REACTIONS TO MANDATED SUSTAINABLE CONSTRUCTION WITHIN THE U.S. ARMY CORPS OF ENGINEERS

By

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A THESIS PRESENTED TO THE GRADUATE SCHOOL
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To my family and my construction industry peers who dedicate themselves to furthering sustainable construction practices

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LIST OF ABBREVIATIONS

A-E-C-CM	Architect/engineer/constructor/construction manager
ASCE	American Society of Civil Engineers
ASE	Army Strategy for the Environment: Sustain the Mission - Secure the Future
ASR	Army Sustainability Report 2007
CID	Conseil International du Batiment
DOD	Department of Defense
EISA	Energy Independence and Security Act
FORSCOM	Forces Command
GBI	Green Building Initiative
GBCI	Green Building Certification Institute
GRI	Global Reporting Initiative
GS	General Services
GSA	United States General Services Administration
IAQ	Indoor Air Quality
ISO	International Standards Organization
ISP	Installation Sustainability Program
LEED	Leadership in Energy and Environmental Design
LEED AP	Leadership in Energy and Environmental Design Accredited Professional
MILCON	Military Construction
PDT	Project Delivery Team
POC	Point of Contact
SDD	Sustainable Design and Development
SPiRiT	Sustainable Project Rating Tool

USACE	United States Army Corp of Engineers
USGBC	Unites States Green Building Coalition
WCED	World Commission on Environment and Development

Abstract of Thesis Presented to the Graduate School
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The construction industry is evolving; it is in a transition state, moving from conventional means to sustainable construction practices. The beginnings of this transition date back to the middle of the twentieth century and began to truly took hold in the 1990s. Since that time the facts of energy consumption and material use and waste connected to buildings and the construction industry have become well known. Innovative members of the industry have begun to change their construction methods to more sustainable practices in response.

Some companies and institutions have mandated the change to sustainable construction; one such institution is the U.S. Army. The U.S. Army mandated the transition to sustainable construction practices in 2002. The U.S. Army Corps of Engineers (USACE) was mandated to train and prepare its personnel to design and build by the guidelines of a sustainable construction rating system. The USACE is currently using the LEED NC 3.0 system for Army projects. All Army projects have been mandated to be built to the LEED Silver standard.

Little to no research has been conducted as to the effects the transition had on USACE personnel. The personnel's perception of the preparation and training that they

received in order to change from conventional construction to sustainable construction practices will be measured via survey and analyzed. The USACE employee's opinions regarding the transition to sustainable construction can be of use to other members of the construction industry who are or will be experiencing the transition to sustainable construction within their own companies.

CHAPTER 1
INTRODUCTION

The world is changing. Whether it is in response to a change in climate or to simply try to be more responsible with limited resources is inconsequential. Sustainability is becoming more than just a catch phrase, its doctrine of conserving and preserving is being adopted by many industries. Even the federal government is spouting the advantages of changing the economy to a clean energy economy (The White House 2010). As sustainability is gaining approval, technologies and standards have and will continue to rush to become more and more efficient to meet the new standards.

The construction industry is at a crossroads of convention and innovation. On one hand the construction industry is accepting of the sustainable movement, one example of their acceptance would be the growing number of construction industry professional who are becoming LEED APs (USGBC 2010). On the other hand, the industry may be forced via mandates into acceptance by universities, organizations and municipalities that require green building practices to be used for their building and renovation projects. Change is not readily accepted in the construction industry due to perceived liability issues and a reluctance to be the first to try something new.

There has been little research on how personnel within the construction industry have dealt with the transition to sustainable design and construction. Are sustainable practices being implemented with or without their support? Do construction industry workers who are working in sustainable construction actually believe in the principles and ethical nature of sustainability? Do they have a personal interest in sustainability, or are they just doing the work they are contracted to perform? There are many questions

that have not yet been asked, the sheer size of the construction community is a limiting factor (United States Department of Labor 2010). In order to begin researching this topic a smaller sample size is needed. For the purposes of this report the managers directly working with sustainability in the United States Army Corps of Engineers (USACE) will be studied.

This report will focus on the USACE's work that is done for the U.S. Army. The U.S. Army conducts all of its construction following its sustainable design and development (SDD) methods. The U.S. Army acquires its funds through the department of defense (DOD). The DOD is one of the largest departments operated by the U.S. government, it had a budget of $529,876,000,000 in 2007 and an estimated budget of $651,163,000,000 for 2009 (U.S. Office of Management and Budget 2009). That money goes towards everything required for the defense of the United States including construction. The DOD's budget for construction in 2007 was $9,167,000,000 and the 2009 budget was estimated to be $21,197,000,000 (U.S. Office of Management and Budget 2009). The amount of the construction budget that went specifically toward U.S. Army construction is not known, but even a fraction of the estimated $21 billion construction budget for 2009 would have made an impact on the sustainable construction market.

The U.S. Army adopted sustainable construction practices in 2002 (Dalton 2008). The USACE was mandated to familiarize its staff quickly and effectively in order to transition from conventional construction to sustainable construction measures. The impact of the transition and the effectiveness of the training on the USACE personnel are not known. The managers within the USACE offices are more impacted by the

mandated change to sustainable construction than other staff members. This report will analyze the managerial personnel's perceptions of sustainable construction and the effectiveness of the training provided to them.

This study is significant in that it will evaluate the personnel of an organization that has transitioned from conventional to sustainable construction via mandate. The report will collect responses via a survey of managers who deal directly with sustainable construction practices in their individual offices. The data collected will determine if the training and other means of preparation were effective in establishing a level of knowledge among the USACE managerial staff who deal directly with sustainability. The perception of the effectiveness of their training will provide the construction industry with knowledge of what means of training were effective when transitioning to sustainable construction via mandate.

Some hypotheses of the perceptions of the USACE personnel to be determined by the study are as follows:

- The higher the level of management (determined by pay grade) the lower the perception of resistance to sustainable construction practices.
- The higher the level of management (determined by pay grade) the more likely they were to feel that their training was sufficient.
- Overall the USACE personnel were not personally interested in sustainable construction prior to the mandate.
- The respondents, if grouped by profession, would have different opinions on the sufficiency of the sustainable construction training.
- The respondents would have differing opinions on why they first became involved with sustainable construction based on profession.

These hypotheses will be further discussed in the methodology chapter of this report. The results will be determined via survey and analyzed in the analysis of results

chapter. Finally, conclusions and recommendations will be given in the final chapter of this thesis.

CHAPTER 2
LITERATURE REVIEW

2.1 Sustainability

In pre-industrialized society there was no question of whether a product or practice was sustainable or not. Resources were typically local and for the most part sustainable. People of the pre-industrial era understood intuitively that they depended on the local ecosystem to support and sustain their lives. Sustainable practices had gone on unhindered for millennia. Fast-forward to present day, the current economy of the developed world is based squarely on consumerism and the need to replace every product with the latest and greatest. This cycle is ingrained in the minds of the latest westernized human generation. It is of no consequence to the conscience of many of this generation to throw barely used merchandise into landfills and then turn around and replace it with a newer version. Yet there is a growing movement that is bucking the trend; it has been gaining ground over the past few decades. The sustainable movement is attracting people from all walks of life. Many people are attracted to the concept of sustainability because of the core principle of reducing the impact that the human species has on the planet. Others see sustainability simply as ‘the right thing to do’.

The growth of sustainable practices and theory has given rise to many subcategories of sustainability. For the purposes of this paper one such subcategory of sustainability will be explored: sustainable construction. Modern sustainable construction has been on the radar for more than twenty years and yet it has not made a significant change in the way the majority of buildings are constructed (Kibert 2008). The bulk of design and construction professionals have been slow to accept sustainable

construction practices, while others have jumped right on board. Many large institutions are leading the way to sustainable construction including the U.S. General Services Administration (GSA), many state and local governments, and universities around the country. The U.S. Army is one of these institutions who has accepted sustainability as a policy and is constructing all of its building using green construction practices.

This literature review will shed light on the concepts and principles of sustainable construction. It will review the US Army's acceptance of sustainable construction practices. The review will also explore why many construction professionals are slow to accept sustainable construction practices, and offer methods of overcoming that resistance to transitioning to sustainable construction practices.

2.1.1 History of Sustainability

The technological advances that have occurred since the beginning of the industrial revolution have drastically changed the planet's systems (Hill and Bowen 2007). The explosion of the human population has lead to the unsustainable consumption of resources. In January 2010 the United Nations Department of Economic and Social Affairs estimated a world population of 6,750,062,000 for the year 2008, this is up from an estimate of 6,670,801,000 for the year 2007(United Nations Department of Economic and Social Affairs 2010). The middle of the 20th century was the starting point of modern sustainable thinking. Environmentalism began in this period of time and lead to such a standing that the first Earth Day was celebrated in Vermont in April 1970. Another product of the advances in environmentalism occurred in 1972 when the United Nations Conference on Human Environment was held in Stockholm (Hill and Bowen 1997). The conference brought about the concept of ecodevelopment. Ecodevelopment is defined as "an approach to development aimed at

harmonizing social and economic objectives and ecologically sound management" (Hill and Bowen 1997, citing Gardner 1989, citing Sachs 1978). According to Hill and Bowen (1997), sustainable development was spawned from ecodevelopment. Sustainable development is the precursor to sustainable construction.

The 1970s and early 1980s was a time of much discussion on how development could uphold the ideals of conservation and preservation that permeated the sustainable vernacular of the time. The dialogue culminated in a conference; the World Commission on Environment and Development (WCED). The WCED produced the much sited publication 'Our Common Future' in 1987. This publication is sometimes referred to as the 'Brundtland Report'. Our Common Future defined sustainable development as "meeting the basic needs of the people without compromising the ability of future generations to meet their own needs" (WCED 1987). The report is the foundation of most research on sustainable development to this day.

2.1.2 Environmental Ethics

The Brundtland Report cited sustainable development as the foundation of the concept of the ethics of sustainability. One major concept of the ethics of sustainability is that the planet is valuable and vulnerable, from the perspective of its inhabitants. It is valuable because of the resources it provides for its inhabitants and the planet is consequentially vulnerable to its inhabitants in their pursuit of resources (Attfield 1999). A set of values was needed to define why resources and the planet itself should be protected from the harm of man. This set of values was defined and is now known as environmental ethics.

2.1.2.1 The ethics of sustainable development

The concepts of sustainable development are a subset of environmental ethics. In 1986 the United Nations created a definition of development in the 'Declaration on the Right to Development', in which development was defined as:

> a comprehensive economic, social, cultural and political process, which aims at the constant improvement of all well-being of the entire population and of all its inhabitants on the basis of their active, free and meaningful participation in development and in the fair distribution of the benefits resulting therefrom. (United Nations 1986)

As per the definition, development can not to be measured by economic growth alone. According to Attfield (1999), sustainable development is a "social state of progress" which is present when the evils of underdevelopment are reduced or completely alleviated and replaced by the good of development. For example, sustainable development is illiteracy replaced by literacy, poverty replaced with meaningful employment, and poor health facilities replaced with health facilities that bring health and wellness to the population. At its simplest, sustainable development is the satisfaction of basic needs (Attfield 1999). Under this definition of sustainable development, if a building is constructed to a sustainable building standard, such as LEED, but it does not offer any benefit to the people of the surrounding community, then it is not considered to be truly sustainable. This benefit that Attfield describes is sometimes difficult to define in measurable terms.

The ethics of sustainable development go far beyond the realm of construction and the built environment. For the purposes of this paper only the ethics of sustainable construction will be explored. Reduce, reuse, and recycle are the basis for most of the environmental movement and so it is also integral in the practices of sustainable construction. There have been additions and evolutions of the basic principles of

environmental ethics. Organizations and individuals have collected and analyzed the basis of sustainable construction and they have created many principles of sustainable construction. One such institution was the international construction research networking organization Conseil International du Batiment (CIB) (Kibert 2008).

2.1.3 The Principles of Sustainability

For the purposes of this report, the discussion of principles will focus on the principles of sustainability that were developed in 1994 by CIB (see Figure 2-1). The seven principles are to be applied to inform decisions regarding phases of the life of a building and to the resources that are utilized by that building. The phases of the building include planning, development, design, construction, use and operation, maintenance, modification, and deconstruction. The resources utilized by a building include: land, materials, water, energy and the surrounding ecosystem (Kibert 2008).

Reduce	•Reduce resource consumption
Reuse	•Reuse resources
Recycle	•Use recycable resources
Nature	•Protect nature
Toxics	•Eliminate toxics
Economics	•Apply life-cycle costing
Quality	•Focus on quality

Figure 2-1. The principles of sustainable construction, adapted from (Kibert 2008)

The reduction of resource consumption is a key principle of sustainable construction. The reduction of resources not only refers to the reduction of physical resources such as metals or cement, but also to the reduction of energy required by the building's occupants. One of the goals of a sustainable building is to allow its occupants to feel physically comfortable and not hinder their work while conserving energy through

use of passive design and proper sizing of mechanical systems (if there are any installed).

Many resources are now available that are made from recycled or reused resources, such as fly ash additives in concrete or recycled steel for structural work. These products and others lend themselves to the principle of using reused resources. Reused and recyclable materials are often confused. Reused materials are made from something that was used as a material for something else prior to becoming whatever it is in its new context. Recyclable materials on the other hand are materials that can be reused after the end of the object's current use. Therefore a reused material for certain had another life before its current use, but a recyclable may be made of a virgin resource but it does have the capacity to be reused after its current use. The decision maker who specifies materials used for a building project should strive to select materials that are both reused and recyclable (Kibert 2008).

Protecting nature is a principle of sustainable development; it begins with the commitment to construct a building and the process of selecting a site. The ecosystem is an often ignored resource, but it provides priceless resources such as clean air and water. Developers and owners should make every effort to build on brownfields or greyfields and in areas of high density that have existing infrastructure. These practices will help to preserve the greenfields, or undeveloped land, and have less of an impact on ecosystems (Kibert 2008).

In order to build sustainably, toxics should be avoided at all costs. Toxic materials are often confused with toxins. Toxins are natural substances that are produced by plants and animals as a defense mechanism. Toxic materials are made by man, and

unlike toxins they often do not readily breakdown and become harmless in a short amount of time (Kibert 2008).

Every project has an impact on economics. Money is being spent and employees are being hired every time a building goes under construction. For a project to be truly sustainable life cycle analyses should be done for the systems for the building. Life cycle costing would show the total cost of a material/system from cradle to grave. One principle of life cycle costing is to get as much value for products that are to be salvaged at the end of the building's life so that there is less cost associated with the product (Kibert 2008).

Quality projects are highly appreciated by the community. The community is more likely to reinvent and remodel a quality building overtime than a building of lower quality. Quality products have higher up-front costs but require few repairs and do not need to be replaced very often, thus making quality more sustainable (Kibert 2008).

