DEVELOPING LEED VERSION 3 BASED ON THE NATURAL STEP AND PROCESS CHANGES

By

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A THESIS PRESENTED TO THE GRADUATE SCHOOL
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To everyone who contributed to my continued education, and helped in shaping my decisions along the way.

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The LEED rating system is a green checklist that gives users the ability to certify their buildings. This system has faced scrutiny due to problems that are inherent in its format and underlying goals. While the system is currently lacking an introduction to The Natural Step may help LEED straighten out some of its issues. The Natural Step is a social framework that allows individuals, organizations, businesses, and governments to practice sustainability. While The Natural Step is not a rating system it maintains some of the principles LEED users feel they do not receive. LEED will be examined in an attempt to create a new version that is based on The Natural Step. To accomplish this goal a procedure to examine each LEED credit and incorporate the principles of The Natural Step will be created. The results show that LEED needs extensive changes in the wording of credits, prerequisites, and the addition of a new process section.

CHAPTER 1
INTRODUCTION

LEED, or Leadership in Energy and Environmental Design, is a process that allocates credits toward the certification of a building. Once the building has achieved a number of these credits, the building becomes certified on one of four levels. The LEED rating system is imperfect however, and opponents to the system feel that owners in an attempt to satisfy credits lose track of the underlying theme of LEED. The theme of LEED is to use the environment only to our needed capacity so that future generations have the same benefits that we had.

The Natural Step is a process that guides people, businesses, communities, and governments onto an ecologically, socially and economically sustainable path. It is a program that is not based on credits, but more on the overall path of your decision making process. The Natural Step looks at strategic management, corporate social responsibility, sustainability analysis, product and service analysis, integration of management systems, networking with other organizations, design for the development of sustainable products, creating order, enhancing communication, supply/value chain, training, and continual learning. It is more of a way of life than a rating system, to enhance and encourage the use of sustainable practices.

With this in mind, the researcher will attempt to look into the underlying themes of The Natural Step, and see if a more comprehensive version of LEED can be developed. One that does not see owners chasing after single credits, but one that allows the owner to incorporate sustainable practices into the lives of its workforce.

Problem Statement

The problem addressed includes the growing issues related to the LEED rating system, and its inability to promote integrated design for green buildings. The rating system allows developers the advantage of gaining the social attributes of LEED without actually designing

buildings that save that much energy. The system currently allows for the collection of credits in a way that no energy saving systems can be involved and a building can still achieve LEED certification. Because of this the system is currently losing credibility. In order to maintain its place in the market the system needs a proven underpinning, and in order to do this the problems with the system need to be established.

The problem was the ability to incorporate The Natural Step into the rating system. While it may be possible to do this, it is important to ask if it is even a good idea? The Natural Step is more of a framework, whereas LEED is a certification system. The two differ completely in their design, thus it may not even be possible to incorporate the two. Ultimately the problem is to incorporate The Natural Step into the LEED rating system to create a better green rating system.

Research Objectives

The purpose of this study was to see if there is a way to improve the LEED rating system with The Natural Step. By researching the topics insight into the advantages, disadvantages, benefits, and needs of each system were analyzed in order to determine a possible path to take. This path would ultimately lead to a seamless incorporation of the two topics, or show the need for overhauls of one or both of the systems.

When addressing the problem it was important to ask: Can these two systems be used concurrently to develop a better system for green building rating? It is also important to determine what would make a system better. The two systems alone both seem to serve their purpose but with flaws. The research was conducted in order to better understand the intricacies of each system, and to determine if there is a better way to reach the goals of each system.

The hypothesis for the research is that the LEED system is too different from TNS. Trying to integrate the systems will not work with the current industry, and forming a better green rating system will have to be done with only one of these systems, or a combination of other systems.

Limitations

The subject matter is fairly new as a researchable topic; therefore limitations are inherent in the process. There is little information regarding the incorporation of green building systems, and this may prove to be a problem in the research of the topic. Due to the limited amount of information there may also be a lack of truly objective information on the subject matter. This may require a subjective view on the information being gathered in order to determine if a new system can be developed.

Contributions

This thesis contributes a new direction of study in the development of green building assessment or rating systems. The body of knowledge regarding the topic was upgraded by attempting to create a LEED system that was based on The Natural Step. Adding a process section for the next update of LEED is also something that has not been looked at before. Current trends in this area show that adding a process section may be beneficial to LEED as it would allow sustainable goals to be implemented in daily activities. This thesis enabled a new line of research for future study.

CHAPTER 2
LITERATURE REVIEW

The topic of study required a solid understanding of both the LEED rating system as well as The Natural Step. The amount of information regarding the two subjects was readily available, however there was very little regarding the ability to incorporate to systems. Because there was a lack of information regarding this area the research focused on three main issues. The focus centered on the history of sustainability, the current state of the LEED rating system, and issues dealing with The Natural Step.

Path Toward Sustainability

The current trend of sustainability seems to be a social effect stemming from years of human pollution, and unethical environmental practices. While this may be partially true, a correct definition of the term is hard to determine. As sustainability has progressed through the years the definition seems to be harder and harder to come by. The term originally came from environmentalists; it has since come to encapsulate a much larger group of people and in fact future generations to come.

The first true definition of sustainability comes from the Brundtland Report, a landmark document in the sustainable debate that took place in 1987. According to the report “Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (WCED 1987). This definition clearly takes a step away from the green debate and looks at the problem as more generational, and long term. By taking an intergenerational stance this definition says use only what is necessary and avoid wasting resources that will pass along bigger problems to the future. In its simplicity this definition offers few limits and the ability for much interpretation. The message, in turn, may

span from the individual living within its own means in its local community to the governmental activities that change the need of world resources.

The Brundtland Report was followed by many new definitions from different organizations that simply reworded and offered a more focused version of the term. Table 2-1 shows many of the definitions that have formed over the years. The table includes information regarding objectives and problems with each definition. While there were many followers the definition from the Brundtland Report paved the way for the sustainable debate and opened the roadways for sustainable thought (Mawhinney 2002).

Now that a definition has been established the next step can be taken in determining what sustainability truly is. The progression of the idea is important as this can be seen in the statement from Mawhinney (2002).

> "It has been noted that the older, greener arguments, which saw sustainable development as concerned solely with environmental issues, have now been replaced by rounder, fuller versions with consideration of social, economic, and environmental aspects of life. From a political point of view this has been useful since it has allowed a wider audience to embrace sustainable development, beyond the earlier devotees who may have become viewed as radical and disruptive" (Mawhinney 2002).

As the political climate regarding sustainability improved, and people began to accept the idea, a need arose as to what the best direction would be that would truly bring sustainability into our lives. In order for a truly sustainable culture to evolve there needed to be a balance in the social, economic, and environmental areas of development.

Beginnings of Sustainability

The idea of sustainability has been around since the 1970's when a group of scientists from MIT got together to model the major trends of global concern. In 1972 they developed the "Limits to Growth" and submitted the report to the Club of Rome (Turek 2006). The Report essentially stated, "If the present growth trends in world population, industrialization, pollution,

food production, and resource depletion continue unchanged, the limits to growth on this planet will be reached sometime within the next one hundred years. The most probable result will be a rather sudden and uncontrollable decline in both population and industrial capacity." While this may seem like an extreme situation the group also offered that "it is possible to alter these growth trends and to establish a condition of ecological and economic stability that is sustainable far into the future. The state of global equilibrium could be designed so that the basic material needs of each person on earth are satisfied and each person has an equal opportunity to realize his individual human potential" (Meadows, et al. 1972). Looking back at the report from present day it seems that the report overstated the problems, and offered a much more pessimistic opinion on the actual problem. The year 1972 also gave way to the UN first international Conference on the Human Environment that brought together leaders from around the world to discuss "the right of all humans to a healthy and productive environment" (Turek 2006).

It was not until the Brundtland Report in 1987 that the term sustainability, or sustainable development, became commonplace. From this point on a seed was planted for anyone who felt the treatment of the environment was becoming a problem. It changed the attitude and atmosphere for future talks on sustainability and brought with it an increased awareness of the subject. There was still little done at this point to stop the problem from getting worse (Mawhinney 2002).

The report successfully changed the political spectrum for the implementation of sustainability; it also provided the basis for the UN Conference on Environment and Development (UNCED) held in 1992. During this meeting 178 countries met "to develop a global consensus on measures needed to balance development pressures against an increasingly imperiled global environment." The most important thing to come from this conference was the

creation of Agenda 21. Agenda 21 was, and still is, considered "the most important agreement related to UNCED. It covers topics on virtually everything regarded important for a sustainable future, ranging from agriculture to biodiversity to hazardous waste to eco-tourism (Turek 2006). Since the 1992 meeting and the creation of Agenda 21 there have been a number of other meetings leading up to the present day. Most have been to check on the status of Agenda 21, and develop better ways of implementation.

Effects of Sustainability Today

Kibert (2005) states that sustainable development is the foundational principal underlying various efforts to ensure a decent quality of life for future generations. This statement illustrates the responsibility of humans to protect the earth for the generations that we bring into the earth. The idea is that our children will have the same opportunities that we have had from the resource we call Earth. In order to fulfill this obligation it is important to understand the problems that humans currently face when addressing sustainability.

In the article entitled "It's the Architecture, Stupid!" Mazria (2003) offers that the main problems are greenhouse gas emissions, a dependence on fossil fuels, and a lack of energy-efficient practices. He states that in order to solve the current problems "what we need is a paradigm shift in the way we view our energy consumption in this country." Mazria feels that small remedies like more efficient cars, and more renewable energy sources are not enough. While each is necessary, they are only small parts of the puzzle.

The biggest problem with unsustainable practices today is that we are focused on areas where nominal reductions in energy consumption and emissions can be achieved. If you take SUVs for example, a major area of concern for environmentalists, and replaced every SUV on the road with a hybrid car you would only see minimal results. This is because every SUV, mini-

van, and light-duty truck on the road today only account for six and a half percent of the total U.S. energy consumed (Mazria 2003).

"Those who develop and promote the framework for environmental initiatives have boxed us into a narrow view of the problem, thereby limiting the scope of potential solutions." This is a major problem and it is difficult to become unstuck on a certain issue after resources have been poured into solving the problem. Therefore it is important to look from the outside in when it comes to the large-scale problems that sustainability addresses (Mazria 2003).

The Big Picture

The best way to look at a large-scale problem is to break down the problem into smaller sections to analyze where the real problem exists. In order to do this with sustainability issues we would first need to look at the world as a whole. Countries in Europe, Asia, and Australia for example are heavily involved sustainable practices. As Americans we do not have control of the entire world so it would seem logical to look at the nation first. The U.S. is also a good candidate for this type of exercise because according to the Union of Concerned Scientists (2005) the U.S. is the number one producer of carbon dioxide emission in the world.

The next step would be to look at the industries that consume the most energy in the nation. According to Mazria (2003) this can be broken down into four areas: industry, transportation, residential, and commercial. This can be seen in Figure 2-1. Mazria breaks this down even further by combining the residential and commercial sectors to show a new picture seen in Figure 2-2. In the new picture, "Architecture consumes approximately 48 percent of all the U.S. energy produced and is responsible for 46 percent of all U.S. carbon dioxide emissions annually. It is also the fastest growing energy-consuming and emissions sector" as seen in Figure 2-3.

Based on these figures it seems that a change in the buildings and architecture would have the biggest impact on the U.S. While building codes are designed to set a minimum standard for the building we live and work in, they have actually had a minimal impact. “In fact, U.S. energy consumption per square foot of building has been increasing slightly since 1990, a testament to the fact that building codes have not been effective in stimulating further reductions in the Architecture sector.” So how can the problem of energy consumption be resolved? It would seem that the building design is the answer. Structures are designed to be isolated from the environment; they require an uninterrupted power supply in order to operate. Without this power supply they are unusable (Mazria 2003).

The current state of architectural education does not really take these issues into account. It is a profession that is constantly updating but, as Mazria (2003) states the “architecture inherited from our predecessors is no longer valid today. The global problems we now face provide the basis for a new architecture and a dialogue with nature that will give this new architecture its uniqueness.” From this point Mazria (2003) goes to lay out three steps that would allow for architecture to update itself with the current needs of sustainability:

- Energy consumption reductions for government owned buildings are implemented in 2004.
- Energy consumption reductions for all buildings are implemented by 2007.
- The 15 percent embodied energy reduction for all buildings is implemented over a five-year period, beginning in 2005.

Obviously the dates have not been met, but the ideas may still useful. No matter when the program can be put in place the implications could be huge, see Figure 2-4.

Leadership in Energy and Environmental Design

According to the United States Green Building Council (USGBC) (2003) building has a huge impact on the environment. The U.S. Department of Energy (DOE) has stated that the United States buildings consume over 30% of our total energy and 60% of our electricity

annually. Five billion gallons of potable water are used to flush toilets daily. A typical commercial construction project produces up to 2.5 pounds of solid waste per square foot of floor space. These buildings are a major source of pollutants that cause air quality problems and contribute to climate change. The DOE states that buildings account for 49% of sulfur dioxide emissions, and 10% of particulate emissions. Buildings also produce 35% of the country's carbon dioxide emissions, a gas that directly relates to global warming. The USGBC (2003) states that by the year 2010, another 38 million buildings are expected to be built. By building green we can substantially reduce the impacts of the building sector on the environment. Green buildings also reduce operating costs, enhance building marketability, potentially increase occupant productivity, and create a sustainable community.

The LEED Rating System

The USGBC was a huge proponent of the green building movement. Through their best efforts they realized that in order to make green building mainstream they needed an instrument to make green building more attractive. So they analyzed the current situation and saw where problems towards the movement existed. The problem they realized was that there was no way to determine if a building was in fact green or not. The limits on how to determine the greenness of a building did not exist, and there was a definite need for a common standard. What they created was the LEED Rating System. The rating system was designed to help the industry grow and offer a new face to green building. It answered the demand for reliable information on the green building process. Based on a rating system and green checklist the LEED system began its development. The hopes of the program were to transform the design and construction of commercial buildings (Schendler 2005).

The LEED Green Building Rating System provides performance standards for certifying the design and construction phases of multiple building types. LEED for new construction is

mainly geared towards commercial, institutional, and high-rise buildings. Credits in the rating system provide guidelines for the design and construction phases of both public and private buildings. “The intent of LEED for New Construction is to assist in the creation of high performance, healthy, durable, affordable and environmentally sound commercial and institutional buildings” (USGBC 2006).

