sure which ones, though.

- 6) They could go after every single item, but there was not much information on every single detail to do that. I do not know if it could be effective due to the lack of information because it was in SD.
- 7) Yes, it would be very beneficial. Having the whole team even during programming would help a lot. A cost analysis could be done by using their expertise. Having them earlier in the process would bring information they could start working with.

Green Building

- 8) The way it is now is based only on costs. LEED is very new to the NC system and we are all about costs and saving money. It should not be this way. It should be a benefit/cost analysis also because it is about the environment. Long term benefits should be considered as well.
- 9) So far, they have not been integrated. There were some many issues with program being large at the beginning and being over budget that LEED has been put to the side. LEED has not been talked to throughout the process as the way it should be. We have a few meeting at the beginning of SD and there has been not much talk since then.
- 10) Yes, it is seen as an extra item in the budget. I think there is an extra up-front cost added but over the life of the building, operational costs are reduced.
- 11) They have been used effectively with the people that were brought early in the process. But players such as the CMR and the cost consultant were left out.

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Individual Evaluation		
Phase	Survey Item	Rating
D e f i n i t i o n	Library Master Plan, 2002	
	Assess the current state	N/A
	Develop criteria to guide development	N/A
	Planning Diagrams	N/A
	Scope of Work	N/A
	Budget	N/A
	Programming & Pre-design, 2008	
	User Needs	1
	Room Program	2
	Cost Model	1
Sustainability Goals: LEED - Senate Bill	2	
Pre-design	2	
D e s i g n	Schematic Design, 2008-09	
	User Needs	2
	Sustainability Goals: LEED - Senate Bill	2
	Life Cycle Cost	1
	Constructability	N/A
	Cost Reconciliation	1

Group Evaluation													
Phase	Survey Item	Facilities Reps			Users			Design Team				CMR	Supplier
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Definition	Library Master Plan, 2002	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Programming & Pre-design, 2008	3	3	2	3	3	2	3	3	3	1	N/A	N/A
Design	Schematic Design, 2008-09	3	3	2	3	3	2	3	3	1	2	3	1

User

NCSU – Library

Vice Provost and Director of the Libraries

Stakeholder Values & Needs

- 1) It is difficult to explain because the original plan called for a Library building and not with these other stakeholder conditions. The process was very compartmentalized and not a process that was totally integrated. The spaces that have been put together do not have a relationship to each other. We had to learn what each other's values were. Communication was an issue due to people's busy schedules. Sometimes, problems are presented to the owner (NCSU) through people different from users. We would like to know more about the breakdown of the numbers to better understand the costs.
- 2) From my point of view, it appears our percentage of space has decreased. This is a problem because it creates a serious deficit. Satisfaction has not quite happened so far, but we are still making the case.

Cost Control

- 3) I am not really aware of that but I think the Designer is doing a great job with cost estimators. However, it is too late to get to the end of SD to look at the costs. It is better to know where you are as you go along.

- 4) If I were the client then the answer is yes. I would feel more comfortable by making any decisions by using VE and that will affect how successful and effective the building will be for the users.
- 5) My inclination would be to say yes, but I really do not know how. However, I would rather reduce scope at the beginning than later in the project.
- 6) I was not part of those meetings, so I do not know about that process with knowledge.
- 7) Absolutely! It would be very helpful to have the CMR and the supplier on board earlier in the process. The supplier did not want to discuss much until having a contract. We knew that the Automated Retrieval System should be smaller based on the information from similar projects, but we did not have a particularly strong voice. I believe we have lost out and the building could be different and has a very odd shape as a result. We missed many details that could help to have a better building.

Green Building

- 8) I have not been involved in those meetings. I would say it has to be from a cost/benefit perspective. LEED is seen as a cost only and that is what happens in large bureaucracy because it becomes very hard to have everybody working toward the same goal.
- 9) I really do not know the answer for this question. However, I feel the architect and the designer are knowledgeable about how to get the building green. In addition, I made the decision to hire a LEED Accredited Professional to work at the Library.