2.2 Sustainable Construction

Sustainable construction is an offspring of the sustainable movement. Sustainable construction is defined by Kibert (2008) as "the ecological, social, and economic issues of a building in the context of its community". Sustainable construction is difficult to define because it is essentially a contradiction. The cornerstone of sustainability is conservation, and the act of building involves the use land and resources, a clear discord. Sustainable construction is a balancing act of conserving and preserving ecosystems while providing a beneficial structure or infrastructure (Kibert 2008).

2.2.1 The Pillars of Sustainable Construction

To understand what needs to be attained in order to have a sustainable construction project, Hill and Bowen (1997) developed through extensive research four

pillars of sustainable construction. The four pillars of sustainable construction encompass social, economic, biophysical, and technical concepts (See Figure 2-2).

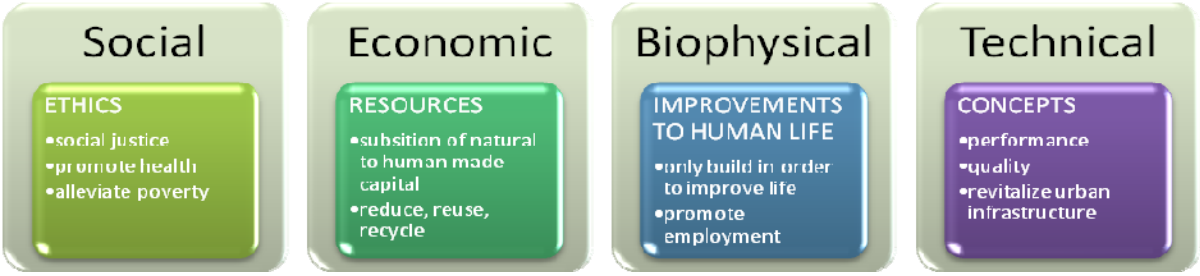


Figure 2-2. The pillars of sustainable construction, adapted from (Hill and Bowen 1997)

2.2.1.1 The social pillar of sustainable construction

The social pillar represents the notion of social equality. Social equality calls for a general improvement of the quality of human life, specifically an improvement on alleviating poverty and inequality (Hill and Bowen 1997). This pillar represents the ethical aspect of sustainability and uses many principles that were laid out in 'Our Common Future' which is also known as 'The Brundtland Report' (WCED 1987). According to Hill and Bowen (2007), the 'Brundtland Report' stated reviving growth as a way to reduce poverty. Some believe that the emphasis on growth found in the 'Brundtland Report' was incorrect and the focus should have been on development rather than growth. The social pillar is perhaps the hardest to define in a single built project. Some specific things that the social pillar of sustainable construction calls on construction practitioners to do are as follows

> Improve the quality of human life by ensuring secure and adequate consumption of basic needs, which are food, clothing, shelter, health, education, and beyond that by ensuring comfort, identity, and choice. Protect and promote human health through a healthy safe working environment. Plan and manage construction process to reduce the risk of accidents, and carefully manage the use of substances which are hazardous to human health. Implement skills training and capacity enhancement of disadvantages people to allow them to meaningfully participate in a project. (Hill and Bowen 1997)

Implementing these policies and others is a means of fulfilling the social requirements of sustainable construction.

2.2.1.2 The economic pillar of sustainable construction

The economic pillar of sustainable construction as proposed by Hill and Bowen (1997) is based on the proposals of the economist Solow. According to Hill and Bowen (1997), Solow suggested that “sustainability was concerned with the substitution of natural to human-made capital”. The depletion of resources due to human consumption is inevitable, but there are ways of substituting technologies that use unsustainable resources which can be replaced by natural means (grown) or recycled at the end of that technology’s useful life.

The economic pillar of sustainable construction also deals with the financial aspects of the building project. These financial aspects include conducting full-cost accounting and ensuring financial affordability for intended users of the building. It is also advised to promote employment through the structure that is being created; by employing locals to build the project and by selecting to build projects which would bring an economic stimulus to the area and/or provide affordable services for the local people (Hill and Bowen 1997). Those actions would both input and keep money circulating in the area in which the project is constructed. Following the principles of the economic pillar of sustainability, It would be ideal to build in areas that are economically depressed in order to make a greater impact on people’s lives.

2.2.1.3 The biophysical pillar of sustainable construction

The term biophysical as defined by Hill and Bowen (1997) is the” atmosphere, land, underground resources, the marine environment, flora, fauna and the built environment”. In order to produce a sustainable construction project, the project shall

not require fossil fuels and minerals or produce substances that are foreign to nature at rates which are faster than the Earth can reabsorb them or create them (Hill and Bowen 1997). Under this condition it is impossible to use petroleum based fuels, which is extremely impractical at this particular point in time.

Another stipulation of the biophysical pillar is that the project must be designed to reduce the use of energy, water, materials, and land at every stage of the project's life-cycle. The reduction of energy requires a reduction in embodied and operating energy (Hill and Bowen 1997). Many so called sustainable construction projects only focus on reducing operating energy; this method does not account for the energy it takes to create the materials and systems of the structure and transport them to the project's location.

Minimizing pollution and maximizing reused and recyclable materials is another requirement under the biophysical pillar. By choosing materials that are reused and/or recycled and also recyclable closes the materials loop. Minimizing the impact on air, land, and water quality is accomplished by using non-polluting and non-toxic products and materials for the project.

2.2.1.4 The technical pillar of sustainable construction

The term 'technical' refers to the performance and quality of a structure. Under the advisement of the technical pillar of sustainable construction, builders are to strive to construct "durable, reliable and functional structures" (Hill and Bowen 1997). Durable buildings stand the test of time and continue to fulfill the needs of occupants as those needs change over time. The durable structure can adapt and reduce the need to build new structures as technology progresses. The functionality of buildings was once more important than the style of the building according to Hill and Bowen (1997). Style can

date a structure quickly and cause the occupants to feel poorly towards the building. If the building's design is based on function and less on style, then the building is more likely to be viewed positively and be in use over time.

High quality is also a directive of the technological pillar of sustainable construction. Using quality materials to construct leads to a longer usable life of a building. According to and Bowen (1997), quality buildings are rarely demolished, they are more like to be well maintained by their owners and occupants and be seen as a thing of beauty by the surrounding community.

2.2.2 Sustainable Construction Rating Systems

In order to implement sustainable practices many programs and rating systems have been developed to give the construction industry a set of guidelines. According to Kibert (2007), rating systems "provide a score that rates the effects of a building's design, construction, and operation, among them environmental impacts, resource consumption, and occupant health". The most popular rating systems were beginning to be formally created in the early 1990s. Nearly twenty years after the movement began gaining momentum the sustainable building movement is now a highly successful part of the building construction industry. There are many types of rating systems that are available for application to construction projects. Each rating system has its own focus, which can be on anything from how to build for a single geographic area or to solely focus on the energy efficiency of a building's appliances. Some of the more popular rating systems are very generic and can be used worldwide, for example the United States Green Building Coalition's (USGBC) Leadership in Energy and Environmental Design (LEED) rating systems or the Green Building Institute's (GBI) Green Globes assessment protocol have rated thousands of buildings across the world.

Rating systems such as LEED and Green Globes have propelled the ease with which organizations can get into the sustainable construction trade (Kibert 2007).

2.2.2.1 The Green Globes Assessment Protocol

The Green Building Institute (GBI) is a nonprofit organization that provides services to promote credible and practical green building. The GBI was originally formed to provide rating systems based on the National Association of Home Builder's (NAHB) rating system for local home builder associations. When an opportunity arose they entered into the U.S. market and began offering the sustainable construction rating system that they had formed in Canada. The Green Globes assessment protocol began to be used for new and existing commercial buildings in the U.S. in 2004 (Green Globes 2010).

The Green Globes assessment protocol assesses commercial projects for the environmental impacts that they generate. The assessment system ranks the impacts of the following categories: energy, indoor environment, site, water, resources, emissions, and project/environmental management. The sustainable construction practices that reduce the impacts are ranked on a 1,000 point scale. A project must gain 35% (350) points of the scale to begin the Green Globes certification assessment process. The process involves qualified third party professionals reviewing the projects documents and conducting site visits. Once the project review is complete if the structure is qualified it will be assigned a rating score of anywhere from one to four Green Globes depending on the overall points earned for reducing environmental impact.

The Green Globes assessment system is similar to other rating systems, but it does have address some issues which makes it unique. Those issues include: project

management, emergency response, planning, durability, adaptability, deconstruction, life-cycle assessment, and noise control.

Table 2-1. The green globes rating system adapted from (Green Globes 2010)

Environmental Assessment Area	Total Points Available
Energy	300
Indoor Environment	160
Resources/Materials	145
Water	130
Site	120
Project Management	100
Emissions	45
Total	1000

2.2.2.2 The LEED Rating System

The Unites States Green Building Coalition (USGBC) launched the Leadership in Energy and Environmental Design (LEED) rating system for new construction in 1998 (Kibert 2008). LEED is currently the most widely used set of rating systems in the United States. According to Kibert (2008), the USGBC specifically set out to make the LEED rating systems market-driven rather than being a government mandate. They wanted to create a system that would market itself by increasing market value of buildings constructed and certified under the LEED system. The USGBC also specifically set out to form the LEED system with a consensus based approach with input from many different sources including government, industry, and academia.

LEED is a collection of standards and it was updated in 2008 to the v3series. The collection now includes LEED for Existing Buildings, LEED Commercial Interiors, LEED Healthcare, LEED for Homes, LEED for schools, LEED for New Construction, and others. The LEED system has become specific for building types and is attempting to become regional by offering a new point available for addressing regional environmental issues. The rating systems certify buildings based upon the number of points earned.

The points are available for attempt, but if a point is not earned or not attempted then that point is forfeited and essentially counts against the project. The categories that points are offered in include: sustainable sites, water efficiency, energy and atmosphere, materials and resources, indoor environmental quality, innovation in design, and regional priority.

The LEED v3 project is scored by the Green Building Certification Institute (GBCI) their third party affiliates. Projects are scored on their construction documents and evidence of implementation of sustainable practices on the job site. Projects can earn a level of Certified, Silver, Gold, or Platinum. The points are based on a 100 point scale, a certified building has received 40-49 points, a silver rating is 50-59 points, and gold rating has earned 60-79 points, and a platinum rated building has earned 80 points or more (USGBC 2009). In 2009 the USGBC spelled out its criteria for weighting points, it goes as follows:

> the allocation of points between credits is based on the potential environmental impacts and human benefits of each credit with respect to a set of impact categories. The impacts are defined as the environmental or human effect of the design, construction, operation, and maintenance of the building, such as greenhouse gas emissions, fossil fuel use, toxins and carcinogens, air and water pollutants, indoor environmental conditions. A combination of approaches, including energy modeling, life-cycle assessment, and transportation analysis, is used to quantify each type of impact. The resulting allocation of points among credits is called credit weighting. (USGBC 2009)

See Table 2-2 for the categories and criteria.

Table 2-2. The LEED rating system categories and criteria adapted from (USGBC 2009)

Assessment Category	Total Points Possible
Sustainable Sites	26
Water Efficiency	10
Energy and Atmosphere	35
Materials and Resources	14
Indoor Environmental Quality	15

Innovation in Design	6
Regional Priority	4
Total	110

After a certification level is awarded, the building receives a plaque that can be placed on the building, see Figure 2.3 for an example. The certified building is also featured on the USGBC website.

Figure 2-3. USGBC plaque indicating a LEED Gold certification, as seen on the M.E. Rinker, Sr. Hall Building on the University of Florida's Gainesville campus

2.2.2.3 The U.S. Army's SPiRiT Rating System

The United States Army adopted green building in 2002 with the implementation of the SPiRiT rating system that was based on LEED NC 2.0. The United States Army Corp of Engineers (USACE) created the SPiRiT rating system, which is an acronym for Sustainable Project Rating Tool, in order to build sustainability and meet the Army's sustainability goals which will be discussed later in this report (Gillespie and Miller 2007). The USACE Engineer Research and Development Center created a document

which lists some of the benefits of using the SPiRiT rating system. Those benefits include:

- preserving a clean environment
- maintaining sustainable sites
- maximizing water efficiency
- lowering ongoing costs, conserve energy and preserve the atmosphere
- conserving materials and resources
- improving the facility delivery process
- ensuring success in current and future missions
- providing healthy places to live and work (US Army Engineer Research and Development Center 2008)

The SPiRiT rating system works much like the LEED system; it ranks projects on a scale system. SPiRiT has a 100 point scale while LEED 2.0 has a 69 point scale. The additional 31 points that LEED NC 2.0 does not offer were available in three additional categories that the SPiRiT system has created that go beyond the LEED NC 2.0's six categories. The added categories are facility delivery process, current mission, and future missions (Gillespie and Miller 2007).

The facility delivery process addresses the organization of the building's delivery process by detailing how to assemble the teams and team leaders, how to create training schedules for maintenance crews, and how to describe the goals and measures of a successful completion of the project (Gillespie and Miller 2007). The current mission category of SPiRiT advises commissioning, and setting up written sustainable operational and maintenance plans and procedures for the building. The future mission category awards points for planning for the life of the building including designing

buildings that can be used for different purposes in the future and labeling components of the structure to make it easier to deconstruct and recycle the parts of the building.

The USACE used the SPiRiT rating system until the beginning of the federal government's 2008 fiscal year when they mandated a change to the LEED v3 system for all projects. The mandate to change to the USGBC's LEED system was issued in a bulletin from the Deputy Assistant Secretary of the Army to the USACE in January 2006. In the mandate the USACE specified that all projects be built to a certifiably silver level on the LEED point scale (Whitaker 2006). Although all projects are built to the silver certification level the Energy Independence and Security Act (EISA) requires only 5% of projects to complete the certification process and receive official GBCI certification (Dalton 2008).

2.3 Sustainability and the U.S. Army

The U.S. Army was founded June 14th 1775; it is currently one of three departments (army, navy, and air force) that answer to the Department of Defense (DOD). The army currently has more than 522,000 active-duty soldiers, 264,000 active reserve component soldiers and these soldiers are supported by more than 250,000 civilians who work for the U.S. Army (U.S. Army 2008). In the late twentieth and the beginning of the twenty-first century, the army began to seriously consider its own sustainability; the army began to focus on their triple bottom line: mission, environment, community (Hallmark 2006).

Over the years communities that once kept their distance from Army installations began to encroach closer to the post perimeters (Hallmark 2006). As the surrounding community grew closer a number of issues with noise and other effects of military training grew to the point that the environmental compliance mission of just maintaining

and conforming to existing laws was longer adequate. According to Hallmark (2006) at this time Forces Command (FORSCOM) developed the FORSCOM Installation Sustainability Program (ISP). The ISP focused on logistical support for sustaining field operations; it was the first step toward long-term sustainability for army operations.