LEED is broken into 69 credits that are distributed through six areas. These six areas have been determined by the USGBC to be the most important areas of green construction. The areas are as follows:

- Sustainable Sites
- Water Efficiency
- Energy & Atmosphere
- Materials & Resources
- Indoor Environmental Quality
- Innovation in Design

Each area contains a portion of the 69 credits including a series of pre-requisites for most categories. By attaining the pre-requisites the building may go on to achieve a level of certification. There are four levels of certification a building may achieve and they are broken down as follows:

- Certified 26-32 points
- Silver 33-38 points
- Gold 39-51 points
- Platinum 52-69 points

If a building achieves these levels of certification the USGBC will recognize the building as certified with a formal letter of certification ad a mountable plaque (USGBC 2006).

In order to gain LEED certification a building must first apply for the process. To do this the team must first register with the USGBC. Fees for registration and certification can be found in Table 2-2. By registering team members establish contact with the USGBC and gain access to

online software, communications, and other information. After registration is completed the design team should begin collecting submittal information and other required LEED information. Information can be submitted through the web in a two-phase application process. The first phase includes the information gathered in the design phase. The second phase includes information for all credits that could not be submitted in the first phase. Once all the necessary information is received by the USGBC a review of the submitted material is performed. The project must satisfy all prerequisites and a minimum number of points for project rating. If a project does not meet the minimum number of credits needed for certification appeals may be filed with a fee (USGBC 2006).

"LEED is a design process that should, reduce operating costs and pollution, help address global warming, improve marketability and durability, preserve the ozone layer, protect occupant health, and improve worker productivity" (Schendler 2005).

Problems With LEED

The intentions of the LEED system were to offer a way for developers to easily implement green strategies on new projects. The system was to allow the creation of more efficient buildings, and reward the efforts socially as a LEED certified building. Somewhere along the way the process faltered. Schendler (2005) states that from 2000 to 2005 LEED certified fewer than 300 buildings, with over 2,000 registered but never reaching certification. During that time another rating system certified over 20,000 homes. Under its own power LEED has become costly, slow, confusing, covered by a seemingly bureaucratic rule. These problems add difficulty to the green building process that is difficult enough already.

A number of major problems have surfaced through the LEED process. Testimonials and case studies were collected by Schendler and Udall (2005) stating five of the major issues current users of the system feel need to be taken into account:

- Problem 1: LEED Costs Too Much
- Problem 2: Focus on Points Rather than Sustainable Buildings
- Problem 3: Energy Modeling is Fiendishly Complicated
- Problem 4: Crippling Bureaucracy
- Problem 5: Overblown Claims of Green Building Benefits are Misleading

These problems lead to a rating system that does not necessarily reflect a building's greenness, and lead to industry professionals looking down on the LEED process.

Possible Remedies

Schendler (2005) comments that the most useful tools are the ones that are designed to be easy to use, while improving accuracy and productivity. The LEED system at current is a difficult, timely process relying on confusing modeling equipment. To make matters worse the review and credit interpretations are short, and offer little to no advice on correcting the problems.

What is happening is that that the difficulty and cost of the process is making it more trouble than it is worth to become LEED certified. Even professionals that have already completed LEED projects and are familiar to the process find that the learning curve is non-existent. It does not become easier from job to job. If this were the case then the initial costs of mastering the process would be worth it. Unfortunately this does not seem to be happening.

In order to the make the process better Schendler (2005) offers ways to improve the current process. One step would be to make more key points mandatory. This would reduce the alleged point mongering and allow the focus to be on a more efficient integrated design. The next change would be to simplify the energy modeling protocols. The modeling tools are extremely difficult to use and learn. This discourages developers to go after the ten most important credits of the entire rating system. The ten energy credits encourage drastic reduction in building energy use,

and can save the most money for the building owner as well. Another change would be to reduce the amount of paper submissions, and encourage the reviewers to make onsite-rating decisions. This would personalize the process by allowing the reviewers to experience the site and see for themselves what has actually been attempted. This allows the subjective opinion of the LEED expert to be added into the credit interpretation. While these are minor changes a major revamp of the whole system may be needed.

The essence of the LEED system is being lost in the current process and until the correct changes can be made the LEED system will continue to lose credibility among industry professionals. It was an innovation in the industry and not all innovations succeed. The idea is great, but the execution has lacked thus far. “The system is not a roadmap to the optimal cost-effective, energy-efficient building, and it doesn’t necessarily encourage integrated building design” (Schendler 2005).

Flaws and Needs of LEED

The building sector uses 30% of total energy, and 60% of electricity annually. These facts give a clear understanding as to why it is important to build sustainably, because buildings use the majority of energy in the United States. The LEED rating system was developed by the USGBC to offer a way to inform developers of the ability to build green. The system does this, each area is clearly delineated and broken down into a number of credits. What the USGBC did that was even more difficult was to create an aura of social responsibility around the LEED rating system. This enabled the system to become commonplace in the industry. Developers wanted the LEED rating system because it made them appear caring, and responsible. It did not matter if developers actually cared that they were building green or not, what was important was that they were doing it (USGBC 2006).

The users of LEED are failing to achieve certification, and with the failed efforts come problems the users see in the system. These problems relate to the cost of the system, the need for a system that is integrated with the design of the building, the complexity of the calculations, the lack of support from the USGBC, and misleading claims of green building. The cost of the system is truly a hindrance to projects wishing to reach LEED on a limited budget.

Although it does take time and money to review each project users feel that money spent on LEED can be spent better on additional green elements. This is leading to a breakdown in the desire to gain LEED certification. Prohibitive costs are something that cannot really be taken away, while users feel that it is taking away from gaining certification, if the building was designed to be LEED from the very beginning the costs should have been factored in. If the costs are not a surprise then they should not be a problem. While there are arguments for both sides the high costs can be directly related to the feelings of lacking support from the USGBC.

Applicants for LEED certification are given the resources of the USGBC to finish their project and gain as many credits as possible. The resources they are offered are mainly web-based and in the form of credit books and past credit interpretations. Users are also offered two free credit interpretation requests. Any more over the allotted two cost the users for an interpretation that may not be applicable. Furthermore reviews of credits are often short and offer no way to remedy the failed attempt. Users feel that with the high cost of the program should come increased support and monitoring from the USGBC. The ability to talk to someone could be incredibly helpful in trying to fix inadequacies of failed credits.

Each problem that users find can be related back to the fact that LEED does not offer an integrated design approach. It is simply a list of credits that the project will either reach or not. There is a desire for LEED to offer the ability for users to begin the design with LEED as an

integral part of the process, not simply something that is in the back of everyone's mind. This is the point where LEED needs to be restructured. The initial versions of LEED did there job in gaining market use and support. It is now time for LEED to move on to the next phase and allow users to complete truly sustainable buildings, not just those able to meet enough of the easiest credits.

The Natural Step

The Natural Step (TNS) was developed in 1989 by a Swedish oncologist named Karl Henrik Robert. Robert determined after working with cancer patients that it was the destruction of the human environment that was leading to terrible consequences for humankind (Kibert 1999). "The extraction of resources such as fossil fuels and metal ores from the planet's crust produces carcinogens and results in heavy metals entering the Earth's surface biosphere. The abundance of chemically produced, synthetic substances that have no model in nature have similar deleterious effects of materials practices on our health" (Kibert 2005).

The beliefs and observations of Robert lead to the design of TNS, once formed TNS began as an organization that helps other organizations move toward sustainability. TNS allows people to focus on sustainability in a work setting and it is something that allows people to become easily involved in. It simply takes a commitment from the individual, but first from the organization to take on sustainable issues.

The Natural Step enables organizations to incorporate sustainable practices into the organizations strategic planning. In order for TNS to work there need to be certain goals and objectives for organizations to reach. TNS does this through four main objectives:

- Eliminate our contribution to systematic increases in concentrations of substances from the earth's crust.
- Eliminate our contributions to systematic increases in concentrations of substances produced by society.
- Eliminate our contribution to systematic physical degradation of nature through overharvesting, introductions and other forms of modification.
- Meet human needs in our society and worldwide, over and above all the substitution and dematerialization measures taken in meeting the first three objectives.

By allowing organizations to try and meet these goals TNS gives committed organizations something that is achievable, and real. The four objectives relate to the Earth's natural cycles, and the human societies impact on them. They attempt to create an integrated system where humans are a part of this natural system, see Figure 2-5.

The integrated system diagram offers a clear visualization of the paths of nature and humans, and shows how the interaction affects each part. By doing this individuals may begin to realize that there is a bigger picture involved in their daily activities. The four objectives may allow these individuals to see that simply trying to fix the symptoms is not enough, in fact it may shift their focus to the underlying social and environmental problems that are really plaguing the Earth. This decreases the complexity of the problem because attacking the source is easier than simply cleaning up the damage that has already resulted.

TNS is based on the quest for good health, welfare and economic prosperity. As nature offers humans the ability to reach these goals it is unfortunate that we are destroying the very systems that we depend on. We are degrading nature's short and long-term productive capacity, and at the same time introducing more and more people that are dependent on the system. We use up renewable resources at a rate that nature does not have time to build new ones. It seems that we are moving into a funnel, seen in Figure 2-6. The funnel includes everyone, from small

families to large corporations, and it demonstrates that we have less and less room to maneuver. The range that it affects is important because it has a direct bearing not only upon us as a society, but also upon the economy.

This is why it is important to change not just the way we live our daily lives, but also the way the country does business. Business owners need to still focus on their company's profitability, but not at the expense of a long-term potential disaster. While short-term losses may be perceived as a bad decision, or due to a circumstance that was out of the companies hands. It may actually have been caused by an earlier investment that contributed to ecological non-sustainable needs (TNS 2000).

The Natural Step Framework

The idea of TNS is something that must be implemented with a solid, proven system that organizations may easily incorporate into their daily routines. To do this a framework was established, TNS Framework offers a methodology for the organizational planning needed to fully implement the program. It enables an organization to integrate business development with sustainability, a strategic approach that will benefit the inevitable reduction in supply from nature. Organizations can improve their future benefits based on changes in:

- Raw material costs
- Energy costs
- Cost of waste
- Environmental legislation
- Differentiated taxation
- Insurance premiums
- Credit ratings
- Customer needs
- Employee needs
- Brand value drivers

TNS Framework has allowed organizations to reduce costs, improve quality and productivity, identified new customers and markets, and avoid future liabilities (TNS 2000).

Backcasting – Strategic Planning for the Future

In order for TNS to function as planned the user must do some careful planning as well. TNS refers to this method of planning as backcasting. Instead of looking at short-term issues and trying to accommodate the business based on these problems, TNS begins by determining what the business should look like in the future. The basis of backcasting is to focus on the causes of environmental and social problems rather than reacting to the effects of them. The future result should be based on the four objectives of TNS, but each business will differ in that the objectives are formed to meet the individual businesses needs. So once this future picture has been determined you must ask the question: What can we do today to reach that result? This allows your short-term strategy to align with your long-term vision. This is probably something many businesses feel they already do, but it is important for organizations using TNS to understand that they cannot strategically pursue a future vision based on this framework without doing this.

There is difficulty however in determining these future goals, or as TNS refers to them as 'system conditions.' The main difficulty being that even the scientific community cannot agree on the actual degree of the futures problems. The system conditions then should not be based on any one specific problem, rather upon basic conditions that a sustainable society needs to operate. These basic needs allow users to backcast with confidence from a future sustainability perspective.

This process in theory should take the basic system conditions combined with the backcasting method to create long-term flexibility with short-term profitability. By aligning organizations with these system conditions the complexity of incorporating numerous organizations becomes simplified. It would be near impossible to create a system that attempts give each and every organization a detailed view of what they should be doing. So TNS allows

the organizations involved to make their own business decisions but simply adds some defining principles to their overall vision.

Steps of Using the Framework

The idea behind TNS seems great but implementing it into a workplace that has already established principles and workflows is another story. TNS Framework offers a method to do this and further as to how to incorporate the programs ideals into the organization. This is done through a series of four steps the first being to find common ground. The second step asks the question: What does your organization look like today? The third step builds off the second in that you ask the same question but based on a sustainable society, and the final step is to prioritize and manage (TNS 2000).

Finding Common Ground

The U.S. offers a population with varying ideals and opinions. The opinions for environmental controls are no different from a country's varying opinions on war, abortion, or the economy. The state of global warming has faced two varying opinions in the U.S. and the world. One group states that if something is not done soon the Earth could be facing devastating problems in the not to distant future. While the other side believes that it is simply the Earth's cyclical patterns and that there is no apparent problem. Some have gone so far as to say "much of the debate over global warming is predicated on fear, rather than science." A comment from Senator Inhofe stirred much debate from the scientific community as he continued by calling the threat of global warming the "greatest hoax ever perpetrated on the American people" (Mann, et al 2005).

These differences of opinion on the national level are generally no different at the local work level either. So it is important to incorporate TNS with a top down approach. The owners of the company must buy into the principles of TNS first and show their commitment to the

workers of the organization. There are likely to be some that do not buy into the program and that is fine, the key is to have a workforce that is dedicated to the ideals of TNS.

Once the workforce is ready to take on the ideals of the company the next step can be taken. The organization needs to create systems thinking to allow for an understanding of the goals and approach to the problems. The systems thinking should be based on the basic principles of the organization followed by the smaller details. The details include issues like value judgments, priorities, design solutions, and behavioral changes that need to take place. These basic principles create rules that the organization lives by, and govern how the system operates. These rules allow the individuals to be innovative as they determine the best way to operate under the system (TNS 2000).

What Do Your Operations Look Like Today?

Every organization today can be viewed as a box with inflows and outflows that are based on the organizations needs and supply. Nothing will disappear inside this box as everything that moves in must come out in one form or another. So to answer this question the organization needs to map the critical flows and practices in regards to the sustainable objectives of the organization. The box gives a visual picture of how the raw materials and energy flow into the box, and then eventually come out in the form of products, services and waste. Figure 2-7 shows an interpretation of these energy flows.