10) My guess would be yes. No one believes that there is no extra cost added. But I have also heard there is not necessarily an extra cost associated. I do think there are costs of changing, and a cost of training.

11) I think the people from Capital Project Management worked hard to make sure that everyone was heard, but I do not know much about it.

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Individual Evaluation		
Phase	Survey Item	Rating
D e f i n i t i o n	Library Master Plan, 2002	
	Assess the current state	3
	Develop criteria to guide development	3
	Planning Diagrams	3
	Scope of Work	2
	Budget	2
	Programming & Pre-design, 2008	
	User Needs	2
	Room Program	3
	Cost Model	1
Sustainability Goals: LEED - Senate Bill	1	
Pre-design	3	
D e s i g n	Schematic Design, 2008-09	
	User Needs	2
	Sustainability Goals: LEED - Senate Bill	1
	Life Cycle Cost	1
	Constructability	1
Cost Reconciliation	1	

Group Evaluation													
Phase	Survey Item	Facilities Reps			Users			Design Team				CMR	Supplier
		OUA	CPM	FO	Library	IEI	Chancellor's spaces	Designer (Snøhetta)	Executive Architect (PBC + L)	Programmer (DEGW)	Cost (Davis Langdon)	Skanska	HK Systems
Definition	Library Master Plan, 2002	3	2	1	3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Programming & Pre-design, 2008	3	3	1	3	3	2	3	3	3	3	N/A	N/A
Design	Schematic Design, 2008-09	3	3	1	3	3	1	3	3	N/A	3	1	1

User

NCSU – Chancellor’s Space (College of Humanities and Social Sciences)

Associate Dean for Academic Affairs

Stakeholder Values & Needs

- 1) I have no problem on how we input into this process. Yes, we were frequently asked and attended many meetings. Our opinions and our values were sought, determined and prioritized. I do not have any recommendations for improvement.
- 2) It is a difficult question to answer because it is still in progress. There have been a number of conversations about just what the configuration of our space will look like. Space has moved around and changed over time; therefore, I do not know the final result. We are working in collaboration with the design team and the people from Capital Project Management at NCSU and we are trying to configure this area to serve our needs, but it is not a setting stone yet.

Cost Control

- 3) I do not know. As a user, I have not dealt with cost issues and I have not been present in those meetings because we are not paying for the space.
- 4) I would agree that VE is certainly a very good thing, but I have not been involved into that process.
- 5) I do not feel qualified to provide a good answer.
- 6) I was not present in any of these cost reconciliation meetings.
- 7) I did not know that there would be a CMR and the supplier is not related to my space.

Green Building

- 8) The fact of going for a LEED-Silver certification has not been widely discussed with me.
- 9) As a user, I do not know.
- 10) Same as the previous questions.
- 11) I would say yes. We have been very pleased with how we have been asked, but most of the actual users of the space are interested in many other things. Things like how much space, where the restrooms are, where the offices are, etc. rather than green features.

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Phase	Survey Item	Rating
D e f i n i t i o n	Library Master Plan, 2002	/
	Assess the current state	N/A
	Develop criteria to guide development	N/A
	Planning Diagrams	N/A
	Scope of Work	N/A
	Budget	N/A
	Programming & Pre-design, 2008	/
	User Needs	3
	Room Program	3
	Cost Model	1
Sustainability Goals: LEED - Senate Bill	1	
Pre-design	3	
D e s i g n	Schematic Design, 2008-09	/
	User Needs	3
	Sustainability Goals: LEED - Senate Bill	N/A
	Life Cycle Cost	N/A
	Constructability	N/A
	Cost Reconciliation	N/A