In July 2001 the Deputy Assistant Secretary of the Army, Environment, Safety and Occupational Health ordered Army installations to adopt ISO 14001. The ISO 14001 standards address environmental management. According to the ISO website, ISO 14001 is meant to “minimize harmful effects on the environment caused by its activities and to achieve continual improvement of it environmental performance” (International Standards Organization 2010).

In the last few years the army has developed the Army Strategy for the Environment (ASE) and the Army Sustainability Report 2007 (ASR). The ASE is the long-term vision of the sustainable army and it sets up goals that the Army will try and achieve. As discussed previously in this report the term sustainability can be defined differently by nearly every entity; the U.S. Army defines a sustainable Army as “simultaneously meeting current as well as future mission requirements worldwide, safeguarding human health, improving quality of life, and enhancing the natural environment” (U.S. Army 2004). The army recognizes that the nature of the world has changed drastically over the last decades, our enemies are no longer are easily recognizable, they cannot be based solely on nationality, the borders of nations do not matter as much as they previously did and the world has essentially become smaller. Advances in technology and increases in population and urbanism are ever increasingly placing stresses on human, economic, and natural resources. What were once local

and regional issues occurring over natural resources and ecological decline are now becoming international issues that influence other countries such as the United States (U.S. Army Sustainability 2008). The U.S. Army is evolving to meet the current needs of safeguarding natural systems on which the United States rely on.

The U.S. Army has compiled a report known as The Army Strategy for the Environment: Sustain the Mission - Secure the Future (ASE). It was the first report of its kind to be created by a U.S. government agency. In the opening statements of the report the Chief of Staff and the Secretary of the Army stated why sustainability is important to the army:

> Sustainability connects our activities today to those of tomorrow with sound business and environmental practices. We have learned over the past decades that simply complying with environmental regulations will not ensure that we will be able to sustain our mission. We must strive to become systems thinkers if we are to benefit from the interrelationships of the triple bottom line of sustainability: mission, environment, and community. To sustain the future Army we must implement effective policies and practices that safeguard the environment and our quality of life in a manner that our nation expects of us. (U.S. Army 2004)

The Chief of Staff and the Secretary of State make reference to the U.S. Army's triple bottom line of sustainability. The triple bottom line in the conventional business sector is people, planet, and profit or economic, social and ecological costs of a product or decision. The triple bottom line of the U.S. Army is defined as mission, environment, and community (see Figure 2-4). Under the sustainability measures, when the U.S. Army makes a decision is must measure the impacts on the mission of the army, the environment, and the surrounding community. The ASR released in 2008 added a plus to the triple bottom line. The plus represents the fact that when sustainable practices are implemented the true cost of doing business is reduced (U.S. Army 2008).

The ASE set up six goals to achieve a sustainable army. The six goals are: foster a sustainability ethic, strengthen army operations, meet test training and mission requirements, minimize impacts and total ownership costs, enhance well-being, and drive innovation.

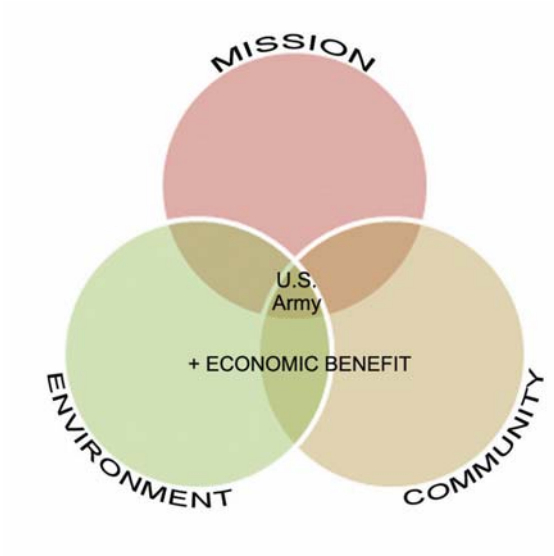


Figure 2-4. The U.S. Army triple bottom line, adapted from (U.S. Army 2008)

The U.S. Army's Sustainability Report 2007 (ASR) was released in September 2008. The U.S. Army was the first government agency to release a sustainability report under the Global Reporting Initiative (GRI) reporting standards. According to its website, the GRI is a network-based organization that has developed a reporting technique based on a consensus of its members. The structured reporting technique offers a way to create sustainability reports in such a way that they can easily be read and compared to other sustainability reports (Global Reporting Initiative 2007). The report builds on the Army Strategy for the Environment's goals as well as providing information on ongoing measurements of sustainability in the army.

The GRI recommended indicators are summarized toward the end of the ASR. The army's supplies data to respond to the required indicators in the form of hyperlinks.

There are quite a few indicators and the army has supplied many references, sometimes several hyperlinks per indicator, in order to provide the required information, but it is very inconvenient and would require research that is beyond the scope of this report to provide that information here.

2.3.1 Army Construction Process

The process of developing and building a military project can be referred to as the military construction (MILCON) process. Sheller (2000) describes the MILCON process, in brief, as follows; it begins at the base, post, or facility level with a need of a new building structure. When the need has been established the funding and design process begins, this process varies between the services. The location and service mission determine whether the building project will utilize a regional design center or a more local design team to create the plans and specifications. Through either process a team of design, engineering, and contracting professionals will be drawn together for the project. See Figure 2.5 for a representation of the MILCON process hierarchy. The commander of the post, base, or facility acts as the owner on a MILCON project. The commander may or may not have experience with MILCON project of similar nature to the one being designed and constructed; they may have no knowledge of the process at all. The team will be working together for the MILCON project but they will individually have other projects that they are working on and each will have a different set of priorities and company styles and culture. These variables make working on a MILCON project complex and difficult. Sheller (2000) states that the best way to implement a green building process for a MILCON project is to have the base, post, or facility commander be heavily involved in implementing the green standard during the MILCON process.

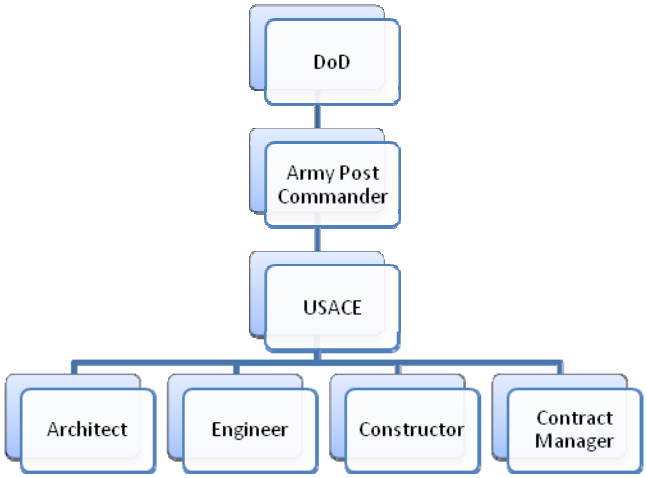


Figure 2-5. The MILCON process hierarchy system.

Todd Sheller studied the implementation of a green standard for MILCON projects and developed a ten step approach for base, post, or facility commanders to implement a “simplistic approach by which energy efficiency and green construction principles can be achieved” (Sheller 2000). The checklist for base commanders was designed for commanders so that they can “pose questions to the engineering (design, and construction) communit(ies) and force a green construction or sustainable project” (Sheller 2000). The checklist begins in the pre-design phase and continues through the construction team selection, design and specification, construction, and post occupation phases.

2.3.2 The Army Corps of Engineers

The U.S. Army Corp of Engineers (USACE) is a federal agency and a U.S. Army command. The USACE is composed of more than 34,000 civilians and Soldiers. They dedicate their work in over 90 countries. Among many other duties, the USACE provides construction and construction management services to the U.S. Army. According to the USACE website environmental sustainability is their guiding principle (U.S. Army Corps of Engineers Headquarters 2010).

With the transition to sustainable construction under the SPiRiT and LEED programs there has been some turbulence. The USACE is trying to rectify the situation. In a USACE engineering and construction bulletin issued on July 9, 2009, the need for regional sustainable engineering program managers was laid out. Nine projects that have been completed under the LEED program were evaluated. Lessons learned were gathered from these projects, they included reference to inadequate or incomplete LEED documentation to support a certifiable project. As a result the Directorate of Civil Works for the Army Corps recommended each military installation with a substantial military construction program to designate or recruit and hire a minimum of one interdisciplinary engineer/architect to serve as a full time district and/or regional sustainable engineering program manager. The completion of the LEED program and the responsibility for certification previously fell to the installation Director of Public Works or the Reserve Component equivalent, supporting Engineer District, designer and constructor would jointly. The project delivery team (PDT) LEED-AP and the SDD point of contact (POC) from the associated division are to hold the project team manager roles for LEED online (Dalton 2008).

Now with the sustainable program redesigned, the projects that are currently under construction should be of high quality. The USACE wants the world to know what a great job they are doing with their sustainable construction processes. In a USACE engineering and construction bulletin issued on October 2, 2009, the Directorate of Military Programs and the Directorate of Civil Works called for more communication of sustainable design and energy efficient features of army projects. The Directorates Dalton and Rivers stated the continued advancement and significant investments in

sustainable construction and declared that they wanted sustainable construction to become part of the Army's construction culture. They touted the need to share the knowledge of sustainable design and energy efficient features not only on site visits but also through written documentation that conveys the salient sustainable features of each Army facility. Each PDT document should address how the facility had (or will) meet the LEED NC requirements for a Silver rating. The documents Dalton and Rivers proposed are to include fact sheets, brochures, written articles, and building signage that communicate the benefits of the Army's investment in sustainable design (Dalton and Rivers 2009).

2.4 The Transition to Green Design

As discussed previously, modern sustainable construction practices and rating systems have been in use by a small portion of the construction community from the early 1990s and even earlier. It seems that sustainable construction practices are beginning to become accepted, but they are still far from being a norm for the industry. The USGBC keeps records of their members; the number has grown from 97 members in 1997 to more than 20,000 as of September 2009. When individuals are interested in sustainable construction the clearest way to show your acceptance currently is to go through the credentialing process and become a LEED Accredited Professional. As of 2009, the USGBC had more than 130,000 LEED APs (USGBC 2010). Today there are an estimated 7,214,900 people within the construction community, 1,659,300 of which are involved in the building of residential and non-residential buildings (United States Department of Labor 2010). If the majority of LEED APs are working within the residential and non-residential than less than 12.7% of the community is a LEED AP. This is an unscientific measurement, because many LEED APs are from the

architectural and engineering fields, and so the percentage of LEED APs within the construction community is much less than 12.7%.

2.4.1 Industry Perceptions of Sustainable Construction

Table 2-3. Survey responses on the perception of the impact of sustainable construction, adapted from (Chong et al. 2009)

	Overall Respondent (%)	Contractors (%)	A/E and Consulting Firms (%)	Owner/ Employee (%)	CM Consultants (%)	Government Employee (%)
Perception of impact of SC*						
Cost	89.0	76.7	71.8	66.7	88.9	86.7
Quality	67.0	50.0	51.3	48.1	72.2	60.0
Schedule	60.0	43.3	48.7	44.4	72.2	40.0
Safety	34.0	13.3	30.8	14.8	50.0	26.7

SC* Sustainable Construction

So why is it that some professionals within the industry choose to accept sustainable construction and others are hesitant to the transition? Chong et.al. (2009) conducted a survey of engineers in the construction profession to understand and interpret what their perceptions of sustainable construction were. Chong et al. surveyed 2,600 selected American Society of Civil Engineers (ASCE) members and other construction-industry related group members and received 257 responses. The respondents felt that sustainability is important or relatively important to the construction industry, however, they felt that there has not been enough research on sustainability and the current design practices did not sufficiently address sustainability (Chong et al. 2009). About 64% of the overall respondents were familiar with LEED, and approximately 70% of the contactor respondents were familiar with LEED. The Chong et al. (2009) survey attests that participation in sustainable construction by employees was very low, with 70% of the responses having 10% or less of their employees participating regularly in sustainable construction related activities. The perceptions of

the impacts of sustainable construction can be seen in Table 2-3. Overall cost was seen to be the biggest impact of sustainable construction, followed by quality, schedule, and safety. The survey question was presented as a fill in the blank and only the responses cost, quality, schedule, and safety were analyzed by Chong et. al (2009).

2.5 Barriers to Sustainable Construction

The barriers to sustainable construction take many forms. There are perceived added costs, fear of the liability assumed by using new technologies, and psychological barriers. The barriers need to be understood by companies and institutions that are considering transitioning to sustainable construction so they can know what arguments and opposition they may face.

2.5.1 Barriers Perceived by the Construction Industry

Turner Construction conducted a survey of the construction industry to develop an understanding of the perceptions of the industry. The results were reported in the Turner 2008 Green Market Barometer. The survey was conducted online and the survey population was focused on executives involved in commercial real estate. There were 754 respondents form a wide background including building owners and operators and construction professionals. The survey found several factors that were perceived to be barriers to sustainable construction. See Figure 2-6 for a graphic presentation of the factors.

The cost and documentation for LEED construction was perceived to be the biggest barrier to transitioning to sustainable construction, followed closely by a perceived long payback period and higher construction costs. A lack of the awareness of benefits was the fourth most perceived factor which discouraged the construction of green buildings and difficulty quantifying benefits was fifth, followed by short-term

budget horizons, fears of more complex construction and increased operating costs. The majority of the perceived factors that discouraged sustainable construction were based on costs. There is perceived to be a higher cost associated with building sustainably it is the first barrier to sustainable construction.

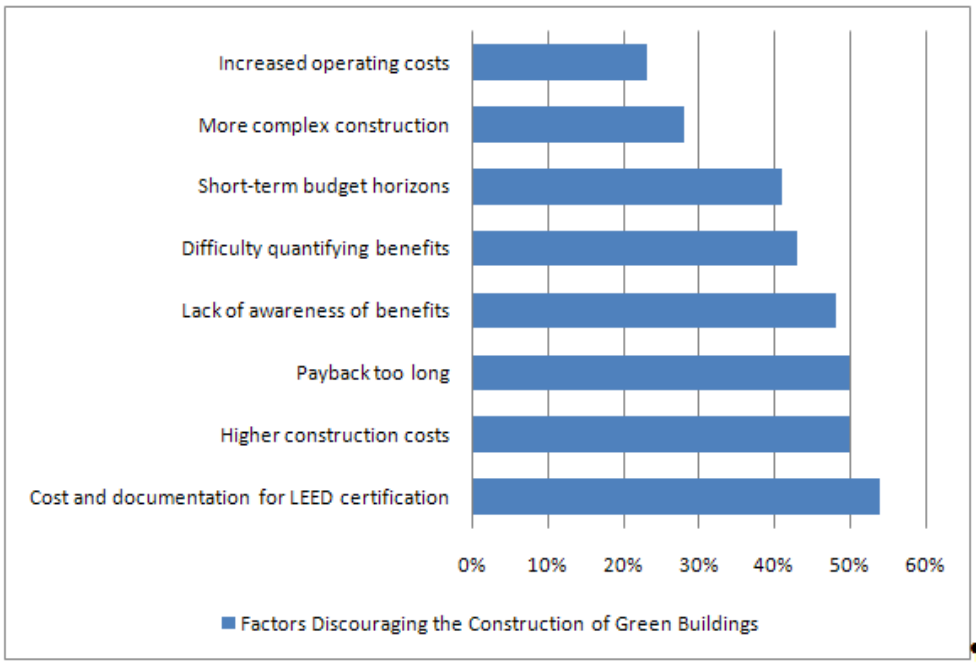


Figure 2-6. Survey responses on the barriers of implementing sustainable construction, adapted from (Turner Construction Company 2008)

2.5.2 Social and Psychological Barriers to Sustainable Construction

The second barrier to sustainable construction is the social and psychological barriers. People perceive sustainable building on a cognitive basis, they are influenced by their organizations and they are influenced by institutions that guide their awareness of connections and impacts on the environment (Hoffman and Henn 2008).