This question is not to be answered by the owners of the company, but rather by all the employees as well. This allows the workers to identify the problems, and it also allows them to create, develop, and implement specific solutions. By giving the employees ownership in the process, it creates a desire for each individual to follow the rules and solutions they create. The solutions should be based on the four sustainability objectives of TNS. By taking the objectives into consideration the organization should be able to reduce the use of resources from the Earth's

crust, decrease the use of potentially toxic man-made substances, reduce the dependence on processes that degrade the Earth's resources, and reduce practices that lead to irresponsible treatment of humans impacted by the organization (TNS 2000).

What Does Your Organization Look Like In A Sustainable Society?

This question needs to be asked in order for the organization to 'lift its vision' and answer questions about the organization in a way that is free from preconceptions of current reality. This may lead to a series of new questions based on the role of the organization in a truly sustainable society. It is good for the individuals to determine what it is the company actually does. Not what they do on a daily basis, but what the company offers the outside society.

The next step is to list every possible connection between the vision of the organization in a sustainable future, and the current state of the organization. The newly planned strategies should be based upon the four objectives of TNS. It is important to document each area that is addressed. This step of the process is imperative in that it is dependent on the second step and it directly correlates to the final step (TNS 2000).

Prioritization and Management

This step determines how the organization ultimately moves towards sustainability. By using measures answered in the third step the organization can begin to choose the measures that will help them move toward sustainability quickly and profitably. To do this the previous questions need to addressed based on the following three questions:

- Are we backcasting from our objectives when prioritizing this measure?
- Are we creating a flexible platform for further improvements?
- Will the measure bring quick enough financial returns?

By looking at these questions and determining which previous measures will provide the best fit the organization can begin developing a concrete strategy. This strategy will prioritize the

previous measures to provide the most financially viable and sustainable goals, without losing flexibility in the market or future profitability. This process offers the possibility of long-term sustainable and financial success (TNS 2000).

Combining The Natural Step with LEED

The LEED system has been very successful in introducing the need for green building in the United States. Prior to its inception there was no real tool that could be used to inform developers of the need for green building. There was scientific fact, but no one was able to develop a system that could be user friendly and informative at the same time. So when the USGBC developed LEED they knew that they needed a system that would inform users of a wide range sustainable needs. They also did a good job of creating social awareness by adding the social benefit of obtaining LEED certification. As the system evolved users became more aware of the need for sustainability and began to realize that LEED had some serious shortcomings. These shortcomings included a lack of quantifiable relationship between points and environmental impact, a 'one size fits all' design, and a lack of scientific backing (Zimmerman, Kibert 2006).

What LEED attempts to do is "bring together the science of sustainability and the needs of the market. The market aspect, however, dominates and the science get much less emphasis." Zimmerman (2006) states that LEED has provided three key requirements for organizational change:

- Provided a shared mental model of green building in the United States.
- Explicitly targeted a market to use the new techniques.
- Established a management structure and support system to expedite change.

While LEED has established some good, concrete needs it has failed to integrate the scientific approach that serves as evidence that the system is truly needed. Opponents of the system have

stated that there is a “lack of credits dealing directly with practices that impact climate change and failure to address persistent organic pollutants. Others have argued that issues are weighted inequitably.” Some believe that “by focusing on impacts, in effect rewards incremental solutions and does not adequately recognize major, step-change or paradigm-shifting advances.” The system was designed to offer investors the ability to pick and choose what best fits their financial needs. The mix of credits gives that option but also leads to problems with the system (Zimmerman, Kibert 2006).

The LEED system has created awareness of the needs for sustainability but has done so in a way that users tend to focus on the credits individually. “LEED is structured primarily around environmental impacts, which tends to lead to end-of-pipe mindsets and incremental solutions.” These ‘incremental solutions’ move away from the purpose of sustainability and allow for essentially unsustainable green buildings. This presents a need to align LEED with a system that can pick up these shortcomings, without compromising its achieved success. The Natural Step is an approach that provides a well-regarded, scientific complement to add to LEED (Zimmerman, Kibert 2006).

The Natural Step, as discussed earlier, is a system that has been developed and reviewed by multiple scientists from around the world. What is interesting about the approach is that there has been remarkable agreement between these scientists on the tools for understanding and managing sustainability:

- A common physics-based definition of sustainability.
- Hierarchical principles to understand what is needed to plan and work towards sustainability.
- How a given framework fits with other frameworks.

The common consensus of TNS enables the ability to take a system that multiple members of the scientific community agree upon, and confidently use the system to update LEED.

Zimmerman (2006) believes that the work on TNS gives us two ways to inform the next generation of LEED. The first uses TNS as a filter to make sure the requirements of LEED align themselves with the overall needs of sustainability. The second, as a way re-wording the language of the credits to ensure that users are delineating from the use of specific objectives, and rather viewing them as a whole process.

In order to use TNS the creators developed a hierarchy of different system levels to incorporate into a complex system. These levels are based on the four system conditions of TNS previously discussed:

1. Principles for the constitution of the system.
2. Principles for a favorable outcome of planning within the system.
3. Principles for the process to reach this outcome.
4. Actions, or concrete measures that comply with the principles.
5. Tools to monitor and audit the relevance, and status of the system.

When LEED is analyzed based on the hierarchy Zimmerman (2006) offers that levels two through five can be easily covered, see Figure 2-8. Because LEED can cover so many of the principles it makes it easier to understand how it gained so much success in the marketplace.

> "Within one tool, sufficient definition of the impacts and rationale for appropriate action presented, along with practical actions that can be taken, that users can immediately understand how to move forward on their projects. Assessment is related to existing standards and guidelines, which reduces the learning curve, and the market recognition of graduated progress provides tangible incentives beyond the intrinsic satisfaction of doing the right thing" (Zimmerman, Kibert 2006).

While Figure 2-8 only analyzed how LEED works based on the hierarchy the next step is to inform LEED even further with the hierarchy. The hierarchy can better align LEED with sustainability by reviewing the existing credits, identifying the proposed system condition the credit should be aligned with, re-wording the intents of each credit, filtering the appropriate process for the completion of each credit, and finally ensuring that the actions reflect the principles they are associated with. This can be seen more clearly in Figure 2-9. This process

allows LEED to incorporate the scientific underpinning of TNS and ultimately achieve more credibility in the green building community. The shortcomings of LEED may disappear as TNS helps to satisfy the needed links between sustainability and building.

Zimmerman (2006) goes on to offer an example of the process by showing how the re-wording of a credit incorporates TNS. The credit re-wording relates to energy & atmosphere credit 2 for renewable energy, and energy & atmosphere credit 6 for green power. More information on the credits can be seen in appendix A. The re-wording combines the two credits in a way that encourages whole systems thinking relating to the process. The original wording is as follows:

- Energy &Atmosphere Credit 2
    - Intent – Encourage and recognize increasing levels of on-site renewable energy self-supply in order to reduce environmental impacts associated with fossil fuel energy use.
    - Requirements – Supply at least 5% of the building's total energy use (expressed as a fraction of annual energy cost) through the use of on-site renewable energy systems.
- Energy & Atmosphere Credit 6
    - Intent – Encourage the development and use of grid-source, renewable energy technologies on a net zero pollution basis.
    - Requirements – Provide at least 50% of the buildings' electricity from renewable sources by engaging in at least a two-year renewable energy contract. Renewable sources are those that meet the Environment Canada Environmental Choice programs' EcoLogo requirements for green power supplies (Zimmerman, Kibert 2006).

This wording is straight forward, right to the point, and states what is needed to achieve the credit without offering the whole system view that the system should be attaining. The proposed re-wording incorporates this need by combining the two credits:

- Objective – Eliminate humanity's contribution to systematic increases in concentration in the ecosphere of substances from the Earth's Crust.
- Intent – Increase the rate of substitution of fossil fuels by renewable energy from the lowest LCA source.
- Indicator – Renewable energy supply, characterized by LCA impact

- Requirements – Supply at least xx% of the building or project's total energy consumption with renewable energy, chosen from the alternative with lowest LCA impact of those available (Zimmerman, Kibert 2006).

Zimmerman (2006) proposes that there are several advantages the new approach offers. The system: provides awareness and education on a deep level to the industry, allows solutions to move faster in the direction of problem solving, takes a physics-based approach so that the end objective is more easily understandable, offers a more integrated set of credits and issues with a goal of satisfying the system conditions, can withstand criticism because science is more easily defendable. While there are alternative frameworks TNS seems to offer a subjective science based approach to an objective and somewhat qualitative LEED rating system (Zimmerman, Kibert 2006).

Sustainable Paradigm Shift

The current view of building today is a combination of owner, architect, engineer, and builder. Each group has its own responsibilities and follows its respective directives toward a common end goal, which is the completion of the project. This is not uncommon to see in any industry be it auto manufacturing, or toy making. Most people view the earth as a set of individual systems working interdependently, and the result of the systems is the environment that we live in. This view is essentially a fragmented view of the earth and its systems. There is a failure to see what is happening as one large single system. Although this large system has individual parts each is working in conjunction with the next to create the whole.

Reed (2006) states "the shift from a fragmented worldview to a whole systems mental model is the significant leap our culture must make – framing and understanding living system interrelationships in an integrated way." The living system Reed speaks of is what humans fail to realize we are a part of. If we do realize we are a part of a living system then we fail to act

accordingly. Even in the area of green building architects address efficiency, yet they fail to act sustainably in the decisions they make. “It is time to change our mental model to one that a) better reflects the new sciences’ understanding of how our universe actually works, and b) enables us to design, build, and heal with the whole system in mind – a deeply integrated worldview” (Reed 2006).

Creating the Shift

Reed (2006) explains that there are multiple ways to change systems. The ways that are currently being used to change these systems are in fact the most ineffective. In order to convince an investor today to use his or her money for something that is more sustainable all you have to do is show the invest concrete evidence that it will make more money. Sustainable development is difficult to show concrete evidence because it is a fairly new process, and there is a level of risk associated that the investor may not want to take on. It is perplexing that the essentially short term risk of investing in a new technology is more important to the investor than the long term risk of potentially dangerous consequences. This is where the problem persists.

The problem is that we are offering a way to change the system based on numbers that just are not there. There simply has not been enough time to see if it works, and according to Reed (2006) the use of numbers is the slowest way to change a system. “Typical green building discussion begins and often ends with a discussion of costs and quantitative benefits of a green approach. The discussion is rarely about a new mental model, it is simply about addressing the status quo in a more efficient manner.”

So it seems that the fastest way towards a paradigm shift is by attempting to change the ‘mental model’ of the society. If an investor truly believes that a sustainable development is the way to go then there will not be a discussion as to why it should be sustainable, but rather how to make it more sustainable.

> "The sustainability movement to this point has been remarkably ineffective at sustaining the small victories it has achieved. It is slow, fragmented, and insufficient. Changing our current mental model is the only way we can achieve the permanent and continuously evolving change – change to higher orders of thinking and understanding, that is required to reverse the damage resulting from our old mental model and 'sustain sustainability'" (Reed 2006).

The mental model is what binds the society into a way of thinking. This way of thinking is currently going in the wrong direction. It will not be easy to change either as it dates back to the beginnings of the industrial revolution, and the dawning of capitalism. However the change is very necessary, and the mental model approach may be the best way to change the current paradigm of building towards sustainable building.

Whole Systems Thinking

The whole systems thinking approach is a way to teach or influence individuals to consider their actions based on the greater good. Decisions in the building arena are often decided on by analyzing the best or cheapest way to complete a project. This is not sustainable thought and whole systems thinking is not being considered. Reed (2006) states that sustainability is not a static condition that can be reached based on simple guidelines. Rather it is a process that must be undertaken.

> "It is also necessary to learn how to participate in partnership with the other systems of life in a mutually beneficial dance of relationship building. This means engaging in a continuous, intentional process of understanding how life works for the benefit of all its aspects, creatures, and elements, and how we can engage with this system in an ongoing, healthy, evolving process. Sustainability is a progression toward a functional awareness that all things are connected; that the systems commerce, building, society, geology, and nature are really one system of integrated relationships; that these systems are co-participants in the evolution of life" (Reed 2006).

This statement shows that there is a larger picture than that of a simple money saving decision. Our decisions need to be based on a partnership of all aspects of life and move towards an integrated system of decision-making.

The whole systems thinking realizes that everything is interconnected, this is very different from most current thought processes. Currently we focus on closed systems, this can be seen in the way projects are completed today. There is a total focus on the site work, then the foundation, then the structure, etc. The whole systems approach would have individuals constantly interacting with one another in an effort to integrate the different systems in a unified process.

Green building has not taken into account this whole systems approach. There is more focus on the "technical and economic systems when designing, constructing and managing our human habitats" (Reed 2006). This is part of the reason that green building has yet to take off in the United States. Designers, and builders have yet to come up with a way to truly integrate the design of buildings in a way that is sustainable. This happens because they are too focused on the bottom line or one particular aspect of the building and they cannot work together to create a truly sustainable building. "When we begin to understand that the purpose of sustainability is sustaining life enhancing conditions," and we can truly integrate our buildings to function in this manner then we will have reached a point of neutral sustainability.

Figure 2-10 shows how sustainability is only a period of neutrality in the green building movement. Either side of neutral in the figure is still better than current practice but it is not until work on both sides of sustainability is done that society can become environmentally neutral.

The Whole Systems Process

The concept of whole systems thinking is simple enough. Convince enough people that they need to consider more than themselves and their business in the decisions they make. Ultimately we will experience a society that has embraced the approach. This is easier said than done. We must first gather an understanding of the core values of each endeavor we consider. This process should be aligned with whole systems thinking. Once the core values have been derived we must carefully consider the environment that the project will be placed. Can we

support the system and can the system support us? This enables us to understand the living system of the area we are about to change, and incorporate the project accordingly (Reed 2006).

The next major step in the process is to create a framework for the project design. This task is done to "translate it into a conceptual design and a set of design guidelines. This serves as the framework or container for decisions made in the subsequent stages – design, selection of appropriate green materials and technologies, construction, operations, and long term operation and maintenance" (Reed 2006).

The conceptual design comes next in that the design team can build upon the values and knowledge of the area they are now working with. The team can now respond to real issues of the environment and aspirations of the people in relation to the opportunities and limits of the place. The team must realize that this is a regenerative process in that they must constantly be thinking about the prior steps or the process will be lost. "Their work demands a continuous balance between visionary ideas and day-to-day needs. The most successful projects were projects in which the client had already made the worldview leap or were working on their own personal development" (Reed 2006). So it is important that not only the design and building teams are involved in this process but that the owner is also vested in the process. The approach will not work without whole systems thinking from each team member.