Group Evaluation													
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	Programming & Pre-design, 2008	3	3	N/A	N/A	N/A	3	3	3	3	N/A	3	N/A
Design	Schematic Design, 2008-09	3	3	N/A	N/A	N/A	3	3	3	3	N/A	3	N/A

Design Team

Snøhetta – Designer

Design Project Manager

Stakeholder Values & Needs

- 1) Yes, the values were properly determined and prioritized. Programming was a lengthy and detailed process with the users and with the stakeholders involved in the building; although, it was very complex. The changes we have now it is because the program has matured and everybody has become familiar with understanding what their needs are. Communication between the groups could be improved. It was very complicated getting feedback because people' schedules were so busy.
- 2) Yes, each user has an appropriate space. The distribution is correctly balanced.

Cost Control

- 3) Sometimes a cost estimation system from the beginning of SD does help, but the design team usually needs some initial time without the involvement of the cost consultant. The cost consultant needs to be updated and be informed of the process from the beginning so they can provide early feedback on certain things that will have an impact on cost. The earlier the better because 85% of the costs are determined when programming. Cost, square foot and quality need to balance with each other based on the priorities.

- 4) The term VE traditionally means something you do after the fact. VE was used in a way during SD. VE was not fully used because period of time was very short, having more time would allow to have a more complete set of documents before starting a detailed cost allowances.
- 5) It is project specific. In this case, the Hunt Library is a signature building which means very high qualities, high performance to do the program, and high level of finishes are expected.
- 6) Generally in most building the skin is very expensive, and the Hunt Library was not the exception, that is why we looked at skin first. One of the most effective ways to reduce costs is to reduce building volume, which was done. The main components are looked first because there is not much information about the rest.
- 7) Yes, it would be very useful to have more detailed information from the supplier (KH System). On the other hand, SD is an appropriate time to bring the CMR.

Green Building

- 8) The fact that operational money usually does not come from the same source as construction money affects the way points are sought. An Integrated Design approach could be used to overcome this barrier at the more conceptual level for your design approaches. The process could be more conceptual and proactive.
- 9) The design team is doing their best to meet those requirements. The integration has not quite happened, but we are working on it. For example, energy model is telling us 40% glazing should not be exceeded.

10) The cost of LEED has been integrated evenly into the relevant components of the building.

There is an extra cost but there is not seen as an extra line item; although there are extra fees and costs relative to LEED that are not part of the construction budget.

11) No, they have been not used effectively. Improvement could be made. It should be a stronger voice to state the real goal of the owner, something like an initial statement.

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Individual Evaluation		
Phase	Survey Item	Rating
D e f i n i t i o n	Library Master Plan, 2002	
	Assess the current state	N/A
	Develop criteria to guide development	N/A
	Planning Diagrams	N/A
	Scope of Work	N/A
	Budget	N/A
	Programming & Pre-design, 2008	
	User Needs	3
	Room Program	2
	Cost Model	2
D e s i g n	Sustainability Goals: LEED - Senate Bill	1
	Pre-design	3
	Schematic Design, 2008-09	
	User Needs	3
	Sustainability Goals: LEED - Senate Bill	2
	Life Cycle Cost	1
Constructability	3	
Cost Reconciliation	3	

Group Evaluation													
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	Programming & Pre-design, 2008	3	3	2	3	3	1	3	3	3	2	N/A	1
Design	Schematic Design, 2008-09	2	3	2	3	3	1	3	3	1	2	2	1

Design Team

PBC+L – Executive Architect

Project Director for the Design Team

Stakeholder Values & Needs

- 1) Yes, we did gather the values and the requirements users had. Values were put in priority. We went through a fairly lengthy process to identify these values. I believe the stakeholders feel the same way. Everyone was heard and their needs were captured.
- 2) From my point of view, yes, each user is in a satisfactory level. I also think that each of those users would like to have more space which is not unusual. But the distribution of the space across the building has gotten pretty balanced. I think space allocation is fair. The process was well structured and I don't see much room for improvement to get the optimum square footage.