People make subconscious decisions that may are incorrect all the time. For the purpose of making decisions on sustainability, the mind tends to have biases including over discounting the future, egocentrism, positive illusions, presumed associations, mythical fixed-pre bias and environmental literacy (Hoffman and Henn 2008). Over

discounting the future is the reason why people underestimate their use of a product. In the case of a building, many times people underestimate the time that they will utilize the building and therefore do not perceive a value in purchasing products with a higher upfront cost but save money in operating and maintenance leading to faster rates of return.

People make self-serving or egocentric decisions. It is human nature to do so. Hoffman and Henns' (2008) example is of a couple who purchases a home in the suburbs because they perceive that the yard and neighborhood are good for raising children, but they have in fact made a decision that lends to suburban sprawl and all the unsustainable consequences. Positive illusions are harmful to sustainable construction because people perceive that the world will be a better place in the future than it actually will be. People want to be optimistic and they believe that world will be a better place no matter what harm they do to planet now. They believe that we will somehow find a way to fix everything and erase all the ill that has been done.

According to Hoffman and Henn (2008) there is a presumed association (maybe more so to the boomer generation) between green construction and the hippie movement of the 1960s and the energy crisis of the 1970s. There is an unsubstantiated assumption that green buildings involve unconventional aesthetics, alternative lifestyles and non-traditional building materials such as rammed earth and straw bale.

The mythical fixed pie is a subconscious bias that occurs in the mind when making decisions about sustainable construction. Hoffman and Henn (2008) describe a fixed pie that people have to split between economic competitiveness and environmental

protection. People cannot see economic competitiveness and environmental protection as separate and having a symbiotic relationship.

The last bias that affects the subconscious mind it environmental literacy. In short it is pure ignorance of the facts of nature and our sources of energy and waste that has a detrimental effect on decisions concerning sustainable construction (Hoffman and Henn 2008).

Within the organizational level perspectives on the socio and psychological barriers to sustainable construction are the key elements of internal structure and interaction, language and terminology, rewards, and organizational inertia (Hoffman and Henn 2008). The structure of the organization must define boundaries and responsibilities of employees. The language must be understood by all who are involved on the project. Sustainable construction has given rise to new technologies and lingo. It is important that everyone understand what is occurring and speak the same language. Rewards must be changed from progress based rewards to combine sustainable practices and productivity. Organizational inertia must get employees accustomed to learning new things and implementing new practices.

Institutional level perspectives on the socio and psychological barriers to sustainable construction have implications on three levels: regulative, normative and cognitive. Regulative institutions must regulate sustainable practices. This regulation can take the form of taxes or incentives among other regulative means. Sustainable construction methods need to become industry norms. Codes should be changed to allow for easier implementation of new materials or technologies to speed up the normative process. Cognitive institutions are the unquestioned biases that most people

in the construction industry prescribe to. Industry professionals need to thick outside the box and question practices for their impact on the environment.

2.5.3 Technological Barriers to Sustainable Construction

Traditionally buildings require very low tech materials and high intensity labor; this is what the construction industry is accustomed to. Building materials of conventional construction are readily available, cheap, and differ very slightly between manufacturers. The demand for these products is very high and manufacturers responded by making standard sizes and systems that were easily installed. A barrier to sustainable construction is the unique nature of many of the new sustainable technologies that are making their debut. The sustainable technologies such as building controls, solar energy systems, and heat recovery systems are high-tech compared to their conventional counterparts and are supplied by specialists who may not be readily available to all locations (Rohracher 2001). Many times specialized labor is required for the installation of sustainable technologies and it takes time to train workers and prepare them for an install that may be a one-of-a-kind. Training for sustainable technologies is not readily available in many communities. It may not be worth a contractor the time and money it takes to train a laborer to install sustainable technologies when the technologies are in a rapid state of development and may change drastically before that laborer is needed for a sustainable technology installation of that type again. It is easier for the contractor to recommend to the owner to not use that particular sustainable technology and to continue using more conventional technologies.

2.6 Overcoming Barriers to Sustainable Construction

Getting a commitment to change is typically a difficult task. Mandating a change to sustainable construction is not going to change the office structure overnight. The transition to sustainable construction takes time and requires a shift in office culture. The barriers discussed earlier will come into play and some personnel may be resistant to changing how they have always done business. The barriers must be overcome one by one until everyone is on-board and willing to change the culture of the company.

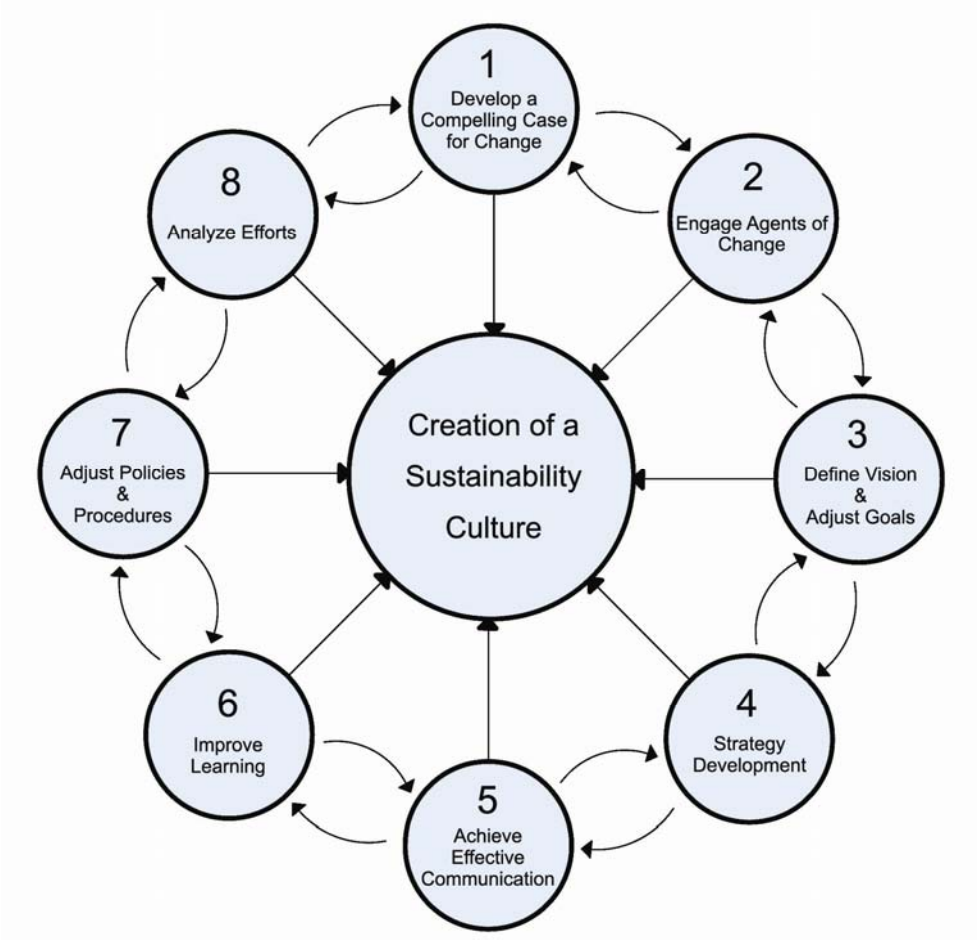


Figure 2-7. Creation of a sustainability culture, adapted from (Hallmark 2006)

Companies and institutions making the change to sustainable construction should have a plan to shape the organization's core values. Hallmark (2006) adapted a system

of eight key elements or planned interventions, which contribute to the creation and development of a culture of sustainability, see Figure 2-7. The arrows represent links between the eight elements, at these times the process should be examined and analyzed for success of the prior element and to see if the change is going on course. All of the eight elements must occur for the cultural shift to sustainable construction to occur completely. The cycle should constantly be moving; when it is moving clockwise then progress in occurring, when it is moving counter clockwise a diagnosis of the elements is occurring and a correction may be needed (Hallmark 2006).

2.6.1 Overcoming the Perceived Cost Barrier to Sustainability

Owners and contractors typically view cost as a major barrier to sustainable construction. Costs are perceived to be higher for sustainable construction than for conventional construction. The actual costs of a building are typically much different than the perceived cost of the building; the actual costs take operation, maintenance and more into consideration. When owners and contractors are considering sustainable construction for a project they need to understand the differences between perceived and actual costs in order to make a good decision. People and companies who may want to implement sustainable construction practices should understand why building sustainably can cost more, and they should also understand that the building may have cost the same if built under conventional means depending on the factors specific to that building.

Davis Langdon is a cost consulting company, and they commissioned Matthiessen and Morris to conduct a study on the actual costs of sustainable construction and compared them to conventionally built projects of the same scope. It was found that there are several factors that influence costs of building; they include: “location, bidding

climate and culture, local and regional design standards, intent and values of the project, climate, timing of implementation, size, and point synergies" (Matthiessen and Morris 2004).

The location of a building is affected because it is more sustainable to build in urban areas, real estate in urban areas can cost more than in rural areas. The bidding climate is affected because contractors do induce some slight costs for constructing sustainably including, the cost of documentation, some schedule impacts during post construction flush-out, and the application of indoor air quality credits of LEED. When the contract is specific to the level of certification that the building requires then the contractor is assuming more risk and may add a fee for the greater risk contingency. This risk will decrease when more contractors become comfortable with sustainable construction. The intent and values of a building must be clearly understood in the early stages of the building, this means that there is more of an upfront investment of time by all project team members which may cost more. However, if the project team is familiar with LEED and sustainable construction then there may not be an added cost at all. The climate that a building will be constructed for can add cost to the sustainably built project because the temperature and humidity of the area greatly affects building system selection (Matthiessen and Morris 2004).

It is worth noting that as a company becomes familiar with LEED and sustainable construction the additional cost of building sustainably decreases. The level of certification also can change the cost of building sustainably. Building a certified or silver certified building adds very little to no additional costs to a project, while gold and platinum ratings can add more costs. The chance of additional costs should not be a

deterrent, according to Matthiessen and Morris (2004); many projects are built sustainably for no additional cost at all.

2.6.2 Overcoming the Socio-Technical Barrier to Sustainability

The construction industry is currently in what Rohracher (2001) describes as a socio-technical shift. Rohracher (2001) states,

> the growing importance of sustainability issues may have important consequences not only on the technological practice of the industry, but also on its structure, its communication channels and the organizational and strategic orientation of its constituent actors.

The boundaries of the industry are changing and power is shifting. Companies that can respond quickly to the up and coming sustainable construction market will become important. While some of the more established actors in the industry will refuse to reorient themselves to sustainable construction practices.

There are three means by which socio-technical analysis could contribute to the transition to sustainable construction. The means are: support of organizational and institutional restructuring, higher transparency, and broadening the design process by integrating actors who have not yet been involved in the process (Rohracher 2001).

2.6.3 Overcoming the Social and Psychological Barriers to Sustainability

The social and psychological barrier to sustainability is an obstacle to be overcome. Hoffman and Henn (2008) offer several methods to achieving a successful transition to sustainable construction practices, including: framing, targeting demographic adopters, education, structural and incentive change, indemnifying risk, evolving green building standards, and tax reform.

Framing the transition to sustainable construction as a positive option will gain faster approval. Green building should be seen as desirable and consider change the

term sustainable building to smart building or high-performance building to find the right fit for the audience. Target key demographic adopters to get the ball rolling, key adopters are more aligned with environmental value than others. Hoffman and Henn (2008) describe several demographics that are more open to sustainably built buildings, they are women, educated and more affluent people, people who live in urban areas and people who live along the east and west coasts of the U.S. Sustainable construction education is a factor in achieving a successful transition to sustainable construction. It is important that all members of the construction and design team and the owner be aware of sustainable construction and what it entails. Structural and incentive changes are the changes that must occur within the construction and design teams. The teams must work more closely when building sustainably and the collaboration process should allow for more communication. Indemnify the risk of new technologies that the contractors will be taking on. Contractors may fear installing new technologies because they are unproven and if there is a failure it will be on their shoulders. There should be a cap as to the contractor's liability for installing a new sustainable technology. Green standards such as LEED must evolve with the changing times, and institutions such as banks and insurance agencies should also evolve to respond to the new sustainable standards. Finally one last measure that Hoffman and Henn (2008) recommend method to achieve success is more the government and other agencies to offer incentives such as tax rebates and financial incentives for those who implement sustainable construction practices.

2.6.4 Overcoming the Knowledge Sharing Barrier to Sustainability

There are currently many barriers to sustainability. According to Wetherill et al. (2007), one of the greatest barriers lies within organizations and even within project

teams. People are not sharing information and experiences that others can benefit from. Being informed of new resources of knowledge and expertise is vital to transitioning to sustainable construction. Wetherill et al. (2007) believe that knowledge can come in many forms, including documents, standards, and lessons learned. Most organizations do not have a system set up for employees to learn from what others have already learned.

To overcome the problems which occur when people cannot easily share information, Wetherill et al. (2007) recommend putting knowledge management systems in place. Knowledge management systems typically involved networked computers with software that allows employees to input information that they have gathered. When someone has a question about something they can search through the knowledge management system to see if there is a document that can help them.

CHAPTER 3
METHODOLOGY

Sustainable construction has been a part of the construction industry's vernacular for a few decades now, and it appears to be on its way to becoming accepted as a norm within the industry. Some companies have accepted sustainable construction practices on their own accord, while others have accepted it out of need to compete. Institutions around the country have adopted sustainable construction measures for their building projects.