Once this process is near completion the team needs to identify indicators that will keep the process in line. Benchmarks can be used to measure levels of improvement needed for the project and they should follow the desired relationships of the project. Monitoring the work is an essential element needed if the process is to evolve. This is a support structure that will lead to the development of conscious engagement and deeper relationships between people and place. As the project moves into the building phase "continuous monitoring and measurement involves

engaging the ‘community’ as participants as the place evolves.” The team “holds the long term aspirations for the project/community, and supports and facilitates the iterative cycles of action, reflection, dialogue as a means of deepening place connections and growing understanding and mutual caring” (Reed 2006).

Table 2-1 Definitions of Sustainability (Mawhinney 2002)

Definition	Message	General Objectives	Difficulties
Brundtland	Intergenerational legacy Constant development	Development on needs only with minimal damage basis	How do you measure needs of the future? Does not address scale?
National Strategies for Sustainable Development	Socio-economic development Intergenerational legacy	Similar to Brundtland but narrower base	How do you measure needs of the future?
UK Department of Environment, Transport and Regions	Social progress, economic growth, environmental and resource protection	Balance of interests	Compromise and conflict – who decides priorities?
Giradet	Citizen need and well-being Environmental protection	Equity and avoid damage to others	Who organizes the operating system?
Wackernagel and Rees	Equitable living Environmental Protection	Acknowledge the limits of resources in equitable manner	Who decides and who organizes? – evidence base?
Robert et al.	Limits to natural resources	Acknowledge the limits of resources	What are the socio-economic effects of this?
Pearce et al.	Equal access to resources across generations	Acknowledge the limits of resources in equitable intergenerational manner	Who decides and organizes? – evidence base?

Table 2-2 LEED Registration and Certification Fees (USGBC 2006)

LEED Registration & Certification Fee Summary			
Registration Fees			
Charges		Fixed Rate	
Members		$450.00	
Non-Members		$600.00	
Certification Fees	Less than 50,000 sf Fixed Rate	50,000-500,000 sf Based on sf	More than 500,000 sf Fixed Rate
Design Review			
Members	$1,250.00	$0.025/sf	$12,500.00
Non-Members	$1,500.00	$0.03/sf	$15,000.00
Construction Review			
Members	$500.00	$0.01/sf	$5,000.00
Non-Members	$750.00	$0.015/sf	$7,500.00

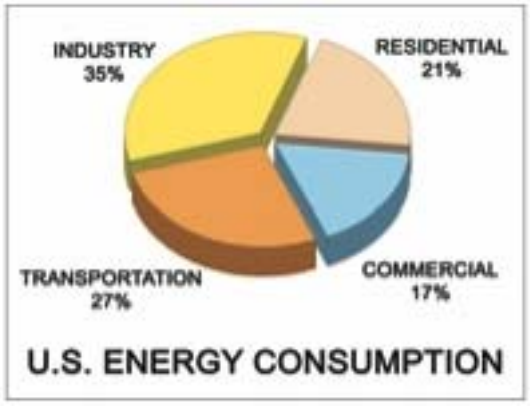


Figure 2-1 U.S. Energy Consumption by Sector. Reprinted with permission from Edward Mazria. Mazaria, E. (2003) "It's the Architecture, Stupid!" *Solar Today*, May-June, 48-51 http://www.mazria.com/ItsTheArchitectureStupid.pdf April 2007

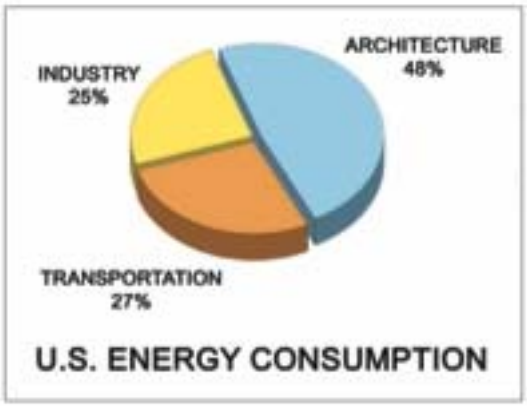


Figure 2-2 Energy Consumption with Building Sector as Architecture. Reprinted with permission from Edward Mazria. Mazaria, E. (2003) "It's the Architecture, Stupid!" *Solar Today*, May-June, 48-51 http://www.mazria.com/ItsTheArchitectureStupid.pdf April 2007

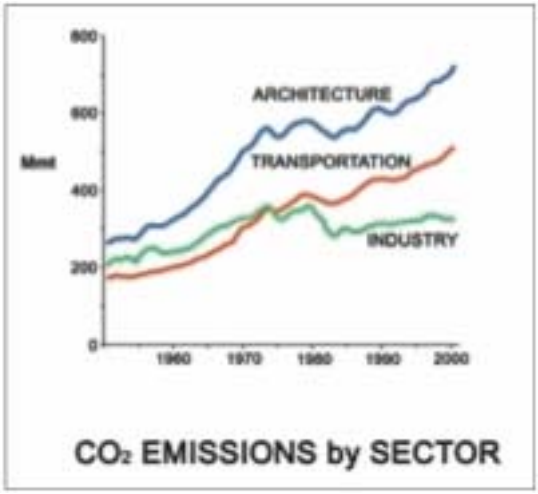


Figure 2-3 Carbon Dioxide Emissions by Sector. Reprinted with permission from Edward Mazria. Mazaria, E. (2003) "It's the Architecture, Stupid!" *Solar Today,* May-June, 48-51 http://www.mazria.com/ItsTheArchitectureStupid.pdf April 2007

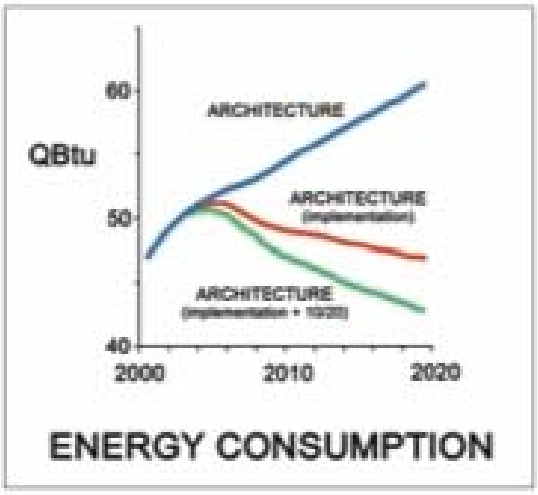


Figure 2-4 Possible Energy Consumption Model. Reprinted with permission from Edward Mazria. Mazaria, E. (2003) "It's the Architecture, Stupid!" *Solar Today,* May-June, 48-51 http://www.mazria.com/ItsTheArchitectureStupid.pdf April 2007

Natural cycles (the larger circle) surround society and define the limits which we have to live within. In a sustainable society, plants (on the left-hand side) build up enough renewable resources to satisfy con-

Figure 2-5 Integration of a Sustainable Society. Reprinted with permission from The Natural Step. TNS. (2002) *The Natural Step Framework Guidebook*, The Natural Step, Ottawa, Ontario

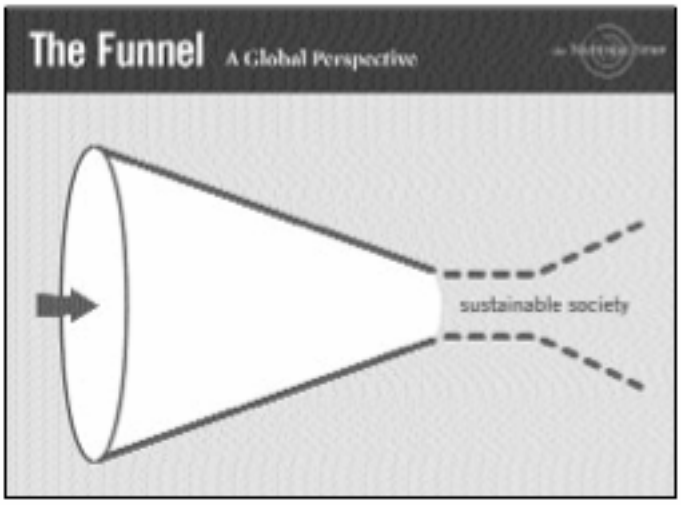


Figure 2-6 Funnel Towards a Sustainable Society. Reprinted with permission from The Natural Step. TNS. (2002) *The Natural Step Framework Guidebook*, The Natural Step, Ottawa, Ontario

Figure 2-7 Energy In to Energy Out. Reprinted with permission from The Natural Step. TNS. (2002) *The Natural Step Framework Guidebook*, The Natural Step, Ottawa, Ontario

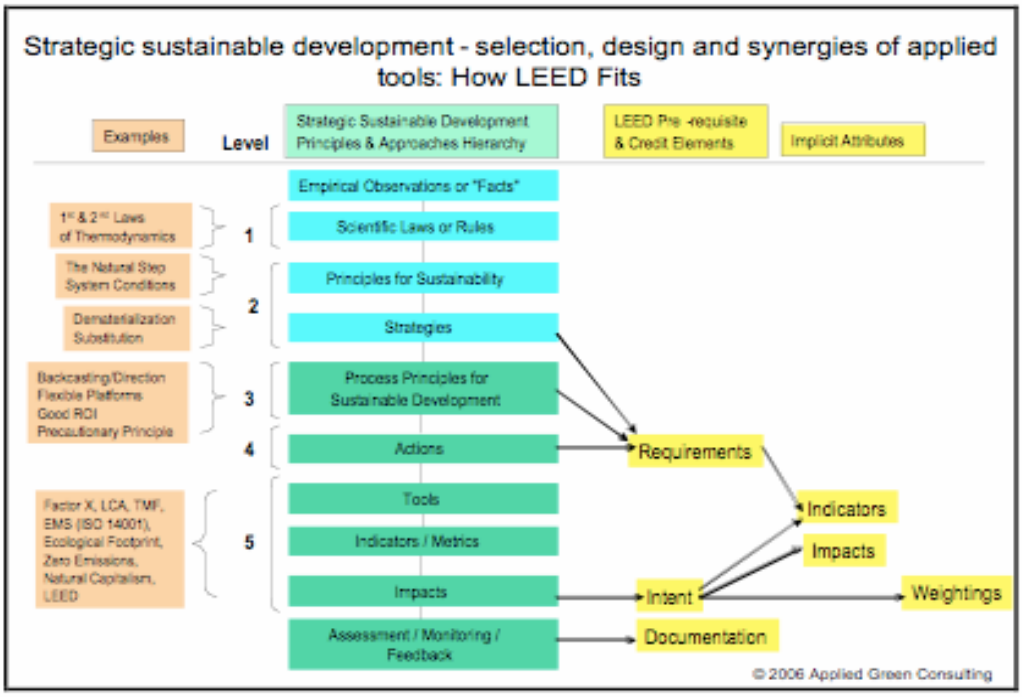


Figure 2-8 LEED Analyzed with Planning Hierarchy. Reprinted with permission from Alex Zimmerman. Zimmerman, A., Kibert, C. (2006) *Informing LEED-NC 3.0 with The Natural Step*, US Green Building Council, Washington, D.C., 26 Dec. 2006

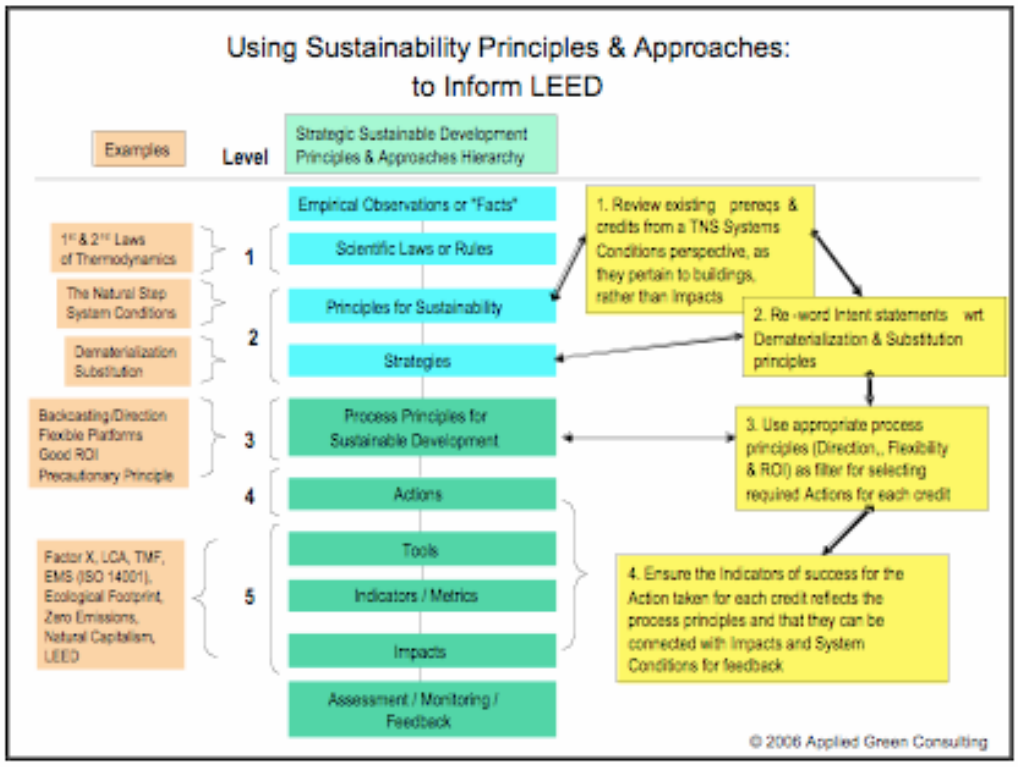


Figure 2-9 Using Planning Hierarchy to Inform LEED. Reprinted with permission from Alex Zimmerman. Zimmerman, A., Kibert, C. (2006) *Informing LEED-NC 3.0 with The Natural Step*, US Green Building Council, Washington, D.C., 26 Dec. 2006