Cost Control

- 3) In order to do a cost estimate you have to have something to count and it is hard to count something before you draw it. Being SD the first piece of that, it is difficult to do it; although, we did have a cost model, a square foot-based, being used for comparison. It is hard to do an estimate other than one on square foot basis. Once you have the first estimate you have a benchmark to work with. A linear relationship between cost and square feet was the assumption, which is not accurate but it is all you have at this point.

- 4) VE is hard to do in SD. It is much easier to do VE in Design Development once you have defined the building. There were certain things that we knew we could not afford, so they were put on the table in SD but then you have to see what you cannot afford and find out what you really can afford. VE would be feasible to apply in late SD, not from the very beginning because you have not drawn anything. If there are too many parameters you lose this whimsy and this excitement people want to add by limiting yourself too much.
- 5) It starts with scope. You have to be close to a target area. In Design Development you begin to take a look at the cost model instead of each square foot, not in SD though. It should take place during the transition between SD and DD. First you get an affordable area and then you check cost. But you have to make sure you are within range, the range is set by using information from similar projects on a square foot basis.
- 6) Generally the cost model tells you what percentages in the budget main components should be. All details are not seen because there is not much information at this point. For example, for the square footage of the building the volume of the exterior skin was too great, so we focused on this. Again, the longer the project goes on the better cost works because you have better information.
- 7) It is beneficial, but the earlier in the process the less they have to work with. Therefore, the less specific their numbers are. We contacted the supplier early on, but we did not obtain specific information until SD. On the other hand, the Construction Manager at Risk must have something drawn to count so that they can be specific. Early participation helps but not much.

Green Building

- 8) There are two aspects. One is the Sustainable or Green Building aspect and the other is the LEED point system for keeping score. They are related but they are different. For the LEED part there are certain points that are inexpensive and certain points that are very expensive to achieve. For the most part the cost/benefit analysis comes into place in this building.
- 9) Yes, they have been integrated. All the decisions made have considered these two aspects as well as the energy model. The cost modeling is not exact at this point.
- 10) LEED is not delineated as an extra line item in the budget. The additional cost that might be is integrated into the overall building cost. There are some things that are already part of the whole process regardless of the LEED requirements.
- 11) People have been heard but more dialogue is needed, not so much on LEED but about Sustainability. There are green components that are also part of being environmental. Some of that is discussed in the context of the building but necessarily identified as green. We are trying to do what will be viewed as green and at the same time viewed as affording the aspirations of this building. Sustainability is more important than the metric.

Instructions

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Individual Evaluation		
Phase	Survey Item	Rating
D e f i n i t i o n	Library Master Plan, 2002	
	Assess the current state	N/A
	Develop criteria to guide development	N/A
	Planning Diagrams	N/A
	Scope of Work	N/A
	Budget	N/A
	Programmimg & Pre-design, 2008	
	User Needs	2
	Room Program	2
	Cost Model	1
Sustainability Goals: LEED - Senate Bill	3	
Predesign	3	
D e s i g n	Schematic Design, 2008-09	
	User Needs	2
	Sustainability Goals: LEED - Senate Bill	3
	Life Cycle Cost	1
	Constructability	3
	Cost Reconciliation	3

Group Evaluation													
Phase	Survey Item	Facilities Reps			Users			Design Team				CMR	Supplier
		OUA	CPM	FO	Library	IEI	Chancellor's spaces	Designer (Snøhetta)	Executive Architect (PBC + L)	Programmer (DEGW)	Cost (Davis Langdon)	Skanska	HK Systems
Definition	Library Master Plan, 2002	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Programmimg & Pre-design, 2008	2	3	1	3	3	3	3	2	3	2	N/A	1
Design	Schematic Design, 2008-09	3	3	1	3	3	3	3	3	2	2	3	2