3.1 Problem Statement

The U.S. Army adopted sustainable construction in 2002 with their SPiRiT rating system. In 2006, the U.S. Army issued a mandate which stated that all vertical construction was to meet LEED Silver New Construction rating standard (or the equivalent). The USACE offices had two years warning as the mandate became effective in 2008. There have been issues within the Army, the USACE, and the designers, engineers, and construction professionals that have worked or are currently working on these sustainably built projects. Little research has been done on what the impact of the transition has been on the personnel who were forced to quickly learn the systems of sustainable construction. This report will analyze what the impact of the mandated transition to sustainable construction on the USACE personnel.

3.2 Conducting Research

In order to find what the impacts of the transition to the sustainable construction were a survey will be conducted. The USACE was chosen as the survey population due to its mandated entry into sustainable construction practices, and the willingness to participate in the study. The USACE routinely conducts research through its research

departments and by personnel who conduct research for sustainable construction training. For the purposes of this survey two higher level staff members distributed the survey via email to their colleges within the USACE that deal directly with sustainable construction. The survey population was 60 people. Based on a confidence level of 95% and a confidence interval of 5, the total number of survey responses was calculated to be 52. There were 26 respondents; this number of respondents gives results at a confidence level of 95% and a confidence interval of 15.

3.4 The Survey

The survey begins with a page that describes the survey and what the research is for. Respondents have the choice to consent to taking the survey or to exit the survey. The consent document was approved by the internal research board of the University of Florida. See Appendix A for the survey questionnaire and IRB 02 Approval.

The population for the survey is USACE professionals who are involved with sustainable construction. The professionals will be made up mostly of engineers, but architects and other professionals may also be within the respondent population. The respondents will identify their professions via a question on the survey. The population will also represent differing levels of experience and time spent within the construction industry.

The survey is in an online format that USACE professionals are accustomed to as they are regularly asked to take surveys in this fashion. The survey is anonymous and consists of 29 questions. The respondents are asked questions based on their opinions of how the transition from conventional construction to sustainable construction is going and how they are being prepared and updated to work at an optimal level of sustainable construction practices.

The data is collected and analyzed in order to better understand how well the transition from conventional to sustainable construction is going within the context of the USACE. The survey data should provide valuable information on personnel's opinions and needs during the process. The analyzed data can be used by other companies within the construction industry as they create plans and to prepare their personnel for the transition to sustainable construction.

3.3 Hypotheses

There are preconceived notions of the construction industry and sustainable construction. From five basis hypotheses can be drawn. Some hypotheses of the perceptions of the USACE personnel to be proven or disproven by the study are as follows:

- The higher the level of management (determined by pay grade) the lower the perception of resistance to sustainable construction practices.
- The higher the level of management (determined by pay grade) the more likely they were to feel that their training was sufficient.
- Overall the USACE personnel were not personally interested in sustainable construction prior to the mandate.
- The respondents, if grouped by profession, would have different opinions on the sufficiency of the sustainable construction training.
- The respondents would have differing opinions on why they first became involved with sustainable construction based on profession.

The first hypothesis is based on the level of management and it presumes that upper management will perceive a lower level of resistance within their offices. The basis of this question is that the upper management of the USACE was so preoccupied with the day-to-day work of the office and managing so many people that the employees who were feeling poorly about the transition would fly under the radar. The personnel

who were not favoring the shift to sustainable construction would seek out co-workers of the same pay grade to voice their concerns to, rather than disturb the higher levels of management. Two questions will be analyzed to prove or disprove this hypothesis. The first question is a question of demographics that asks the respondent to select their pay grade. The second question asks respondents to rank the number of personnel resistant in their office.

A second hypothesis to be evaluated is if a person with a higher level of management is more likely to feel that their training was sufficient. The level of management will be determined. As the level of management increases for a survey respondent, the more likely that they are responsible for training their subordinates. When someone is responsible for training they will be more likely to give a higher mark for the personnel's response to the training.

A third hypothesis is that the USACE personnel will not be personally interested in sustainable design. When people are mandated to do something they do not typically want to participate. Questions from the survey will evaluate the number of people resistant to the change to sustainable construction and will directly ask the respondent about their interest in sustainable construction.

The fourth hypothesis to be evaluated is that the USACE personnel when grouped by profession will have opinions on the sufficiency of their training that differ from other professions represented in the USACE personnel. The USACE is composed of many types of professionals. For this study three types of professionals will be grouped together and analyzed. The USACE personnel will be grouped into three profession types: architect, engineer and project manager. The hypothesis is that each group of

professionals will have similar opinions on the sustainable construction training that they have received and the three different groups' opinions will be different from each other.

The fifth hypothesis states that the USACE personnel when grouped by profession will have similar responses on why they first became involved in sustainable construction. The USACE personnel will be grouped into three profession types: architect, engineer and project manager. A secondary part of this hypothesis states that the three different groups of professional types will have responses that are different from each other.

CHAPTER 4
RESULTS

4.1 Survey Results

The survey was organized by five categories of questions this chapter delivers the results of each of the five categories as a group under a subheading. The first category is the resulting demographics of the survey population. The second category is the collected data on the respondent's personal reaction to sustainable construction. The third and fourth categories reveal data on the respondent's personal practical experience with sustainable construction and the USACE's role in sustainable construction respectively. The fifth and final category of questions provides data on the perceived resistance to sustainable construction as seen by the survey respondent.

4.1.1 Survey Population Demographics

4.1.1.1 Survey population results for profession

Table 4-1. Survey respondent demographics by profession

Answer Options	Response Percent	Response Count
engineer	46.2%	12
architect	38.5%	10
project manager	15.3%	4
answered question		26

The survey respondents represent three of the professions that exist within the USACE. The survey was sent to colleges of two major sustainability experts within the USACE. Engineers represent 46.2% of the respondents, architects represent 38.5% of the respondents, and project managers represent 11.5% of respondents. One respondent answered 'other' to this survey question. That respondent gave his response as regional project manager. His responses will be included with the respondents who identified themselves as project managers. Thus bringing the number of project managers represented to 4 and the project manager percentage of the survey

population to 15.3% (see Table 4-1). The results of the survey population's demographics organized by profession can be seen graphically in Figure 4-1.

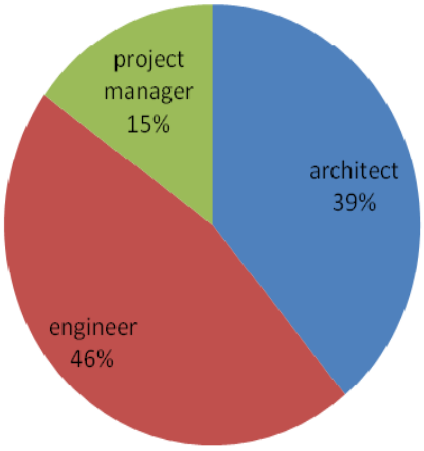


Figure 4-1. Survey respondent demographics by profession

4.1.1.2 Survey population results for pay grade

Table 4-2. Survey respondent demographics organized by pay grade

Answer Options	Response Percent	Response Count
GS 12	30.7%	8
GS 13	42.3%	11
GS 14 or higher	26.9%	7
answered question		26

Unlike other organizations and companies in the construction industry, pay grades are widely used in the USACE to distinguish personnel. It is not uncommon for people to know what their colleague's pay grade is. Pay grade is determined by experience and education. Pay grade represents job title and management level within the USACE. Pay grades are determined by the federal government and are listed as General Schedule (GS) and a number. Table 4-2 relates the pay grade data of the survey respondents. The lower pay grades of GS 10 and GS 9 or below are not represented in the survey respondents. There was one respondent who identified as GS 11 pay grade; his data will be included with the GS 12 respondents. For the

purposes of this report, a GS 12 or GS 13 pay grade represents a person at a high middle management position and a GS 14 or higher pay grade indicates someone with upper management status. The data is biased due to the responses being only of higher levels of management. A graphic representation of the respondent pay grade data is shown in Figure 4-2.

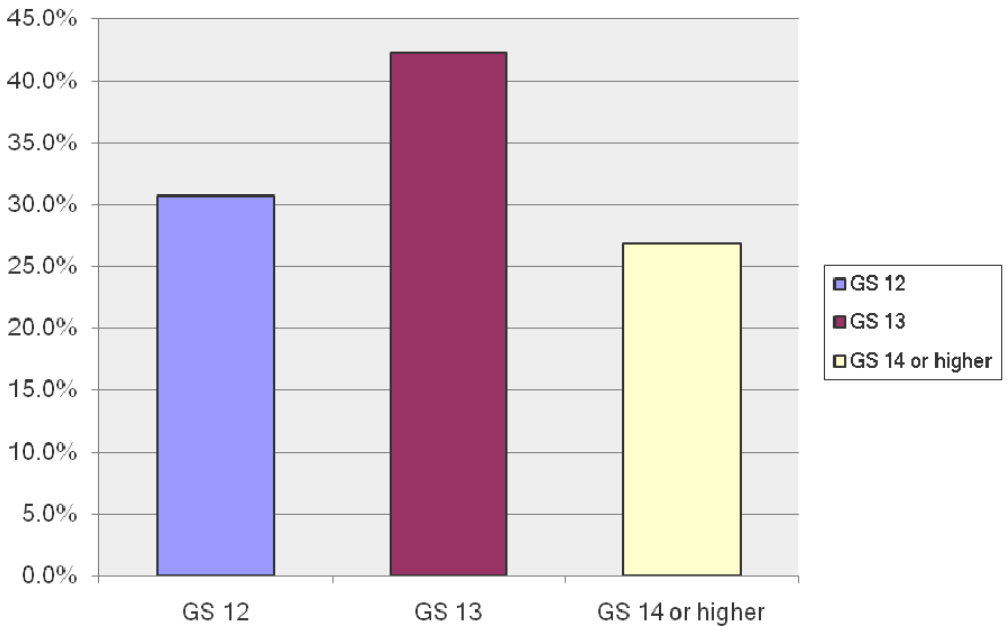


Figure 4-2. Survey population pay grade demographics

4.1.1.3 Survey population results for experience in construction industry

Table 4-3. Survey respondent demographics organized by experience

Answer Options	Response Percent	Response Count
5-10 years	23.1%	6
10-15 years	11.5%	3
15 years or more	65.4%	17
answered question		26

Experience within the industry was determined by a question asked of the survey respondents. The question asked the respondent to identify himself within a selection of ranges of years of experience. The results of the survey are shown in Table 4-3. There were no survey respondents who identified themselves as having 0-5 years of

experience. Of the respondents, a majority of 65.4% identified themselves as having 15 years or more experience in the construction/engineering industry. The next largest population was the respondents with 5-10 years of experience; they represent 23.1% of the survey population. The respondents with 10-15 years of experience in the industry represent 11.5% of the survey population. The responses for years of experience in the industry show a strong bias towards a more experienced survey population (see Figure 4-3).

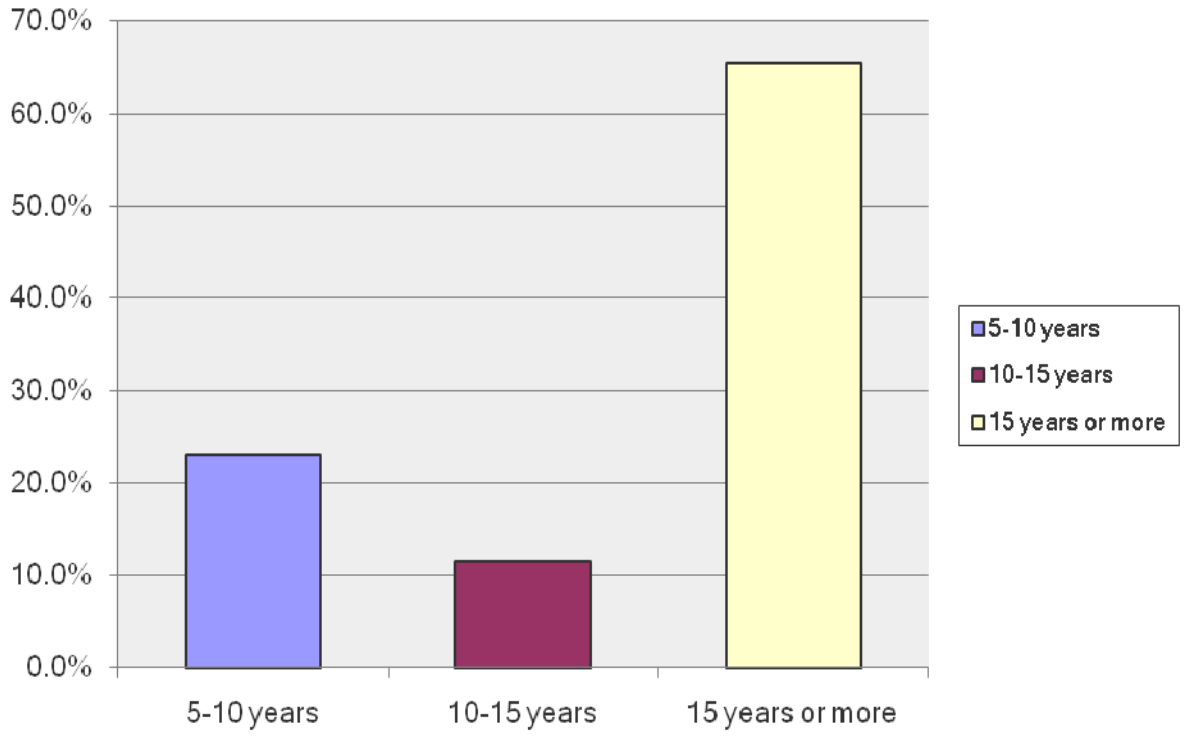


Figure 4-3. Survey respondent experience demographics

4.1.1.4 Survey population results for experience with sustainable construction

Table 4-4. Survey population's years of experience with sustainable construction

Answer Options	Response Percent	Response Count
2-5 years	38.5%	10
5-8 years	38.5%	10
10+ years	23.1%	6
answered question		26