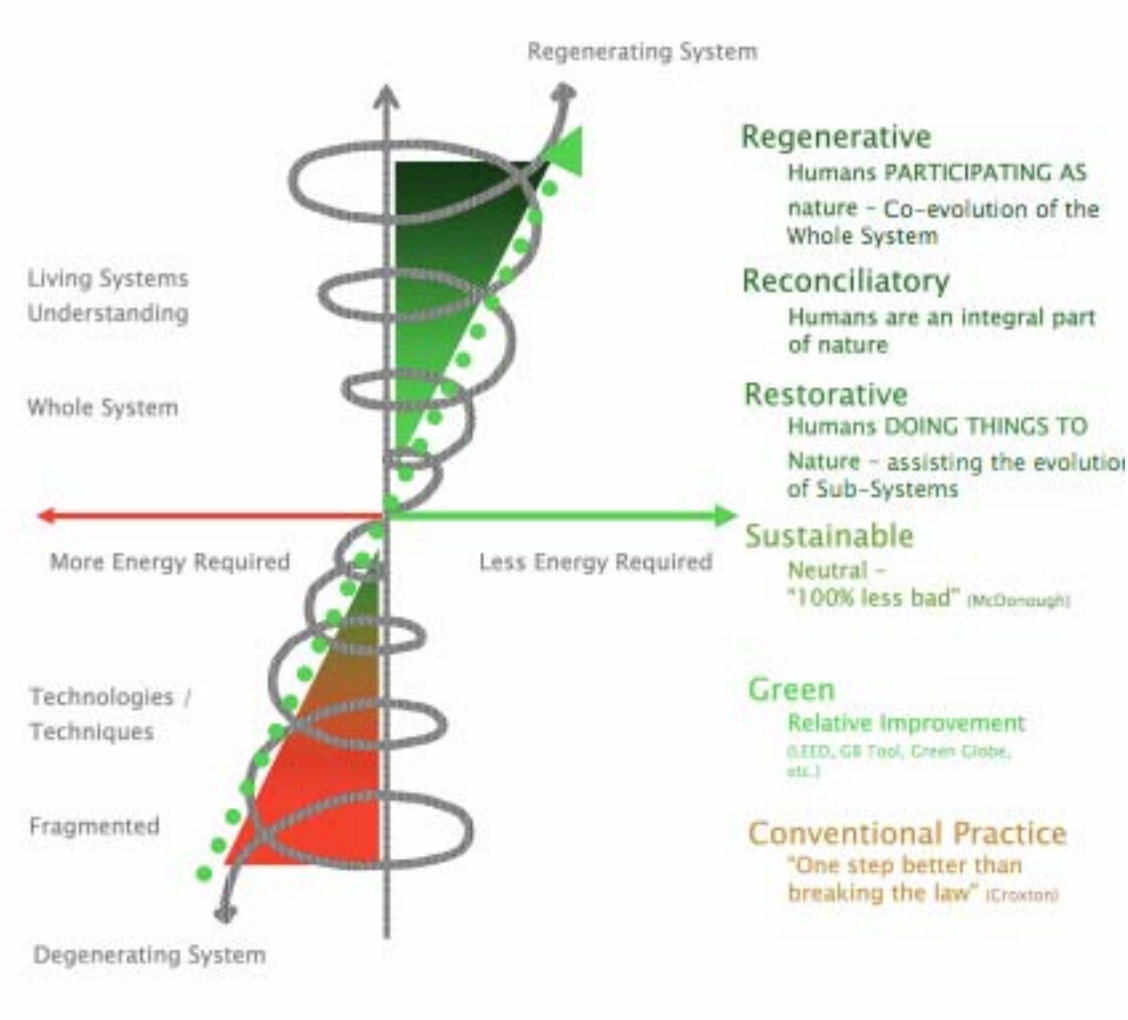


Figure 2-10 Trajectory of Environmentally Responsible Design. Reprinted with permission from Bill Reed. Reed, B. (2006) "Shifting our Mental Model – 'Sustainability' to Regeneration" *Building Research & Information,* April

CHAPTER 3
METHODOLOGY

The objective of this thesis is to analyze the ability to create LEED version 3 based on the framework of The Natural Step and its processes. The study provided information regarding these topics as related to the construction industry. At this point in time there is not a wealth of information regarding the creating of LEED version 3, or regarding implementing The Natural Step into a separate certification system.

The methodology developed for this research will be based on the objective and hypothesis of the thesis. The objective of this thesis is to determine the possibility of using The Natural Step as a complement to the LEED rating system. The hypothesis for the project is that LEED rating system is too different from the structure of The Natural Step to integrate the systems. More specifically, the two systems will not incorporate into one another to form a better single system.

In an attempt to combine the two systems three steps will be used to develop the concept for a revised LEED building assessment system. The first step is to determine current trends in the industry regarding LEED, and The Natural Step. This determined the current state of the system and discovered the strengths and weaknesses of each system. This review enabled a concise analysis of each systems framework. This portion also determined which system to keep as the basis for the new system. The literature review provided a basis for the foundation of this research.

The second step will be to establish a framework that allowed a way to approach each LEED credit similarly and use The Natural Step as the foundation for the credit. Creating a process flow to approach each credit established a path to incorporate important parts of each system. The parts to include were determined through the literature review, and the trends of industry professionals.

The third step will be to develop a new section for LEED based on processes. Research on the topics determined that The Natural Step includes processes that at this time do not fit into the LEED system. Because of this the process section needed to be created, allowing important aspects of TNS to be included into the LEED rating system.

Assess The Current View of The Systems

The current industry view of the systems is important to understand before moving into the analysis. A review of information on the topic will be performed to establish a basis for the research. As this information is reviewed the focus is to find areas that work well for each system, as well as to find the areas that the industry feel are deficient. This also allows for a thorough understanding of each system, a necessity for later phases of the analysis.

Current information regarding these topics is readily available. The only area that does not have a large amount of information concerned updating of LEED, and integrating The Natural Step into a rating system.

Establish a Method for Integration

In order to integrate LEED and TNS a procedure will be developed to approach the problem. The LEED system was established as the basis for the integration. Each credit was looked at individually to determine its validity with TNS. As this process began the important parts of each system had to be established. These parts can be seen more clearly in the results and analysis section.

Research showed that LEED has established itself as a proven system in the building industry. TNS also did this but on a much smaller scale. Because of this the larger LEED system will be kept as the basis for the changes. All changes made to the systems will be made to the LEED system. This is important because it keeps the market share that had been gained by LEED, and allows the system to change based on perceived needs of the industry.

TNS will be used to update LEED because the inherent properties of its system push users towards a sustainable pathway. Once the role of TNS is established the parts of the system that would have the most impact on a system like LEED will be determined. This ultimately comes down to two separate areas, those that would incorporate into the credits, and those that would incorporate into the LEED system.

Each credit of LEED will then be approached using the four system conditions of TNS. It will be determined which conditions work best for the particular credit based on the purpose of the credit, and its ability to improve its sustainable goals. As the goal of TNS is to achieve sustainability over a period of time certain credits will be changed into prerequisites. This will be done to increase the sustainable efforts of each LEED section, and allow the building to begin a sustainable path.

New elements will also be added to the LEED credits. These elements, based on TNS, included enhanced monitoring and communication. As the credits are analyzed the needs for communication and monitoring will be established and added to the credit. In order to enhance each LEED credit it will be determined if they will require monitoring. Advanced communication efforts require a qualified USGBC member to review a communication plan for the project, and maintain a relationship with the building team to offer guidance throughout the process.

As each section of LEED is analyzed a matrix showing the changes of each credit will be created. This matrix gives a clearer view to the trends and changes TNS requires.

Develop a Process Section

The addition of a process section will be included in the LEED system. This section is important because it adds a new level to the LEED process. This level allows sustainable efforts they may not fit within the credits to be added into the system. This section will allow the

processes that the industry feels are important to find a place in LEED. The process section also includes the needs of TNS that do not fit into the credits of the existing LEED system. These processes were based on observed needs of the LEED system, and testimonials regarding the advantages of using TNS.

This section will be added as its own section separate from the credits of the LEED system. This section will be developed as a guide for users to establish the foundations of a sustainable organization and furthermore a sustainable project.

CHAPTER 4
RESULTS AND ANALYSIS

Process Section

There were elements of TNS that went above and beyond the ability of the LEED rating system. The format of LEED does not lend itself to easily be upgraded because it is based on credits. Because there was a need to incorporate processes into the new version of LEED a new section was added. This new process section enables LEED to be more than a one-dimensional rating system. It allows the system to incorporate process functions that are inherent in TNS, as well as other green systems.

The monitoring aspects of TNS were extremely important to add into the new system. The essence of the monitoring system is based on the fact that everyone in the organization has bought-in to the sustainable efforts and can discuss future processes based on this fact. In order for this to be added to LEED there was an added requirement for organizations working in the LEED building to buy-in to TNS system, or a similar updated system from the new LEED version. This may prove to be difficult as the purpose of some buildings is to fill occupancy. LEED buildings have statistically shown to have lower vacancy rates, due to increased health effects. This means that most organizations occupying LEED buildings may already have a vested interest in sustainability, but now they will be required to incorporate them into their organization.

Another area that was included into the process section dealt with whole systems thinking and integrated design. These two aspects of TNS were difficult to incorporate into the LEED rigid credit structure. These processes needed to be incorporated because they enhance the overall sustainable goals of the project. One of the more important needs of LEED is to have a design team that has a strong understanding of the LEED system and will design the building to

attain the most credits possible. This is often not the case, and a project will find design team members not fully understanding the process and fail in a particular area that ends up affecting a number of the other credits. TNS calls for whole systems thinking in that the process to sustainability requires an integrated thought process that considers each aspect of the organization from large to small decisions.

Through whole systems thinking came integrated design. Research showed that integrated design was beneficial to the design of green buildings. With integrated design buildings could be designed with no LEED credits in mind and they at design completion they would already exceed the credit requirements of LEED. Not only does this design approach enable the achievement of LEED credits but it also pushes designers to enhance their design ideas, and moves towards new green technologies.

Communication between parties is an essential part of integrated design. Separating systems into respective areas is a must for a quick design, but the communication efforts needed to be increased from each party. Requiring team members to have constant contact with the owner, architect, engineers and builders under the guidance of a USGBC appointed LEED member may allow for this to work. The number of meetings and time between meetings should be decided upon at the project conception and approved by the USGBC LEED team member. Forcing users to increase their communication requirements facilitates the flow of information to all parties. This requirement was included to ensure that LEED buildings are receiving the needed efforts of all parties working on the project.

The process section was included as a separate prerequisite section to the LEED manual. These processes must be attempted and approved by the USGBC in order for LEED to be an option. The inclusion of whole systems thinking, integrated design, increased communication,

and a buy-in to TNS gives weight to the LEED certification. Requiring interested parties to perform these measures increases the level of sustainable thought, and begins to change the way of thinking for this society.

How TNS can affect LEED

Because the system needed to retain the market and users of past LEED versions the format stayed closer to the LEED system. To add TNS into this system rewording of objectives, credits, and prerequisites that follow the approach of TNS were included. Each area was rethought based on the four system conditions of TNS. This created wording that is less straightforward, but encourages a higher level of thought when trying to accomplish a credit. The thought process is based on environmental and social impacts that will occur after completion of the credit. Because of this increased consideration it was found useful to add weighting to certain credits, or make more prerequisites, for those credits that will have larger impacts. The energy saving credits were especially important here. While they do require difficult and expensive energy modeling sequences they are the most important credits that LEED has.

This also brings up an important part of the new equation. By assigning a LEED team member from the USGBC the process could be guided by a hand that knows what works and what does not work. After all the USGBC is the one that approves and denies the credits. The addition of this member should provide a valuable asset to projects and add to the monitoring of job.

These options are in no way a complete or definitive way to update the new version of LEED. These recommendations are simply based on the research of the subjects. Each idea came directly from the process section, LEED, or TNS system and they are as follows:

1. An end product that will be easy to use, science-based, encourages whole systems thinking and integrative design, results in a subjective process where team members are encouraged to think sustainably, and requires monitoring throughout the life of the building.
2. Rewording of objectives, credits, and prerequisites that follow the approach of TNS.
3. A requirement for organizations working in the LEED building to buy-in to TNS system, or a similar updated system from the new LEED version.
4. Whole systems thinking in that the process to sustainability requires an integrated thought process that considers each aspect of the building and environment surrounding the building.
5. Require team members to have constant contact with the owner, architect, engineers and builders under the guidance of a USGBC appointed LEED member.
6. Increased guidance from the USGBC with respect to the design for a sustainable LEED building.

These suggestions are based on perceived problems with the LEED system, and studies regarding TNS process.

LEED Version 3: Incorporating The Natural Step

In order to update the LEED credits based on TNS a clear understanding of TNS must be achieved. The earlier suggestions cannot all be seen in the update and must be achieved through the leadership of the USGBC. The following attempt only looked at suggestion one, two, four and six. Suggestions three, and five were not placed into consideration because they deal more with the processes of TNS, and they were addresses in the process section. Each section was broken down into its credits and prerequisites in order to show a full update of the system. Credit updates include the new intents, and requirements of the updated system. In addition the credit will include an objective designed to encourage whole systems thinking about the current credit.

Sustainable Sites

Sustainable sites contain fourteen points, and one prerequisite. The purpose of this section is to minimize the impact of construction on the surrounding environment during and after construction. The Natural Step can affect this section through the second and third system

condition. These conditions attempt to eliminate systematic increases in concentration of substances, and to eliminate physical degradation of nature through modification. It would also be of interest to monitor the success of these credits after the completion of construction. Changes to requirements exist for credits 1, 4, 5, and 7. For credit 1 the wording of the requirement has changed to include a wider range of areas that cannot be developed. Credit 4 changes only for credit 4.4. The change incorporates the need for less parking, and encourages the use of parking garages to minimize the amount of newly developed parking. Credit 5 has changed in that a USGBC LEED member must check the site development plan prior to construction. There will also be periodic checks by this member to determine if the credit is being met. Credit 7 changes mainly for credit 7.2. This change increases the amount of roof space to 100% except for permanent equipment. Credit 7, and credit 8 will also require periodic monitoring to determine if the credit is being followed after construction. The following updated credits can be seen in Table 4-1.

- SS Prerequisite 1: Construction Activity Pollution Prevention
    - Objective – Eliminate systematic destruction of the Earth and local ecosystems by controlling site work activities.
    - Intent – Eliminate soil erosion, waterway sedimentation, and airborne dust generation during the construction process.
    - Requirements – The requirements will not substantially change for this credit, as they currently cover the needs of the credit.
- SS Credit 1: Site Selection
    - Objective – Meet the needs of society by eliminating the physical degradation of the natural environment. Encourage social well being by creating development in previously used areas.
    - Intent – Eliminate development on sites that contain undeveloped land. Responsibly develop so that environmental impacts are minimal.