Design Team

PBC+L – Executive Architect

Assistant Project Director for the Design Team

Stakeholder Values & Needs

- 1) It was a very good process. The biggest issue we had as the Executive Architect was to come in the middle of the Programming phase. We were not there from the beginning. I believe there are some holes because some of the decisions stakeholders made at that point were not final decisions. There is still some movement in the program, and the reason for that is the given take for cost and trying to establish priorities. It could be improved by doing more diagrams early on; in addition, the process could be improved if all players were involved from the very beginning.
- 2) Each project user is comfortable with what they have in terms of space. I am not sure that they understand the implications of everything they have asked for in terms of an integrated building. They are still thinking of this building as they have a corner, as opposed to the whole idea was a building that brought together these diverse groups. As designers we have not provided users enough information to understand a complete integration.

Cost Control

- 3) There is a cost estimation system from the beginning of SD because of the work done in Programming. We had a target number; the issue is that we were able to check as we went. There was an initial cost set by the Cost Consultant based on building type and project size.

- 4) I do not believe VE can be done much sooner than at the end of SD. SD is a process of exploring and establishing owner priorities. We have an iconic building that we want to be different, it is hard to do VE until we get the building to point it can be grabbed on to. This point would be at least three quarters of SD process. Because of the nature the Hunt Library, it has been a lot harder to define what the building is compared to other buildings.
- 5) There are other ways to reduce costs. Reducing the building system could be an option. There are so many parameters in this building because of the iconic nature, and because of this Energy and LEED certification. These are things the owner (NCSU) has not done yet. We will look at systems later on and make the building more efficient.
- 6) Yes, it is feasible to apply the process for every single item. Right now, the final reconciled budget is over the target. The CMR brought some different alternatives for the design team to look at. So, we are looking at alternative mechanical/electrical systems, and alternative envelope systems.
- 7) Yes, it would be very helpful to have the supplier team on board to give us the design parameters. Having the discussions between the CMR and the cost consultant for the design team earlier, during the time the target cost was set, would bring valuable input because of their knowledge of the local market. The cost consultant has the knowledge of the Designer and the CM has the knowledge of the market. Bringing the two together from the beginning would be very helpful.

Green Building

- 8) The process should be based on benefit/cost analysis. The idea of achieving the LEED certification is to look at the building for the long term and what it contributes to the carbon foot print, and energy efficiency. The owner needs to look at their standards and think about them not in terms of just cost or maintenance cost, but in the long term.
- 9) We are still integrating what we need to do to meet Senate Bill 668 and bring LEED-Silver into the design. The integration has not quite happened, but we are working from different angles.
- 10) I do not know if it is seen as an extra item in the budget. I do not think it has been identified like that. I disagree that LEED is not an extra cost. There is more work on the part of everyone to get the building certified, to do the paperwork, etc. There are more up front costs and someone has to pay for them; although, the long term costs are recoverable.
- 11) Yes, the programming consultant really put the effort to make sure that each user had a voice in developing the program. In addition, Capital Project Management is making sure that the stakeholders are involved as well. As we move forward other stakeholder groups will be incorporated.

MATRIX TO ASSESS THE LEVEL OF PARTICIPANTS' INVOLVEMENT IN THE JAMES B. HUNT LIBRARY

Instructions

- * Find the two tables to be filled: Individual Evaluation (right) , and Group Evaluation (below)
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Phase	Survey Item	Rating
D e f i n i t i o n	Library Master Plan, 2002	/
	Assess the current state	N/A
	Develop criteria to guide development	N/A
	Planning Diagrams	N/A
	Scope of Work	N/A
	Budget	N/A
	Programmimg & Pre-design, 2008	/
	User Needs	1
	Room Program	1
	Cost Model	2
Sustainability Goals: LEED - Senate Bill	3	
Predesign	1	
D e s i g n	Schematic Design, 2008-09	/
	User Needs	2
	Sustainability Goals: LEED - Senate Bill	3
	Life Cycle Cost	1
	Constructability	1
Cost Reconciliation	3	