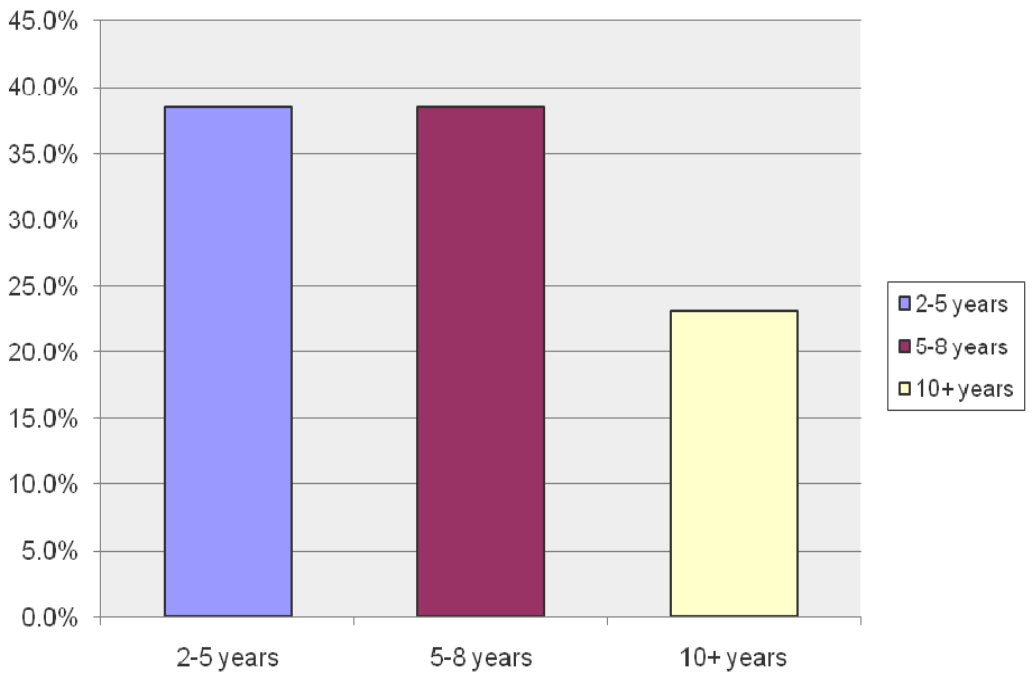


Figure 4-4. Survey respondents' years of experience with sustainable construction

Experience with sustainable construction was determined by a question asked of the survey respondents. The question asked the respondent to identify himself within a selection of ranges of years of experience with sustainable construction. There was one respondent that identified as having two years or less experience; this response will be combined with the respondents who identified as having 2-5 years of experience with sustainable construction. The results of the survey are shown in Table 4-4 with the adjustment made for the response added to the 2-5 year category. With the adjustment made, the respondents who identified as having 2-5 years of experience with sustainable construction represent 38.5% of the survey population. The survey respondents who represent 5-8 years of experience with sustainable construction also represent 38.5% of the survey population. That being said, a majority of 77% of the survey population has less than 8 years of experience with sustainable construction. Six of the respondents identified themselves as having more than 10 years of

experience with sustainable construction (see Figure 4-4). The respondents with more than 10 years of experience with sustainable construction can be identified as having been there from the beginning of the Army's change to sustainable construction practices. These more experienced respondents are most likely knowledgeable of the LEED rating system and may have been influential in the USACE's mandate to build using sustainable construction techniques.

4.1.1.5 Survey respondents' level of responsibility for sustainable practices on their respective project teams

Table 4-5. Respondents' level of responsibility for sustainable construction

Answer Options	Yes	No	Response Count
Are you the main person responsible for sustainable construction practices on your project team?	21	4	25

The second question in this series asks the respondent if they are the main person responsible for sustainable construction practices on your project team. The survey population has 21 people who said that they were the main person responsible for sustainable construction and 4 people replied that they are not the main person responsible, one person declined to answer (see Table 4-5). This data shows that the survey population is mostly made up of higher level people who are in leadership positions, at least where sustainable construction is of concern.

4.1.2 Respondents' Personal Reaction to Sustainability

An anonymous survey is a good way to get candid data of personal opinions from a survey population. The survey respondents were asked three questions in an agree (yes) or disagree (no) format. These questions are designed to get a clearer understanding of the respondents' personal reaction to sustainability.

4.1.2.1 Respondents' acceptance of sustainable culture in their personal life

Table 4-6. Respondents' acceptance of sustainable culture in their personal life

Answer Options	Yes	No	Response Count
Do you recycle at home?	25	1	26

The first of these questions asks the respondent if they recycle at their home. Twenty five respondents identify that they do recycle at home and one respondent stated that he did not recycle at home (see Table 4-6). The purpose of asking the survey population if they recycled at home was to determine if the respondents had chosen to embrace a more sustainable culture at home as well as at work. The data shows that the survey population is attempting to act in a way that is more embracing of sustainability in their personal lives as well as in the office.

4.1.2.2 Respondents' current personal interest in sustainable construction

Table 4-7. Respondents' current personal interest in sustainable construction

Answer Options	Yes	No	Response Count
Are you personally interested in sustainable construction?	25	0	25

The second question in this series asks the respondent if they are personally interested in sustainable construction. This was an important question to ask because it provides the survey population's candid response to their feelings toward sustainable construction. All 25 of the 25 respondents responded positively to this question (see Table 4-7). This proves that sustainable construction has become accepted by the survey population.

4.1.2.3 Respondents' personal interest in sustainable construction prior to mandate

Table 4-8. Respondents' personal interest in sustainable construction prior to mandate

Answer Options	Yes	No	Response Count
Were you interested in sustainable construction prior to the mandate to use the SPiRiT and/or LEED rating systems for MILCON projects?	20	5	25

The third question in this series asks the respondent to confirm or deny an interest in sustainable construction prior to the mandate to use the SPiRiT or LEED rating systems for MILCON projects. The results are shown in Table 4-8. Of a survey population of 26 there were 25 responses. Twenty respondents indicated that they were interested in sustainable construction prior to the mandates while 5 respondents indicated that they became interested after the mandates. Stated another way, 80% of the survey population was interested in sustainable construction prior to the mandates and 20% of the survey population became interested after the mandates were issued.

4.1.2.4 Respondents' introduction to sustainable construction

Table 4-9. Reason for respondents' first involvement with sustainable construction

Answer Options	Response Percent	Response Count
office mandate	38.5%	10
personal interest	80.8%	21
other	0.0%	0
answered question		26

The survey population was asked why they first became involved with sustainable construction. This question expands on the question previous to this one. The respondents were asked to choose all of the following options that applied to them. The choices included: office mandate, personal interest or other. No respondent chose the other option. There were 26 respondents for this question. Twenty one (80.8%) respondents specified that they first became involved in sustainable construction because of a personal interest (see Table 4-9). Ten of the 26 respondents (38.5%) stated that they first became involved in sustainable construction when it was mandated. The results show that all but 5 of the 26 respondents first became involved in sustainable construction due to personal interest. There were 10 respondents specified that they became involved after an office mandate, 5 of those 10 respondents

first became involved only because of the office mandates. The other 5 respondents became involved due to the mandate but also stated that they became involved due to personal interest. By choosing both personally interested and mandated, these 5 respondents may have been personally interested in sustainable construction and the mandate gave them an avenue to practice what they were interested in.

Table 4-10. Reasons respondents indicated a personal interest in sustainable construction

Answer Options	Response Percent	Response Count
became interested after attending a class or seminar	27.3%	6
became interested through main stream media exposure	27.3%	6
through a colleague in the office	36.4%	8
conference, publication, other, etc.	59.1%	13
answered question		22

Some respondents identified themselves as having a personal interest in sustainable construction, as seen in Table 4-7 and Table 4-9. A secondary question asked those respondents who indicated a personal interest in sustainable construction to specify how they became personally interested by choosing from a list of options, the respondent was allowed to select all the options that applied to them. There were 22 respondents who chose to answer this question; the resulting data can be seen in Table 4-10. The response that was most common was exposure to a conference or publication, this option was selected by 13 respondents who represent 59.1% of the survey population. The second most selected option was exposure to sustainable construction via a colleague; this option was selected by 8 of the respondents.

4.1.3 Practical Sustainable Building Construction Experience

4.1.3.1 Number of projects built using sustainable construction practices

The USACE has many offices, and each office is responsible for different projects. The survey population was asked to indicate how many projects there office has built

using the LEED or SPiRiT rating systems during the last five years. For the resulting data see Table 4-11. The majority of the respondents (66.7) indicated that their offices had built more than 6 projects. While four respondents indicated between 1 and 6. Four of the respondents indicated that they had not built any projects using LEED or SPiRiT rating systems in the last five years. Some of the respondents may come from the same offices, so this data is inconclusive.

Table 4-11. Number of projects built using LEED or SPiRiT rating systems in survey population offices

Answer Options	Response Percent	Response Count
none	16.7%	4
1-3	4.2%	1
4-6	12.5%	3
6+	66.7%	16
answered question		24

4.1.3.2 Comfort with using sustainable construction

Table 4-12. Length of time it took survey population's offices to become comfortable with sustainable construction

Answer Options	Response Percent	Response Count
0-6 months	4.0%	1
7-12 months	4.0%	1
1 year or more	40.0%	10
not running smoothly yet	52.0%	13
answered question		25

The respondents were asked how long it took for their office's personnel to become comfortable with sustainable construction. Each respondent was given the choice of one of the following options: 0-6 months, 7-12 months, one year or more, or not running smoothly yet. There were 25 respondents to this question, see Table 4-12 for the data. Eight percent of the respondents indicated that it took less than one year for their office personnel to become comfortable using sustainable construction practices. Forty percent of the respondents indicated it took more than one year to become comfortable and 52% of the respondents indicated that sustainable

construction is not running smoothly yet in their offices. Sustainable construction practices began to be used by the USACE over five years ago, individual offices may have started sustainably built projects later than other offices. There is a general indication that things are not running smoothly at the majority of offices due to the high number of responses that indicated that opinion.

4.1.4 The perception of the survey population on the USACE's ability to train and provide information to personnel regarding sustainable construction

The USACE was mandated to follow sustainable construction practices. They provide training and information for their personnel on using LEED rating system and other sustainable construction practices. The data that will be analyzed in this subsection will look at the survey population's opinions and perception of how the USACE is doing in their implantation of sustainable construction practices.

Table 4-13. Data of multiple questions from survey

Answer Options	Yes	No	Response Count
Have you had any training for sustainable construction in the past year?	20	6	26
Do you believe that the USACE has done a good job with training personnel on how to build to the LEED standard?	19	7	26
Does top management in your office encourage and support sustainable construction process and practices?	26	0	26
Does the USACE keep employees updated with sustainable construction (LEED) information well?	18	8	26
When you have questions relating to sustainability do you know who to ask (within the USACE)?	25	1	26
When you ask questions relating to sustainability do you get an adequate response?	23	1	24

The first question in this series of six asks respondents if they have had any training for sustainable construction within the last year. There were 26 respondents to

this question, 20 of those respondents had training within the last year and six did not. See Table 4-13 for the data. The second question in the series asked respondents if the USACE has done a good job with training personnel to the LEED rating system standards. There were 26 respondents to this question. Nineteen respondents felt that the training provided by the USACE for LEED was good. However 7 respondents indicated that the training that has been provided by the USACE was not good enough, this is 28% of the survey population.

The third question in this series of six questions asks the respondent if the top management in their office is encouraging and supportive of sustainable construction practices. There were 26 respondents to this question; all of them indicated that the top management is encouraging and supportive of sustainable construction practices and processes (see Table 4-13). However there is a limitation to this question, the survey population as shown earlier in this chapter is composed of higher middle management and upper management personnel. These personnel are essentially grading themselves therefore the data cannot be considered credible.

The fourth question in this series asks the survey population if the USACE has done a good job at keeping them updated with information on LEED. There were 26 respondents to this question, 18 of those respondents indicated that the USACE has kept them informed well. There were 8 respondents who felt that the USACE had not done a good job at keeping them informed on the latest LEED information. The 8 respondents represent 32% of the survey population.

The fifth question the series asks respondents if they have a question relating to LEED do they know who to contact. There were 26 respondents who answered this

question, all but one of the respondents knew exactly who to ask if he had a question. The data for this question indicates that the USACE has communicated the POCs for LEED questions well.

The sixth and final question in this series asks respondents if they get an adequate response when they ask a question pertaining to LEED. There were 24 respondents who answered the question, 23 of the respondents indicated that the response has been adequate. One respondent felt he did not get an adequate response to questions pertaining to LEED (see Table 4-13). This data indicates that the USACE has POCs that are well informed and can communicate information effectively.

4.1.4.1 Introduction to sustainable construction within the office setting

Table 4-14. The perception of the way that USACE offices transitioned to sustainable construction practices

Answer Options	Response Percent	Response Count
an immediate mandated change	13.6%	3
was slowly introduced through mandates	68.2%	15
was introduced by individuals in the office and slowly accepted by the office	18.2%	4
answered question		22

The respondents to the survey were asked how their office changed from conventional construction to sustainable construction practices. There were 22 respondents to this question (see Table 4-14). A majority of 68% of the respondents indicated that the transition was slowly introduced by mandates. Four respondents indicated that sustainable construction was introduced by individuals in the office and was slowly accepted by the office personnel. Three respondents indicated that the transition to sustainable construction was an immediate mandated change; these respondents had little time to adjust or prepare.

4.1.4.3 Respondent exposure to training media

The survey population was asked to select all the types of training they had been exposed to over the last year. The responses can be seen if Table 4-15. There were 26 respondents to this question. Four of the respondents indicated that they have had no training in the last year for sustainable construction. The largest response for a single type of training was indicated by 62% of the respondents as a presentation by a sustainability expert. Two types of training share second place with 50% of respondents indicating that they had relieved these types of training in the last year, these types of training were in-office presentation and a seminar/webinar (online seminar). A close third was a meeting (online or in-office) with 46% of respondents indicated that they had taken part in one.

Table 4-15. Respondent's exposure to types of training media in the last year

Answer Options	Response Percent	Response Count
in-office presentation	50.0%	13
training manual	26.9%	7
meeting (online or in-office)	46.2%	12
presentation by sustainability expert	61.5%	16
seminar/webinar (online seminar)	50.0%	13
other	7.7%	2
none	15.4%	4
answered question		26

4.1.4.4 Respondent amount of training in sustainable construction

Table 4-16. Amount of time spent in training for sustainable construction in the last year

Answer Options	Response Percent	Response Count
less than one days worth	11.5%	3
1-2 days	15.4%	4
2-4 days	19.2%	5
4+ days	38.5%	10
no training at all	15.4%	4
answered question		26

A question asked of the survey population was to specify the amount of time (in days) that they had spent in training for sustainable construction within the last year.

There were 26 respondents; four had received no training for sustainable construction in the last year (see Table 4-16). Of the 22 respondents that have received training in the last year the most common amount of time spent training for sustainable construction was four or more days, 39% of the survey population selected this response. The second, third, and fourth rankings of responses were all very close. The second highest ranking response for USACE personnel that had received sustainable construction training in the last year represented 19% of the survey population; they had two to four days of training. Fifteen percent of the survey population indicated that they have had one to two days worth of training on sustainable construction in the past year and 12% of the population selected that they have had less than one days worth of training.