- Requirements – Do not develop in areas that will destroy natural habitats or endanger the natural use of areas that are environmentally sensitive. These areas include: Prime farmland, undeveloped land lower than five feet above the 100-year flood zone, land that is a habitat for an endangered species, land within 100 feet of wetlands, undeveloped land within 50 feet of any water bodies, land that is public parkland.

- SS Credit 2: Development Density and Community Connectivity
    - Objective – Meet the needs of society by eliminating the physical degradation of the natural environment. Encourage social wellbeing by creating development in previously used areas.
    - Intent – Encourage development in urban areas with existing infrastructure. Eliminate degradation of existing natural areas.
    - Requirements – The requirements for this credit will not change. They establish guidelines for developing in dense areas and encourage sustainable practices.

- SS Credit 3: Brownfield Redevelopment
    - Objective – Meet the needs of society by eliminating the physical degradation of the natural environment. Encourage social wellbeing by creating development in previously used areas.
    - Intent – Reduce the physical degradation of nature by remediating previously contaminated site.
    - Requirements – Current LEED requirements are sufficient, no change required.

- SS Credit 4.1, 4.2, 4.3, 4.4: Alternative Transportation
    - Objective – Reduce physical degradation of nature through the use of environmentally friendly transportation systems. Meet human needs by encouraging physical activity through alternative transportation methods.
    - Intent – Eliminate physical degradation from pollution and development impacts through reduced automobile use.
    - Requirements – 4.1, 4.2, and 4.3 – No change needed. 4.4 – Reduce impact of parking structures by providing minimum needed parking. Increase amount of preferred carpool parking, and encourage the use of public parking garages.

- SS Credit 5.1, 5.2: Site Development
    - Objective – Eliminate increases in physical degradation by using only parts of the site that are needed for development.

- Intent – Increase amount of undeveloped space for a project. Retain large amounts of unaltered open space.

- Requirements – 5.1 – On undeveloped site determine needed space for construction operations and send site use diagram to USGBC LEED member for approval or suggestion. Site will be monitored randomly throughout the project to determine if plan is being followed. On sites brownfield site, improve the site to maximum amount of natural habitat. USGBC LEED member should check site remediation plan. 5.2 – No change, except USGBC LEED member should check that plan for open space requirement. LEED member may determine that more open space is required or that amount needed is unachievable. If unachievable the credit may be awarded at USGBC's discretion.

- SS Credit 6.1, 6.2: Stormwater Management

  - Objective – Eliminate increases in concentrations of water due to altered natural environment. Do not allow water runoff to pollute local ecosystems.

  - Intent – Eliminate disruption of natural hydrology by causing minimal site disturbance, and managing stormwater runoff.

  - Requirements – Current requirements provide adequate measures for reducing stormwater runoff.

- SS Credit 7.1, 7.2: Heat Island Effect

  - Objective – Eliminate the adverse treatment of the surrounding environment by new heat sources.

  - Intent – Create measures that will reduce or eliminate the heat island effect caused by new construction.

  - Requirements – 7.1 – No change required. 7.2 – Increase percentages to a combination of 100% of the roof area, or 100% by use of a single method. Require monitoring throughout the life of the building to determine if systems are functioning as designed.

- SS Credit 8: Light Pollution Reduction

  - Objective – Eliminate increases in concentrations of light produced from the project site.

  - Intent – Eliminate light trespass from the building site, eliminate sky-glow to increase night sky access, improve nighttime visibility through glare reduction, and eliminate development impact on nocturnal environments.

- Requirements – The current requirements are sufficient. They require simple calculations, and work to eliminate light pollution. Monitoring the site periodically would be beneficial.

Water Efficiency

This section includes five points and no prerequisites. The focus is related to reducing water needed for landscaping, reducing wastewater, and reducing overall water use. In order to properly implement TNS to this section a water use reduction credit will be changed into a prerequisite. This will force design teams to incorporate whole systems thinking into the water systems. The percentage requirements of the other credits were increased to establish the need for better design. Changes to this section can be seen in Table 4-2.

- WE Prerequisite 1: Water Use Reduction 20%
    - Objective – Eliminate contribution to the physical degradation of nature's fresh water supply. Stop overharvesting unneeded fresh water.
    - Intent – Current LEED requirements are sufficient, no change required.
    - Requirements – Change only the support of USGBC in preparing a baseline model. Process should be simple, applicable to future projects, and easily learned.
- WE Credit 1: Water Use Reduction 40%
    - Objective – Eliminate contribution to the physical degradation of nature's fresh water supply. Stop overharvesting unneeded fresh water.
    - Intent – Current LEED requirements are sufficient, no change required.
    - Requirements – Change only the support of USGBC in preparing a baseline model. Process should be simple, applicable to future projects, and easily learned.
- WE Credit 2: Water Efficient Landscaping – Reduce by 70%
    - Objective – Eliminate contribution to the physical degradation of nature's fresh water supply. Stop overharvesting unneeded fresh water.
    - Intent – Current LEED requirements are sufficient, no change required.
    - Requirements – Current LEED requirements are sufficient, no change required.

- WE Credit 3: Water Efficient Landscaping – No Potable Water or No Irrigation
    - Objective – Eliminate contribution to the physical degradation of nature's fresh water supply. Stop overharvesting unneeded fresh water.
    - Intent – Current LEED requirements are sufficient, no change required.
    - Requirements – Current LEED requirements are sufficient, no change required.
- WE Credit 4: Innovative Wastewater Technologies
    - Objective – Eliminate contribution to the physical degradation of nature's fresh water supply. Stop overharvesting unneeded fresh water.
    - Intent – Eliminate introduction of wastewater into nature through procedures that may safely recharge natural water systems.
    - Requirements – A combination of water reducing wastewater facilities and wastewater treatment must be used on site. Facilities must reduce needed wastewater by 50%. At least 70% of wastewater must be treated and reused or reintroduced on site. Current calculations are sufficient for determining reductions.

Energy and Atmosphere

This section contains seventeen points and three prerequisites. This section is arguably the most important section of the LEED rating system. The first credit for optimizing energy performance needs be included as a prerequisite to a level. That credit is essentially the essence of LEED, and many users overlook its importance. By changing it to a prerequisite, users will be forced to design their buildings for optimal performance. The new prerequisite for minimum energy performance gains two points. It is difficult to perform the energy modeling therefore two points will reward the users for meeting the requirement. Prerequisite 1 also added the non-required credit for commissioning after the project has been completed. This prerequisite will require that a USGBC LEED member approve the commissioning plan. The credits were combined because the need for monitoring is essential to TNS and this credit captures the need for advanced monitoring of the building systems. Credit 1 has changed only in that the number of points has been reduced to nine. This is due to the increased requirements for the third

prerequisite. A USGBC LEED member will also be required to assist in the energy modeling procedure, and offer assistance when needed. Credit 2 has combined the credits for on-site renewable energy and green power. This was done to establish that alternate sources of energy are important to the building process. By combining the credits and offering two points for compliance the demand for this type of energy may increase. Changes can be seen in Table 4-3.

- EA Prerequisite 1: Building Commissioning and Monitoring
    - Objective – Eliminate our contribution to systematic increases in concentrations of substances from the Earth's crust.
    - Intent – Provide sufficient documentation for the USGBC LEED member regarding the energy related systems. Documentation should include verification of system installation, calibration, and that systems meet owner requirements.
    - In addition require current LEED version 2.2 EA credit 3 for enhanced commissioning be included as part of this prerequisite.
    - Requirements – No change required. Except that a USGBC LEED member needs to be in communication regarding the commissioning and future commissioning procedures.
- EA Prerequisite 2: Fundamental Refrigerant Management
    - Objective – Eliminate contributions to systematic increases in concentrations of substances produced by society into the atmosphere.
    - Intent – Eliminate the use of ozone-depleting materials that are potentially harmful to future generations.
    - Requirements – Current LEED requirements are sufficient, no change required.
- EA Prerequisite 3: Minimum Energy Performance
    - Objective – Meet human needs in our society while reducing increases in concentrations from the Earth's crust.
    - Intent – Significantly reduce the amount of energy required for newly constructed buildings.
    - Requirements – Meet current prerequisite. In addition gain one point from LEED version 2.2 EA credit one.

- EA Credit 1: Optimize Energy Performance
    - Objective – Meet human needs in our society while reducing increases in concentrations from the Earth's crust.
    - Intent – Significantly reduce the amount of energy required for newly constructed buildings. In addition achieve increasing levels of energy performance above a baseline building from prerequisite 3.
    - Requirements – No change required. Except for the introduction of a support system from the USGBC, or through USGBC LEED member for the use of the baseline building performance measures.
- EA Credit 2: On-Site Renewable Energy and Green Power
    - Objective – Eliminate our contributions to increases in concentrations of substances taken from the Earth's crust.
    - Intent – Incorporate on-site renewable energy and/or green power into the buildings energy supply.
    - Requirements – Current LEED requirements are sufficient, no change required.
- EA Credit 3: Enhanced Refrigeration Management
    - Objective – Eliminate contributions to systematic increases in concentrations of substances produced by society into the atmosphere.
    - Intent – Eliminate the use of ozone-depleting materials that are potentially harmful to future generations.
    - Requirements – Current LEED requirements are sufficient, no change required.
- EA Credit 4: Measurement and Verification
    - Objective – Meet needs in our society by continually monitoring the systems that reduce the use of substances from the Earth's crust
    - Intent – Continually monitor building systems to insure optimal energy performance.
    - Requirements – No change required. Can gain two points for this credit instead of one.

Materials and Resources

This section contains thirteen points with a single prerequisite. The focus is on building reuse, waste management, using recycled content, and using locally harvested material. This section relates to eliminating increases in concentrations from the earth's crust. It also relates to the fourth system condition of TNS, meeting the needs of society over and above current measures. To make this section more in line with TNS an extra prerequisite will be added regarding construction waste management. This addition will ensure that builders are attempting to divert as much waste as possible. If they are required to divert some waste then the likelihood of diverting more is increased. The only other changes to this section is requiring a USGBC LEED member to assist with credits 2, 4, and 7. The assistance should deal with the calculations for these credits and a list of possible resources the USGBC has acquired in a database for suppliers of these types of products. This will enable users to identify multiple suppliers and find the best cost for the project. By establishing the database a higher demand may be associated with these types of products. Table 4-4 shows the changes made to this section.

- MR Prerequisite 1: Storage and Collection of Recyclables
    - Objective – Eliminate contribution to increases in concentrations of substances that are produced by society. Encourage recycling techniques that divert flows of waste to landfill.
    - Intent – Reduce amount of waste that is sent to landfill from construction site.
    - Requirements – No change required.
- MR Prerequisite 2: Construction Waste Management – Divert 35% from Disposal
    - Objective – Eliminate systematic increases in concentrations of substances produced by society by reintroducing used materials into processing flow.
    - Intent – Encourage the diversion of construction waste from landfill by sending reusable material back into materials loop.
    - Requirements – Current LEED requirements are sufficient, no change required.

- MR Credit 1: Construction Waste Management – Divert 65% from Disposal
    - Objective - Eliminate systematic increases in concentrations of substances produced by society by reintroducing used materials into processing flow.
    - Intent - Encourage the diversion of construction waste from landfill by sending reusable material back into materials loop.
    - Requirements – Current LEED requirements are sufficient, no change required.
- MR Credit 2.1, 2.2, 2.3: Building Reuse – Maintain 75%, 95% of Existing Walls, Floors, and Roof, 2.3 – Maintain 50% of Interior Non-Structural Elements
    - Objective – Eliminate contribution to increases in concentrations of substances produced by society. Use materials to their maximum life, and prevent them from becoming waste.
    - Intent – Encourage the use of existing building materials to their full life expectancy. Conserve resources, retain cultural resources, reduce waste and reduce environmental impacts of new buildings as they relate to materials manufacturing and transport.
    - Requirements – No change required, except for the addition of guidance from USGBC LEED member. LEED member should promote conscious thought processes by offering suggestions towards saving building materials. Current calculations are simple and do not require change.
- MR Credit 3.1, 3.2: Material Reuse – 5%, 10%
    - Objective - Eliminate systematic increases in concentrations of substances produced by society by reintroducing used materials into processing flow.
    - Intent – Encourage the reuse of building materials to reduce need for virgin materials. This process reduces impacts related to extraction and processing of resources.
    - Requirements – Current LEED requirements are sufficient, no change required.
- MR Credit 4.1, 4.2: Recycled Content – 10%, 20% (post-consumer + 1/2 pre-consumer)
    - Objective - Eliminate systematic increases in concentrations of substances produced by society by reintroducing used materials into processing flow.
    - Intent – Encourage the development of recycled materials for building products. This reduces impacts of harvesting raw materials.
    - Requirements – Current LEED requirements are sufficient, no change required. The percentages should move up with future versions, as the demand for

recyclable materials increases. The USGBC should provide a list of recyclable material producers.

- MR Credit 5.1, 5.2: Regional Materials – 10%, 20% Extracted, Processed and Manufactured Regionally
    - Objective – Meet human needs of our society through the use of resources that have minimal impact on the increase of substances from the earth's crust.
    - Intent – Encourage the local development of construction products through increased demand. This results in a stronger local economy and promotes social well being.
    - Requirements – Current LEED requirements are sufficient, no change required.
- MR Credit 6: Rapidly Renewable Materials
    - Objective - Meet human needs of our society through the use of resources that have minimal impact on the increase of substances from the earth's crust.
    - Intent – Increase demand for products that are rapidly renewable. This reduces the need for materials that take long periods of time to develop, and increases social awareness.
    - Requirements – Current LEED requirements are sufficient, no change required.
- MR Credit 7: Certified Wood
    - Objective - Meet human needs of our society through the use of resources that have minimal impact on the increase of substances from the earth's crust.
    - Intent – Use only wood that has been responsibly harvested. Reduce impacts of strip clearing and other environmentally insensitive practices.
    - Requirements – Current LEED requirements are sufficient, no change required. A list should be given by the USGBC regarding certified wood producers.