Group Evaluation													
p h a s e	Survey Item	Facilities Reps			Users			Design Team				CMR	Supplier
		OUA	CPM	FO	Library	IEI	Chancellor's spaces	Designer (Snøhetta)	Executive Architect (PBC + L)	Programmer (DEGW)	Cost (Davis Langdon)		
Definition	Library Master Plan, 2002	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Programmimg & Pre-design, 2008	2	2	N/A	3	3	2	3	2	3	3	N/A	1
Design	Schematic Design, 2008-09	3	3	2	3	3	2	3	2	1	3	3	1

CMR (Construction Manager at Risk)

Skanska

Project Executive on Preconstruction Process

Stakeholder Values & Needs

- 1) As Construction Managers, normally we do not have an active role nor are we on board in the programming phase. Although, based on our observations, we could say that the architect worked very well with the end users to identify all of their needs. For the Hunt Library, this process was very well done. Designers seemed to be very aware about what users' requirements they needed to meet.
- 2) Again, we are not real players in the programming phase. From the interaction we have seen among users, they seemed to be very pleased with the current layout of the building and the amount of space that has been provided to them. There have been some negotiations on the space, but the outcome of these negotiations has been successful.

Cost Control

- 3) For the Hunt Library, we were able to come on board very early in the SD process. We were able to gather information from the design team; we could see what the designer was putting on paper, and so we gave input back to the design team prior the end of SD. You have to get to a point where some schematic design is achieved. If we start trying to change it before that point it will never be finished.

- 4) I think VE truly start when schematic design process is done. It is only at the moment SD hits paper when we can truly start VE or providing feedback. Before SD, the concepts are vague and preliminary for the CMR to have an accurate input back to the design team.
- 5) Reducing the scope of the project would ultimately be the last thing to achieve our goal of meeting a budget. There are so many avenues to meet a budget, e.g., the level of finishes can be changed, the sophistication of the mechanical/electrical systems can vary dramatically, and the structural systems (concrete, steel) can be explored. VE in SD should not focus on reducing scope.
- 6) At SD there are few details definitive, there are some system descriptions, and not many drawings associated to these systems. Starting to get too detailed is getting ahead of us. We want to drive the big picture concept based on the pricing information we had from past similar projects. We can't go to the detail level because SD is just a concept. Therefore, we focus only on the big numbers.
- 7) As far as the supplier; (HK System) is the only supplier for the ARS, so that product was not going to change. I don't think that the supplier has a bearing on cost control.

Green Building

- 8) Green Building has come to the point where people want to have a LEED certification. It is not just a cost of achieving certain points, but looking at the long term benefit of achieving those points.

- 9) I would say yes. Senate Bill 668 requirements are being integrated into SD. About The LEED-Silver certification, the design team has a good idea of where they are points wise. The two aspects have been properly integrated into design.
- 10) My opinion is that a LEED-Silver certification does add initial first cost to the building. It is not seen as an extra item but it is integrated into the building. The level of certification will impact the project budget.
- 11) Being inclusive and collaborative is a positive thing of the owner (NCSU). From my opinion, communication is very good among all stakeholders. The owner tries to bring everyone into the design process.

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	Scope of Work	N/A
	Budget	N/A
	Programmimg & Pre-design, 2008	
	User Needs	N/A
	Room Program	N/A
	Cost Model	N/A
Sustainability Goals: LEED - Senate Bill	N/A	
Pre-design	N/A	
D e s i g n	Schematic Design, 2008-09	
	User Needs	1
	Sustainability Goals: LEED - Senate Bill	2
	Life Cycle Cost	1
	Constructability	3
	Cost Reconciliation	3

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	Programmimg & Pre-design, 2008	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Design	Schematic Design, 2008-09	2	3	1	3	3	1	3	2	N/A	2	2	1