4.1.4.5 Sufficiency of training received

Table 4-17. Perception of the sufficiency of training received

Answer Options. Chose a selection based on the following scale, 1 being less than sufficient training and 5 being the training received was more than sufficient.	Response Percent	Response Count
1	4.2%	1
2	12.5%	3
3	25.0%	6
4	41.7%	10
5	16.7%	4
answered question		24

As a secondary question to the question above, the survey population was asked to rank the sufficiency of the training that they had received in the last year. The respondents were asked to rank their perception of the training sufficiency on a scale of one to five, with one being less than sufficient and five being more than sufficient. The results are shown in Table 4-17. There were 24 respondents to this question. The most common response was a rank of four was represented by 42% of the population. A rank of four represents the training was slightly more than sufficient (see Figure 4-6).

The second most popular response was made by 25% of the survey population. They choose a rank of three, meaning the training was adequate for their needs. The third most popular response was a rank of 5; it was selected by 17% of the survey population. These respondents felt the training they had received in the past year was more than adequate. The fourth most popular response was a rank of 2; this response was selected by 13% of the population. A rank of two represents the training was slightly less than adequate. Only one respondent selected a response of one, that the training was less than adequate.

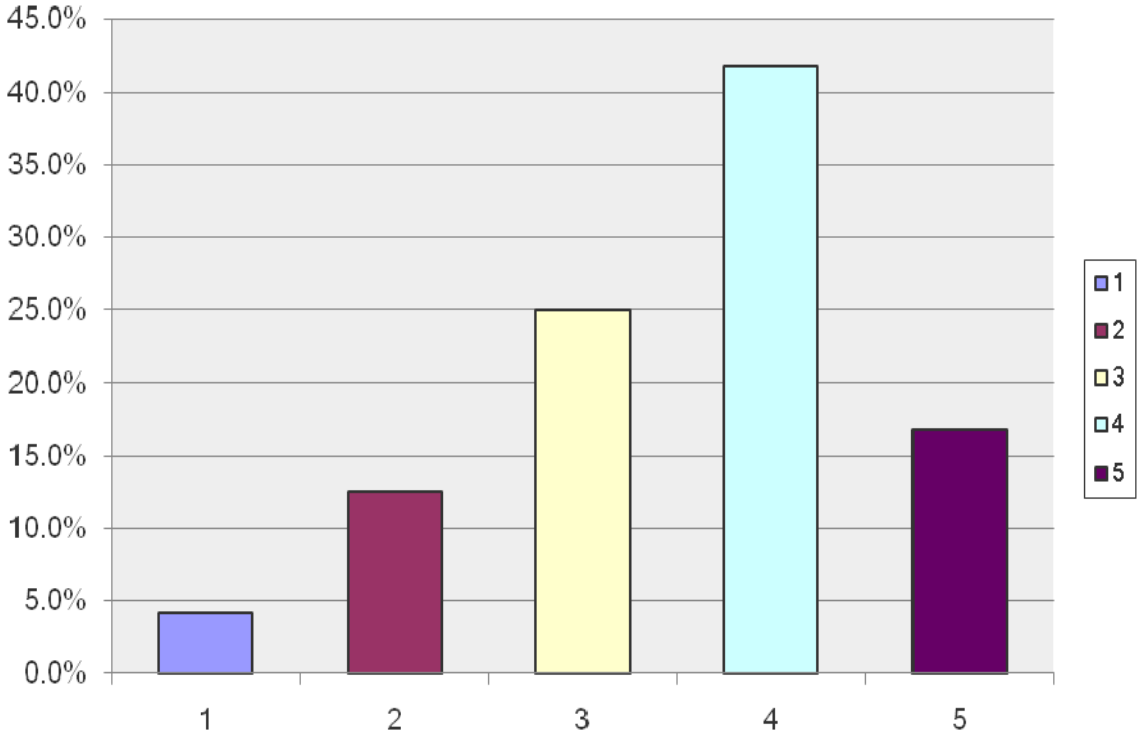


Figure 4-5. Perception of the sufficiency of training received

4.1.5 Resistance to Sustainable Construction

Some people are inherently resistant to change. The transition to sustainable construction from conventional construction may be met by resistance by some people.

The following subcategory of this chapter reports the results of three questions that related to the resistance to sustainable construction.

4.1.5.1 Perceived resistance to sustainable construction

Table 4-18. Perceived resistance to sustainable construction

Answer Options	Yes	No	Response Count
Were there people in your office that were resistant to changing to sustainable construction (LEED/SPiRiT)?	15	9	24

The survey respondents were asked if they know of any colleagues that were or still are resistant to the change from conventional construction to sustainable construction. Of the survey population 24 respondents chose to answer the question, see Table 4-18 for the data. Fifteen of the respondents knew of at least one colleague in their office who was resistant to sustainable construction. Nine of the respondents did not perceive anyone who was resistant to the change in their office.

Table 4-19. Perceived amount of people resistant to sustainable construction transition

Answer Options. Chose a selection based on the following scale, 1 being most people were accepting and 5 being most people were resistant to the change.	Response Percent	Response Count
1	12.5%	3
2	37.5%	9
3	33.3%	8
4	4.2%	1
5	12.5%	3
answered question		24

A secondary question that follows up one the previous question was asked of the respondents. This question asked the survey population to rank how many of the people in their office were resistant to sustainable construction on a scale of one to five. A score of one being most people were accepting and a score of five represents most people were resistant. See Table 4-19 for the data. The majority of respondents, 38% of the survey population selected a score of two to represent the resistance level in their

office. A score of two represents that most of the people in the respondent's office were accepting of the change but some were not accepting of the USACE's transition to sustainable construction. The second most popular answer was a score of three, 33% of the survey population selected this score. A score of three represents that half of the people in the respondent's office were accepting of the change and half were not accepting of the USACE's transition to sustainable construction. The third most popular response at 13% of the survey population each, these scores were one and five. A score of one represents that most people in the respondent's office were accepting of sustainable construction and a score of five represents most people being resistant. The least popular score was four, 4% of the survey population chose this score. A score of four represents that most people in the respondent's office were resistant to sustainable construction but there were some who were accepting of the transition.

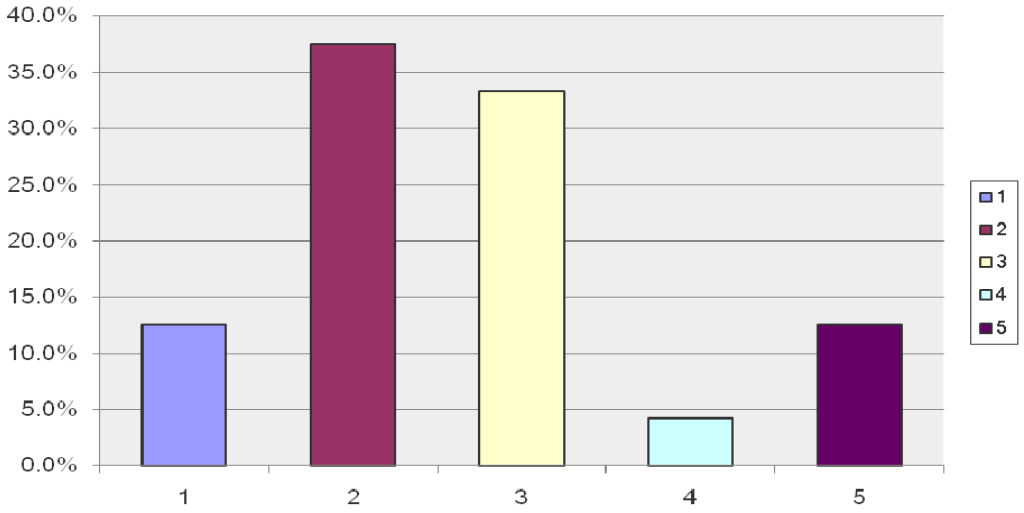


Figure 4-6. Perceived amount of people resistant to sustainable construction transition

4.1.5.2 Methods used to overcome resistance to sustainable construction

Survey respondents were asked how the USACE dealt with resistance to the transition to sustainable construction from conventional construction. The data can be

viewed in Table 4-20. There were 25 respondents for this question. Four of the respondents indicated that there was no one resistant to the transition to sustainable construction within their office. Of the respondents that perceived resistance within their office the most popular response was that the USACE offered training. Thirty two percent of the survey respondents selected ‘other’ and 8% of the survey population indicated that nothing was done by the USACE to overcome the resistance to sustainable construction. Some of the responses that respondents offered as an ‘other’ method of overcoming resistance were one on one discussions, encouraged people to become members of the USGBC, and arranged field trips for USACE personnel.

Table 4-20. Methods employed to overcome resistance to transition to sustainable construction

Answer Options	Response Percent	Response Count
offered training	44.0%	11
reprimand was given	0.0%	0
nothing was done	8.0%	2
other	32.0%	8
there was no resistance	16.0%	4
answered question		25

CHAPTER 5
ANALYSIS

5.1 Analysis of Survey

5.1.1 Analysis Regarding Hypothesis 1

The first hypothesis stated that a higher the level of management (determined by pay grade) would have perception of lower resistance to sustainable construction practices. In order to resolve the first hypothesis two questions from the survey will be analyzed. The first question asked respondents to select their pay grade. Twenty six respondents answered the question about their pay grade. There was only one response for GS 11; this response will be combined with the GS 12 personnel. The second question that will be analyzed is the question that asked respondents to rank the level of resistance they perceived from the staff in their respective offices. The perceived a level of resistance was ranked on a scale of one to five, with five being a high level of resistance to the transition to sustainable construction from staff. There were 24 respondents to this question. The responses from the two respondents that answered the pay grade question but not the perceived level of resistance question will not be included in this analysis. See Table 5-1 for the results of the respondents who answered both questions.

Table 5-1. The results of the perceived level of resistance based on pay grade of respondents

	Score (1 = low resistance, 5 = high resistance)					
Pay Grade	1	2	3	4	5	Total respondents
GS 11/12	1	1	2	1	2	7
GS 13	0	5	5	0	1	11
GS 14 or higher	2	3	1	0	0	6

A graphic representation that can be seen in Figure 5-1 shows the responses by volume to the question of level of perceived level of resistance separated by pay grade.

The GS 11/12 pay grade category has more volume toward the right, which represents a perceived level of resistance of five from their office. A rank of five is a high level of resistance. The GS 13 pay grade category has a high volume near the middle of the chart representing some resistance to the transition to sustainable construction. The respondents that identified as GS 14 or higher had responses that are on the left side of the chart. The left side of the chart represents a perceived lower resistance to the transition to sustainable construction.

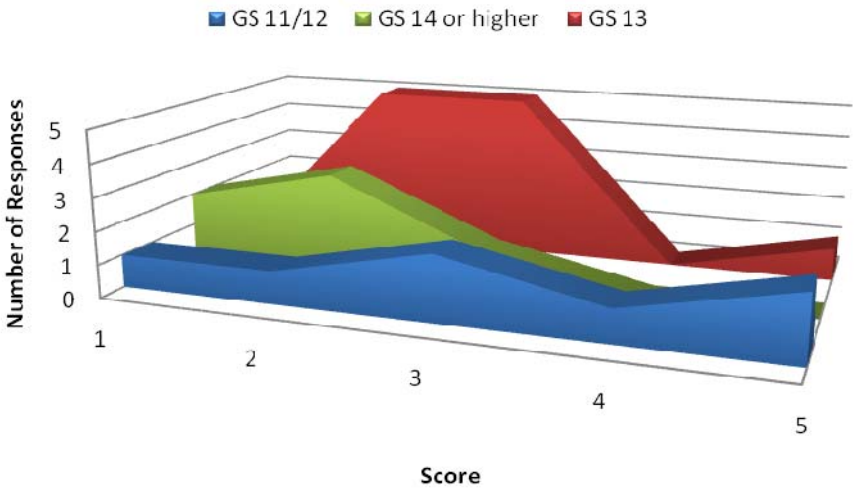


Figure 5-1. Survey respondent by pay grade compared to perceived level of resistance to sustainable construction

The clearest way to rank the perceived level of resistance is to look at the means for the responses by GS pay grade. For the respondents who identified themselves as pay grade GS 12 and GS11 there were 7 responses and the mean of those responses was 3.29. For the respondents who identified themselves as pay grade GS 13 there were 11 responses and the mean of those responses was 2.73. For the respondents who identified themselves as pay grade GS 14 or higher there were 6 responses and the mean of those responses was 1.83. The results are shown graphically in Figure 5-2. The hypothesis proved correct from this data. The GS 11/12 respondents thought

there was a level of resistance to sustainable construction of 3.60. A response of 3.60 means that a large number of people in their office were resistant to the transition to sustainable construction practices.

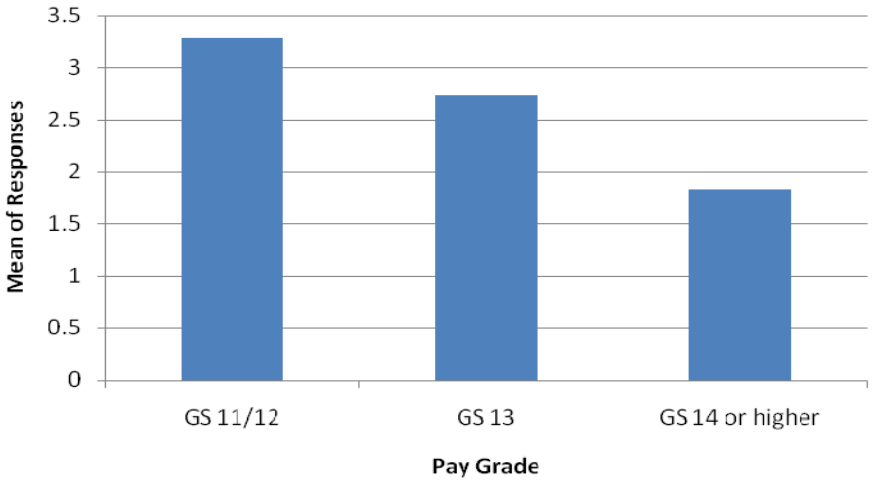


Figure 5-2. Mean of responses ranked by respondent pay grade

The responses show a clear trend in the responses based upon pay grade. The higher pay grades are higher levels of management and they perceived the lowest level of resistance to the transition to sustainable construction. The respondents who identified as GS 13 perceived some resistance to the transition to sustainable construction. The GS 11 and GS 12 respondents perceived the highest amounts of resistance to sustainable construction.

The first hypothesis appears to be true. There are many reasons why the responses would follow this trend. One possible reason is that the GS 14 or higher respondents were more involved in the transition and were more informed from the beginning of the transition. Other possible reason why the responses followed this trend is because the lower level staff don't show their resistance to their managers out of fear of repercussion.

5.1.2 Analysis Regarding Hypothesis 2

The second hypothesis stated that a higher the level of management (determined by pay grade) would feel that the training they have had regarding sustainable construction was sufficient to meet their needs. In order to resolve the second hypothesis two questions from the survey will be analyzed. The first question asked respondents to select their pay grade. Twenty six respondents answered the question about their pay grade. There was only one response for GS 11; this response will be combined with the GS 12 personnel. The second question that will be analyzed is the question that asked respondents to rank the level of sufficiency of the training they have received. The perceived level of training sufficiency was ranked on a scale of one to five, with five meaning the training was above and beyond sufficient and one meaning the training was less than adequate. There were 24 respondents to the sufficiency of training question. See Table 5-2 for the results of the respondents who answered both questions.