Indoor Environmental Quality

This section contains thirteen points, and one prerequisite. It is geared toward increased human comfort. It deals directly with the fourth system condition in going over and above normal needs of society. This section requires little change because it already does the best job of going over and above societal needs. There will however be an added prerequisite in the

combination of credit 3.1 and 3.2 for Construction IAQ Management Plan. This will require the builders to act responsible in the installation of air delivery systems during and after construction. Other changes to this section involve a USGBC LEED member to be involved with credits 2, 4, 7, and prerequisite 3. This member will assist with all necessary calculations, and with suggestions for compliance. Credit 4 has been changed to include no use of hazardous chemicals within the building. Credit 7 has changed with the use of options for compliance. A clearer view of changes can be seen in Table 4-5.

- EQ Prerequisite 1: Minimum IAQ Performance
    - Objective – Meet human needs of society by going over and above the required contribution to human health needs.
    - Intent – Exceed societal needs for air quality by establishing minimum IAQ performance measures. These measures shall increase indoor air quality, and provide better health measures for its occupants.
    - Requirements – Current LEED requirements are sufficient, no change required. Calculations are adequate.
- EQ Prerequisite 2: Environmental Tobacco Smoke (ETS) Control
    - Objective - Meet human needs of society by going over and above the required contribution to human health needs.
    - Intent – Ensure that occupants are not exposed to dangerous tobacco smoke. Areas containing tobacco smoke should not be accessible to people simply passing by, this should be established by design and ventilation effectiveness.
    - Requirements – Current LEED requirements are sufficient, no change required.
- EQ Prerequisite 3: Construction IAQ Management Plan – During Construction/After Occupancy
    - Objective - Meet human needs of society by going over and above the required contribution to human health needs.
    - Intent – Eliminate indoor air quality problems by establishing a plan to minimize pollution of air distribution systems. This plan should exceed the current needs of society in an attempt to ensure the proper comfort and wellbeing of building users.

- Requirements – A combination of existing credit requirements for credit 3.1, and 3.2 shall be used for this prerequisite. A USGBC LEED member should also check the air quality plan and suggest necessary changes.

- EQ Credit 1: Outdoor Air Delivery Monitoring
    - Objective - Meet human needs of society by going over and above the required contribution to human health needs.
    - Intent – Exceed current building requirements by implementing a system to monitor the ventilation effectiveness of the building. System should monitor each area of the building and adjust to the ventilation needs to ensure building occupant comfort.
    - Requirements – Current LEED requirements are sufficient, no change required.
- EQ Credit 2: Increased Ventilation
    - Objective - Meet human needs of society by going over and above the required contribution to human health needs.
    - Intent – Exceed current societal needs by introducing outdoor air ventilation systems that will enhance comfort of building occupants.
    - Requirements – Current LEED requirements are sufficient, no change required. A USGBC LEED member shall assist and check the required calculations for this credit.
- EQ Credit 3.1, 3.2, 3.3: Low-Emitting Materials, 3.1 – Adhesives and Sealants, 3.2 – Paints and Coatings, 3.3 – Carpet Systems
    - Objective - Meet human needs of society by going over and above the required contribution to human health needs.
    - Intent – Eliminate the use of indoor air contaminates that are harmful to the comfort and wellbeing of building occupants.
    - Requirements – Current LEED requirements are sufficient, no change required.
- EQ Credit 4: Indoor Chemical and Pollutant Source Control
    - Objective - Meet human needs of society by going over and above the required contribution to human health needs.
    - Intent – Eliminate the introduction of hazardous pollutants to the building.

- Requirements – No change required. Except that hazardous cleaning supplies may no longer be used in the building. Monitoring by the USGBC should be scheduled to determine compliance with the credit.

- EQ Credit 5.1, 5.2: Controllability of Systems, 5.1 – Lighting, 5.2 – Thermal Comfort
    - Objective - Meet human needs of society by going over and above the required contribution to human health needs.
    - Intent – Meet the need of each building occupant to control lighting and thermal comfort.
    - Requirements – Current LEED requirements are sufficient, no change required.
- EQ Credit 6.1, 6.2: Thermal Comfort, 6.1 – Design, 6.2 - Verification
    - Objective - Meet human needs of society by going over and above the required contribution to human health needs.
    - Intent – Meet the needs of society by providing a comfortable thermal environment that will enhance the wellbeing of building occupants.
    - Requirements – Current LEED requirements are sufficient, no change required.
- EQ Credit 7.1, 7.2: Daylight and Views, 7.1 – Daylight 75% of Spaces, 7.2 Daylight 90% of Spaces
    - Objective - Meet human needs of society by going over and above the required contribution to human health needs.
    - Intent – Go over and above the need of building occupants to have outdoor views. Provide daylighting whenever possible.
    - Requirements – Current option 1 requires no change, the calculation is simple and information easily accessible. If option 2 or 3 is used a USGBC LEED member should provide support for computer simulation, and offer past records regarding indoor light measurement techniques.

Summary

The changes made to LEED reflect the perceived needs of the industry and the scientific underpinning of TNS. The addition of TNS created a new process section that will require users

to take on the whole systems approach to design. TNS was also used to update each credit and prerequisite. Some credits were combined others were changed into prerequisites, while others were simply given more weight based on the difficulty to achieve the credit or the impact that it has. Each credit and prerequisite was also enhanced with an objective. The objective was based on the four system conditions of TNS, and helped to add the science-based approach that LEED lacked.

The changes reflected the framework of TNS and the result is an updated version of LEED that is science-based, more difficult to achieve, requires increased communication and monitoring, encourages integrated design, and ultimately moves society towards a sustainable paradigm shift.

Table 4-1 Changes to Sustainable Sites

Sustainable Sites LEED Version 3	Change of Intent Wording	Change in Requirements	Require Periodic Monitoring	Require Use of USGBC LEED Member	New Prerequisite	Number of Points
Prerequisite 1:Construction Activity Pollution Prevention	X					1
Credit 1: Site Selection	X	X				1
Credit 2: Development Density and Community Connectivity	X					1
Credit 3: Brownfield Redevelopment	X					1
Credit 4.1, 4.2, 4.3, 4.4: Alternative Transportation	X	X				4
Credit 5.1, 5.2: Site Development	X	X	X	X		2
Credit 6.1, 6.2: Stormwater Management	X					2
Credit 7.1, 7.2: Heat Island Effect	X	X	X			2
Credit 8: Light Pollution Reduction	X		X			1
					Total Points	15

Table 4-2 Changes to Water Efficiency

Water Efficiency LEED Version 3	Change of Intent Wording	Change in Requirements	Require Periodic Monitoring	Require Use of USGBC LEED Member	New Prerequisite	Number of Points
Prerequisite 1: Water Use Reduction 20%	X			X	X	1
Credit 1: Water Use Reduction 40%	X			X		1
Credit 2: Water Efficient Landscaping - Reduce by 70%						1
Credit 3: Water Efficient Landscaping - No Potable Water or No Irrigation						1
Credit 4: Innovative Wastewater Technologies	X	X				1
					Total Points	5

Table 4-3 Changes to Energy and Atmosphere

Energy and Atmosphere LEED Version 3	Change of Intent Wording	Change in Requirements	Require Periodic Monitoring	Require Use of USGBC LEED Member	New Prerequisite	Number of Points
Prerequisite 1: Building Commissioning and Monitoring	x		x	x	x	1
Prerequisite 2: Fundamental Refrigerant Management	x					1
Prerequisite 3: Minimum Energy Performance	x	x			x	2
Credit 1: Optimize Energy Performance	x			x		9
Credit 2: On-Site Renewable Energy and Green Power	x	x				2
Credit 3: Enhanced Refrigeration Management	x					1
Credit4: Measurement and Verification	x					2
					Total Points	18

Table 4-4 Changes to Materials and Resources

Materials and Resources LEED Version 3	Change of Intent Wording	Change in Requirements	Require Periodic Monitoring	Require Use of USGBC LEED Member	New Prerequisite	Number of Points
Prerequisite 1: Storage and Collection of Recyclables	x					1
Prerequisite 2: Construction Waste Management - Divert 35% from Disposal	x				x	1
Credit 1: Construction Waste Management - Divert 65% from Disposal	x					1
Credit 2.1,2.2,2.3: Building Reuse	x			x		3
Credit 3.1,3.2: Material Reuse - 5%, 10%	x					2
Credit 4.1,4.2: Recycled Content	x			x		2
Credit 5.1,5.2: Regional Materials	x					2
Credit 6: Rapidly Renewable Materials	x					1
Credit 7: Certified Wood	x			x		1
					Total Points	14

Table 4-5 Changes to Indoor Environmental Quality

Indoor Environmental Quality LEED Version 3						
	Change of Intent Wording	Change in Requirements	Require Periodic Monitoring	Require Use of USGBC LEED Member	New Prerequisite	Number of Points
Prerequisite 1: Minimum IAQ Performance	x					1
Prerequisite 2: Environmental Tobacco Smoke (ETS) Control	x					1
Prerequisite 3: Constuction IAQ Management Plan	x	x		x	x	2
Credit 1: Outdoor Air Delivery Monitoring	x					1
Credit 2: Increased Ventilation	x			x		1
Credit 3.1,3.2,3.3: Low-Emitting Materials	x					3
Credit 4: Indoor Chemical and Pollutant Source Control	x	x		x		1
Credit 5.1,5.2: Controllability of Systems	x					2
Credit 6.1,6.2: Thermal Comfort	x					2
Credit 7.1,7.2: Daylight and Views	x	x		x		2
					Total Points	16

CHAPTER 5
CONCLUSION

Updating LEED is something that will happen in the somewhat near future. Past updates have included relatively small changes to credits. The most recent change coming in LEED version 2.2 was the addition of web-based credit submission. This reduced a large percentage of the paper work required and offered an easy format for submitting documents to LEED. The question of updating LEED version 3 based on TNS is something that will most likely be highly debatable. Each update is supposed to follow the general changes and needs of the market to keep a state of the art system in place for green building certification. Updating based on TNS may not hold that much water in the eyes of the USBGC.

Although the updated version 3 is going to happen, the question must be asked why should TNS be used? TNS offers an answer to many of the alleged problems with the current LEED system. It is pre-established and effective system that keeps organizations on a profitable and organized track towards sustainability. LEED is in need of an update that will shift the perception of LEED to something that is an ongoing process, not simply for the construction of new buildings. TNS provides an excellent scientific justification for most LEED credits. It should also help to shift the paradigm of sustainability in the U.S. to something that needs to happen in our everyday lives.

Will an Update Based on TNS Work?

In order for the update to work at least part of the recommended changes will need to be included. Changing the wording of credits, prerequisites, and objectives will be necessary and simple. It will only take an understanding of the TNS system conditions, and an update based on that system. Whole systems thinking are another must if the update will really work. Somehow this process must be incorporated in the design of LEED buildings. Without this the paradigm

shift will inevitably not happen. This portion of the update establishes the importance of each system that is affected when we change the environment, and creates a new approach to thinking that many do not currently follow.

Communication requirements are also a necessity for the update. While the green building process already requires intense communication between parties the guidance from the USGBC will be extremely helpful. Setting up a tentative plan for communication efforts will only help in the process, and the use of TNS's backcasting can also help to achieve this need. Adding a USGBC LEED team member may be prohibitive to the update. This is something that may not be totally feasible, as the costs for certification will certainly increase, and costs are already a concern for LEED.

Buying into TNS will be another challenge for the update. This is actually quite important if the process is to really work. Requiring the buy-in will only decrease the time required to cause a paradigm shift. Unfortunately this will be difficult to do, as case studies have shown when organizations buy-in to TNS system there is a number of employees that will quit or simply think the system is silly. Forcing ideals onto people that simply do not believe what your doing is right is no way to encourage change. However this will certainly be an advantage for sustainability by informing more people of its importance.

The update will require lots of manpower and time to complete. It may be cost prohibitive and some of the elements may be difficult to incorporate. Ultimately, society may not be ready to accept TNS into our current ideals. This is a direct effect of the United States lagging efforts to deal with environmental degradation, and to make the sustainable ideals important. There are still many areas of our society that believe there is no problem with the environment, and that the cyclical nature of the Earth will eventually heal itself.

Science has proved that this is simply not the case. Past forecasts by scientists have definitely overblown the affects of poor environmental practices, and they are very well overblown now. The claims are not misguided however and there is a need for change now before it is too late to change our societal views. The inability of the government to accept this stance is harmful to the planet and the nature of our society. This may in fact reduce the impact of the update, and further reduce the use of LEED.

The update will surely be viewed as positive within the target market of the USGBC, but is this enough of the market to make LEED a bigger success? It may be too difficult for a full integration of TNS into LEED to really be effective. Perhaps the LEED version 3 simply needs to incorporate part of the system, and more in a future update. It is not possible to know if the update will be a success, but the need is evident.

Recommendations for Future Study

The research for this study was based solely on printed articles, books, and case studies regarding the topics intended. Future work may include interviews with established industry professionals to gauge the current need for change and possibility of using TNS for a LEED update. This would give a deeper understanding of the needs within the industry and not simply from published articles.

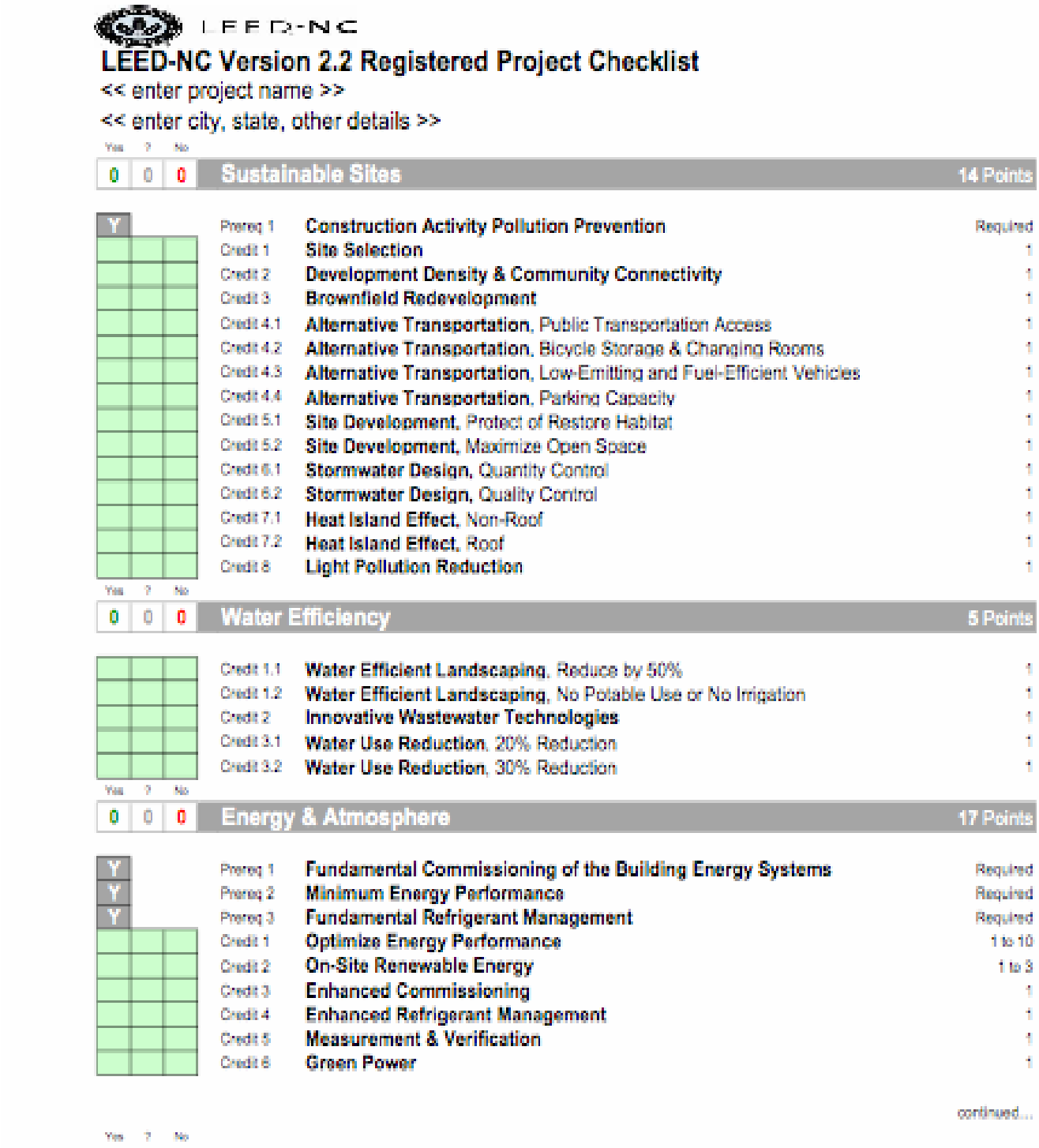
Another possibility would be to compare the use of TNS and other sustainable guidelines. TNS has many resources that would be an advantage to LEED, other guidelines are sure to have positive attributes that may fit into LEED better. A table showing the advantages and disadvantages of each system may be beneficial in looking for a general direction that these guidelines follow. It may be easier to incorporate ideals that many guidelines share than singling out one system.

If research was to be held off for some time another study could be done after LEED version 3 came out. This would allow the researcher to see the direction the USGBC has taken to gain a better understanding of what they feel is important. If any of the changes made were similar to suggested changes in this thesis, then a more in depth study of TNS could be taken.

The success or failure of LEED in the near future is also something that should be taken into account. A study into LEED could be taken to see trends in the changes made as compared to the market that is being targeted by the USGBC. The size of the target market will offer the direction the USGBC is taking at each period studied, and will surely correlate to the emerging trends in LEED.

Another possibility would be to analyze the proposed process section of this research. There are many processes that could be added to the LEED system that would prove beneficial to the overall design and efficiency of a LEED project. Identifying possible processes that could be added, and more in depth research into a process section could be very beneficial to the industry.

APPENDIX
LEED VERSION 2.2 CHECKLIST



LEED-NC

LEED-NC Version 2.2 Registered Project Checklist

<< enter project name >>

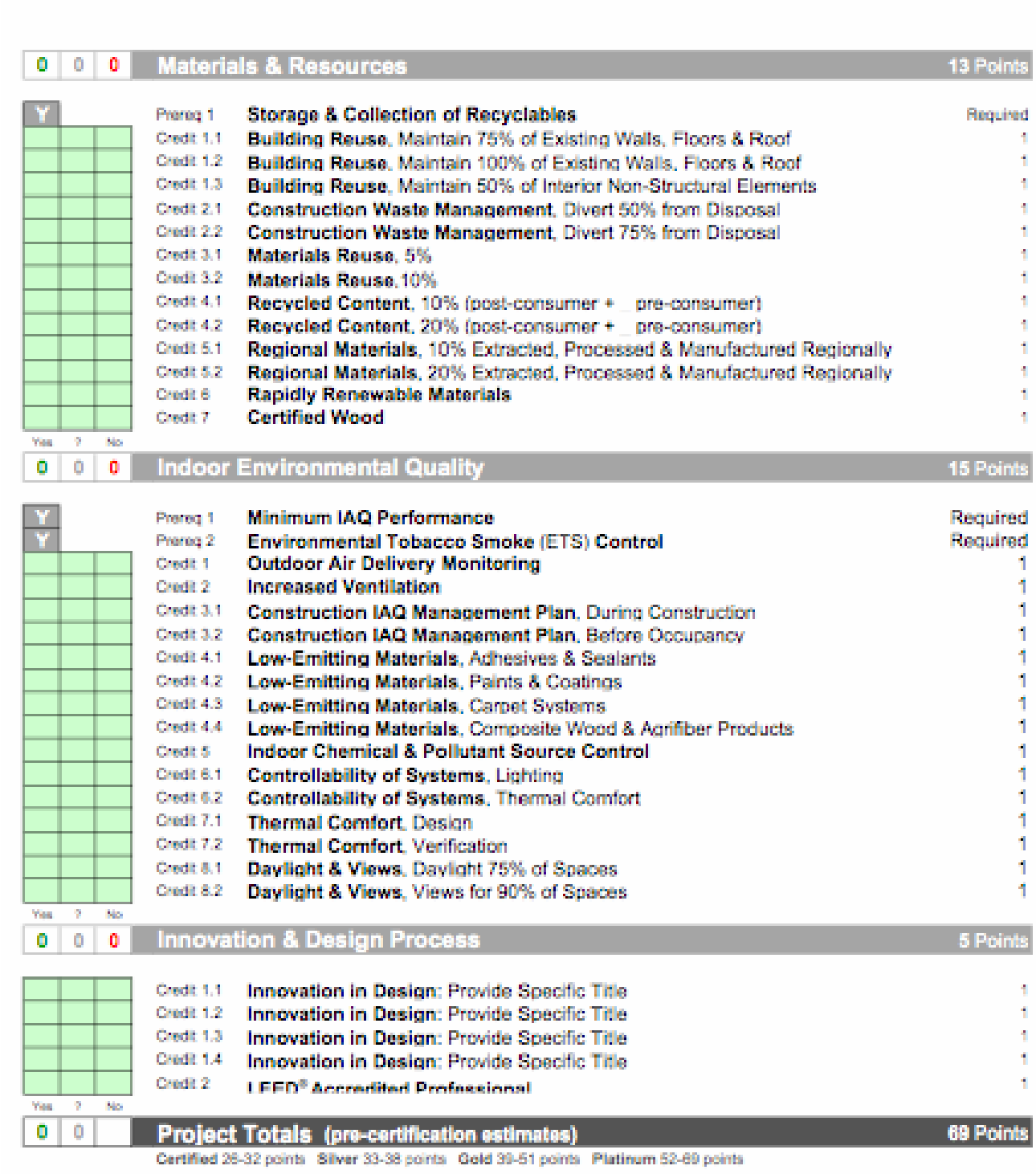
<< enter city, state, other details >>

Yes	?	No			
0	0	0	**Sustainable Sites**		14 Points
Y			Prereq 1	**Construction Activity Pollution Prevention**	Required
			Credit 1	**Site Selection**	1
			Credit 2	**Development Density & Community Connectivity**	1
			Credit 3	**Brownfield Redevelopment**	1
			Credit 4.1	**Alternative Transportation**, Public Transportation Access	1
			Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	1
			Credit 4.3	**Alternative Transportation**, Low-Emitting and Fuel-Efficient Vehicles	1
			Credit 4.4	**Alternative Transportation**, Parking Capacity	1
			Credit 5.1	**Site Development**, Protect or Restore Habitat	1
			Credit 5.2	**Site Development**, Maximize Open Space	1
			Credit 6.1	**Stormwater Design**, Quantity Control	1
			Credit 6.2	**Stormwater Design**, Quality Control	1
			Credit 7.1	**Heat Island Effect**, Non-Roof	1
			Credit 7.2	**Heat Island Effect**, Roof	1
			Credit 8	**Light Pollution Reduction**	1
Yes	?	No			
0	0	0	**Water Efficiency**		5 Points
			Credit 1.1	**Water Efficient Landscaping**, Reduce by 50%	1
			Credit 1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation	1
			Credit 2	**Innovative Wastewater Technologies**	1
			Credit 3.1	**Water Use Reduction**, 20% Reduction	1
			Credit 3.2	**Water Use Reduction**, 30% Reduction	1
Yes	?	No			
0	0	0	**Energy & Atmosphere**		17 Points
Y			Prereq 1	**Fundamental Commissioning of the Building Energy Systems**	Required
Y			Prereq 2	**Minimum Energy Performance**	Required
Y			Prereq 3	**Fundamental Refrigerant Management**	Required
			Credit 1	**Optimize Energy Performance**	1 to 10
			Credit 2	**On-Site Renewable Energy**	1 to 3
			Credit 3	**Enhanced Commissioning**	1
			Credit 4	**Enhanced Refrigerant Management**	1
			Credit 5	**Measurement & Verification**	1
			Credit 6	**Green Power**	1

continued...

Yes ? No

Figure A-1 LEED-NC Version 2.2 Checklist: Sustainable Sites, Water Efficiency, Energy and Atmosphere. Reprinted with permission from USGBC. USGBC. (2006) *LEED-NC Version 2.2 Reference Guide*, US Green Building Council, Washington, DC.



0	0	0	**Materials & Resources**	13 Points
Y			Prereq 1 **Storage & Collection of Recyclables**	Required
			Credit 1.1 **Building Reuse**, Maintain 75% of Existing Walls, Floors & Roof	1
			Credit 1.2 **Building Reuse**, Maintain 100% of Existing Walls, Floors & Roof	1
			Credit 1.3 **Building Reuse**, Maintain 50% of Interior Non-Structural Elements	1
			Credit 2.1 **Construction Waste Management**, Divert 50% from Disposal	1
			Credit 2.2 **Construction Waste Management**, Divert 75% from Disposal	1
			Credit 3.1 **Materials Reuse**, 5%	1
			Credit 3.2 **Materials Reuse**, 10%	1
			Credit 4.1 **Recycled Content**, 10% (post-consumer + ½ pre-consumer)	1
			Credit 4.2 **Recycled Content**, 20% (post-consumer + ½ pre-consumer)	1
			Credit 5.1 **Regional Materials**, 10% Extracted, Processed & Manufactured Regionally	1
			Credit 5.2 **Regional Materials**, 20% Extracted, Processed & Manufactured Regionally	1
			Credit 6 **Rapidly Renewable Materials**	1
			Credit 7 **Certified Wood**	1
Yes	?	No		
0	0	0	**Indoor Environmental Quality**	15 Points
Y			Prereq 1 **Minimum IAQ Performance**	Required
Y			Prereq 2 **Environmental Tobacco Smoke (ETS) Control**	Required
			Credit 1 **Outdoor Air Delivery Monitoring**	1
			Credit 2 **Increased Ventilation**	1
			Credit 3.1 **Construction IAQ Management Plan**, During Construction	1
			Credit 3.2 **Construction IAQ Management Plan**, Before Occupancy	1
			Credit 4.1 **Low-Emitting Materials**, Adhesives & Sealants	1
			Credit 4.2 **Low-Emitting Materials**, Paints & Coatings	1
			Credit 4.3 **Low-Emitting Materials**, Carpet Systems	1
			Credit 4.4 **Low-Emitting Materials**, Composite Wood & Agrifiber Products	1
			Credit 5 **Indoor Chemical & Pollutant Source Control**	1
			Credit 6.1 **Controllability of Systems**, Lighting	1
			Credit 6.2 **Controllability of Systems**, Thermal Comfort	1
			Credit 7.1 **Thermal Comfort**, Design	1
			Credit 7.2 **Thermal Comfort**, Verification	1
			Credit 8.1 **Daylight & Views**, Daylight 75% of Spaces	1
			Credit 8.2 **Daylight & Views**, Views for 90% of Spaces	1
Yes	?	No		
0	0	0	**Innovation & Design Process**	5 Points
			Credit 1.1 **Innovation in Design**: Provide Specific Title	1
			Credit 1.2 **Innovation in Design**: Provide Specific Title	1
			Credit 1.3 **Innovation in Design**: Provide Specific Title	1
			Credit 1.4 **Innovation in Design**: Provide Specific Title	1
			Credit 2 **LEED® Accredited Professional**	1
Yes	?	No		
0	0		**Project Totals (pre-certification estimates)**	69 Points

Certified 26-32 points Silver 33-38 points Gold 39-51 points Platinum 52-69 points

Figure A-2 LEED Version 2.2 Checklist: Materials and Resources, Indoor Environmental Quality, Innovation and Design Process. Reprinted with permission from USGBC. USGBC. (2006) *LEED-NC Version 2.2 Reference Guide*, US Green Building Council, Washington, DC.

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BIOGRAPHICAL SKETCH

Kyle Robert Galligar was born in Tampa, Florida on October 11th 1982. He was raised in Jacksonville, Florida where he attended Stanton College Preparatory High School. During this time he played varsity football, soccer, and ran track. After graduating from high school in 2001 Kyle attended Florida State University, where he earned a Bachelor of Science in real estate. While attending FSU Kyle began taking classes at the Florida A&M University School of Architecture. Soon after Kyle was accepted into the University of Florida Master of Architecture program. During his visit to the school he learned of the M.E. Rinker Sr. School of Building Construction, and was soon accepted to the Master of Science in Building Construction pzrogram. Kyle has since completed the coursework for a Master of Science in Building Construction, with a concentration in sustainability. Kyle has also become a LEED Accredited Professional.