Table 5-2. The results of the sufficiency of training on sustainable construction based on the pay grade of respondents

	Score (1 = insufficient, 5 = more than sufficient)					
Pay Grade	1	2	3	4	5	Total number of responses
GS 12	1	2	3	1	0	7
GS 13	0	0	2	6	2	10
GS 14 or higher	0	1	1	3	2	7

A graphic representation that can be seen in Figure 5-3 shows the responses by volume to the question of level of the perceived sufficiency of training organized by pay grade. The GS 12 pay grade category has more volume in the middle of the chart, which represents an overall satisfaction with the training that these personnel have

received. The GS 13 pay grade category has a high volume near the right of the chart representing a level of high satisfaction with the training that those personnel had received. The respondents that identified as GS 14 or higher also had responses that are on the right side of the chart.

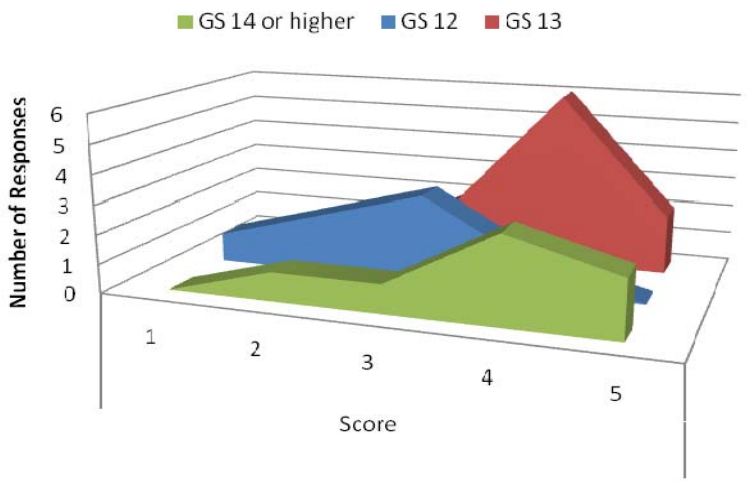


Figure 5-3. Survey respondent by pay grade compared to level of sufficiency of training for sustainable construction

Figure 5-4. Mean of responses to sufficiency of training received ranked by respondent pay grade

The clearest way to rank the perceived level of resistance is to look at the means for the responses by GS pay grade. For the respondents who identified themselves as

pay grade GS 12 and 11 there were 7 responses and the mean of those responses was 2.57. For the respondents who identified themselves as pay grade GS 13 there were 10 responses and the mean of those responses was 4.00. For the respondents who identified themselves as pay grade GS 14 or higher there were 7 responses and the mean of those responses was 3.85. The results are shown graphically in Figure 5-4. The hypothesis is supported but not necessarily proven by this data. There was one GS 11 respondent who was an outlier and cannot be included in the conclusion because there was only one response from that pay grade category. The GS 12 respondents thought the training they have received on sustainable construction was sufficient. The GS 13 and the GS 14 or higher respondents had means that were very close, 4.00 and 3.85 respectively. These responses show that the higher levels of management feel that the training they have received for sustainable construction has been more than sufficient for their needs.

The second hypothesis states that the higher levels of management, based on pay grade, will feel that the training they have received on sustainable construction will have been more than sufficient than personnel from lower pay grades. The second hypothesis is neither proven nor disproven by this data. The GS 12 data did show that they were slightly less positive about their training; nonetheless, they did feel it was sufficient for their needs. While both the GS 13 and GS 14 or higher respondents felt almost equally that the training they have received was more than sufficient for their needs.

5.1.3 Analysis Regarding Hypothesis 3

The third hypothesis to be resolved stated that overall the USACE personnel were not personally interested in sustainable design prior to the mandate from the DOD. The

survey asked one specific question regarding this hypothesis. The resulting data from that question is in Table 5-3.

Table 5-3. Respondents' personal interest in sustainable construction prior to mandate

Answer Options	Yes	No	Response Count
Were you interested in sustainable construction prior to the mandate to use the SPiRiT and/or LEED rating systems for MILCON projects?	20	5	25

There were 25 respondents to the question. Of the 25 respondents, 20 of the USACE personnel were interested in sustainable construction prior to the mandate. These 20 respondents represent 80% of the total respondents to this question, an very high percentage. This data disproves the hypothesis that the USACE would not have been interested in sustainable construction prior to the mandate from the DOD to perform all MILCON projects to meet a LEED silver standard. The limitation to this data is that the personnel that were selected as the survey population are highly involved with the USACE's transition to sustainable construction. These respondents are very well informed on sustainable construction, and that may have influenced the responses.

5.1.4 Analysis Regarding Hypothesis 4

The fourth hypothesis to be evaluated is that the USACE personnel when grouped by profession will have opinions on the sufficiency of their training that differ from other professions represented in the USACE personnel. The USACE is composed of many types of professionals. For this study three types of professionals will be grouped together and analyzed. The USACE personnel will be grouped into three profession types: architect, engineer and project manager. The hypothesis is that each group of professionals will have similar opinions on the sustainable construction training that they have received and the three different groups' opinions will be different from each other.

The fourth hypothesis requires that the survey population be separated by profession type. The respondents were asked to select their profession from a list that contained engineer, architect, project manager and other. One respondent chose other that response will not be included in this analysis. Of the 25 responses that will be used in the analysis the largest group represented is the engineers with 12 respondents identifying as engineers. The second largest group is the architects with the survey population having 10 members who identified as architects. The smallest profession represented in the survey population is the project manager group, 3 respondents identified as project managers.

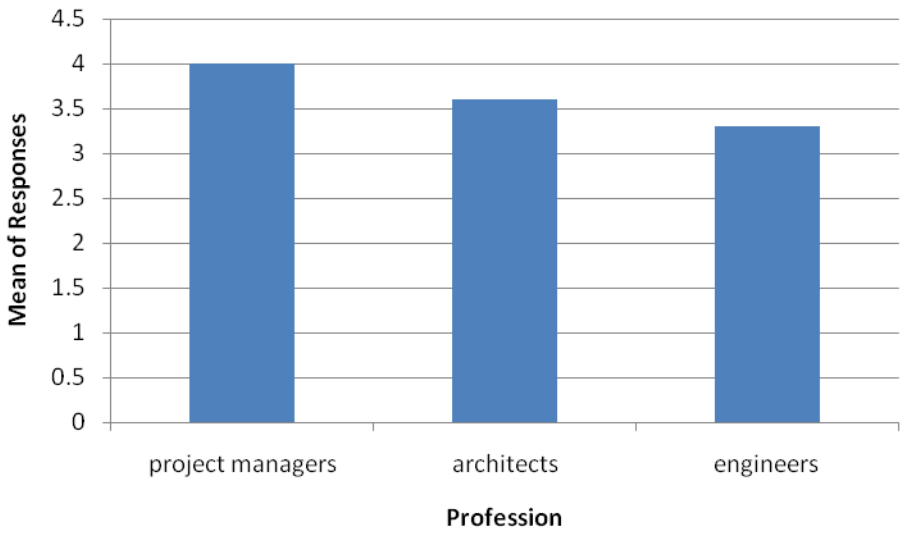


Figure 5-5. Mean of responses to sufficiency of training received ranked by respondent profession

The survey respondents were also asked to rank how sufficient their training for sustainable construction has been. The scores were based on a 1 to 5 scale, one being that the training was insufficient for the respondent's needs and five represented training that was more than sufficient to meet their needs. The means of the scores for each represented profession were calculated. The engineers have a mean score of 3.3, the architects have a mean score of 3.6 and the project managers have a mean score

of 4 (see Figure 5-5). The project manager group felt that the training was slightly more sufficient than their needs required. The architects and engineers on average also felt that the training they received was slightly more sufficient than what their needs required, but not by as much as the project managers.

5.1.4 Analysis Regarding Hypothesis 5

The fifth hypothesis states that the USACE personnel when grouped by profession will have similar responses on why they first became involved in sustainable construction. The USACE personnel will be grouped into three profession types: architect, engineer and project manager. A secondary part of this hypothesis states that the three different groups of professional types will have responses that are different from each other.

The survey respondents were asked how they first became involved in sustainable construction. They were asked to choose all that apply, there were two responses that were selected and those were by office mandate and/or by personal interest. The engineers were more likely to have first been involved in sustainable construction because of the mandate. Fifty eight percent of the engineers (seven respondents) responded that they had first become involved in sustainable construction by office mandate. Of those seven respondents who identified themselves as having first becoming involved in sustainable construction due to office mandate, four of them were also personally interested in sustainable construction when they first became involved.

The architects were more likely to have been first involved with sustainable construction due to personal interest. Eighty percent of the architect respondents first became involved in sustainable construction due to personal interest. Twenty percent of the architect respondents became involved in sustainable construction due to the

mandate alone. The three project managers represented in the survey population were all first involved in sustainable construction due to personal interest alone.

Table 5-4. Respondents' first involvement with sustainable construction by profession

Profession	Total number of respondents in group	First Involvement with Sustainable Construction	
		Office Mandate	Personal Interest
engineer	12	7	9
architect	10	3	8
project manager	3	0	3

CHAPTER 6
CONCLUSION

Summary

The results of the survey portrayed the perceptions of the USACE management staff who are directly involved with sustainable construction regarding the mandated transition to sustainable construction. The survey designed for this survey was a way to collect the needed information in a uniform fashion. The results of the survey were designed to be analyzed or compared in many ways. The objectives of this study were to prove three hypothesizes that were developed prior to releasing the survey. Those five hypothesizes were:

- The higher the level of management (determined by pay grade) the lower the perception of resistance to sustainable construction practices.
- The higher the level of management (determined by pay grade) the more likely they were to feel that their training was sufficient.
- In general the USACE personnel were not personally interested in sustainable construction prior to the mandate.
- The respondents when grouped by profession had differing opinions on the sufficiency of the training they received. All the respondents felt that the training was at least sufficient to different degrees.
- The respondents when grouped by profession did have differing opinions on why they first became involved in sustainable construction. The project managers were more likely to have become involved in sustainable construction due to personal interest alone, while the engineers were more likely to have first become involved due to office mandate.

The results of the survey were revealed in Chapter 4 and then the results were analyzed in Chapter 5.

Limitations

The survey was distributed by a USACE staff member who chose the survey population. The USACE staff member chose to send the survey to other USACE

personnel that were familiar with the transition to sustainable construction within the USACE and some of the survey population members had actually had a role in implementing the change. The survey population was also skewed to higher ranking and more experienced personnel. The resulting data was biased because of the survey populations' role in implementing sustainable construction and their familiarity with sustainable construction.

Recommendations for Future Study

There are a few recommendations for further study. The first recommendation is to continue the research with the USACE. A researcher could take this same survey to a larger population of USACE personnel to get a bigger sample size and continue this research. The second recommendation is to use the same survey but use different survey populations. If survey populations were chosen from companies or organizations within the construction industry that have also transitioned from conventional construction to sustainable construction, then the results could be compared. If there had been more responses, or a larger population then a more in depth analysis could be performed.

APPENDIX A
IRB APPROVAL

UF | Institutional Review Board
UNIVERSITY of FLORIDA

PO Box 112250
Gainesville, FL 32611-2250
352-392-0433 (Phone)
352-392-9234 (Fax)
irb2@ufl.edu

DATE: March 2, 2010

TO: Sharon Neff

FROM: Ira S. Fischler, PhD, Chair
University of Florida
Institutional Review Board 02

SUBJECT: **Approval of Protocol #2010-U-0195**

TITLE: Impacts of the Change from Conventional Construction to Sustainable Construction Practices in the U.S. Army Corp of Engineers (USACE)

SPONSOR: None

I am pleased to advise you that the University of Florida Institutional Review Board has recommended approval of this protocol. Based on its review, the UFIRB determined that this research presents no more than minimal risk to participants, and based on 45 CFR 46.117(c), An IRB may waive the requirement for the investigator to obtain a signed consent form for some or all subjects if it finds either: *(1) That the only record linking the subject and the research would be the consent document and the principal risk would be potential harm resulting from a breach of confidentiality. Each subject will be asked whether the subject wants documentation linking the subject with the research, and the subject's wishes will govern; or (2) That the research presents no more than minimal risk of harm to subjects and involves no procedures for which written consent is normally required outside of the research context.*

The IRB authorizes you to administer the informed consent process as specified in the protocol. If you wish to make any changes to this protocol, ***including the need to increase the number of participants authorized***, you must disclose your plans before you implement them so that the Board can assess their impact on your protocol. In addition, you must report to the Board any unexpected complications that affect your participants.

This approval is valid through **February 24, 2011**. If you have not completed the study by this date, please telephone our office (392-0433), and we will discuss the renewal process with you. It is important that you keep your Department Chair informed about the status of this research protocol.

ISF:dl

APPENDIX B
SURVEY

Impacts of the Change from Conventional Construction to Sustainable Construction Practices in the U.S. Army Corp of Engineers (USACE)

Information about survey taker

1 What is your specialty? Select all that apply
   - o Engineer
   - o Architect
   - o Environmental
   - o Contracts
   - o Real Estate
   - o Project Management
   - o Other

2 What is your pay grade? Select one.
   - o GS 9 or lower
   - o GS 10
   - o GS 11
   - o GS 12
   - o GS 13
   - o GS 14 or higher
   - o I'm not USACE personnel

3 How long have you been working in the construction/engineering industry? Select one.
   - o 0-5 years
   - o 5-10 years
   - o 10-15 years
   - o 15+ years

3 Do you recycle at home? Select one.
   - o Yes
   - o No

4 Are you the main person responsible for sustainable construction practices on a project team? Select one.
   - o Yes
   - o No

5 Years familiar with sustainable construction (LEED, SPiRiT)? Select one.

- o < 1
- o 1-2 years
- o 2-4 years
- o 4+ years

6 Do you have a personal interest in sustainable construction (LEED, SPiRiT)? Select one.
- o Yes
- o No

7 Why did you first start becoming involved in sustainable construction (LEED, SPiRiT)? Select all that apply.
- o Was mandated
- o Was both mandated and interested
- o Became interested after attending a class or seminar
- o Became interested through main stream media

Sustainability

8 How many projects has your office built using sustainable construction rating systems (LEED, SPiRiT) in the last 5 years? Select one.
- o None
- o 1-5
- o 6-10
- o 11+

9 How quick did the office change to sustainable construction practices? Select one.
- o Was an immediate mandated change
- o Was slowly introduced through procedures
- o Was introduced by individuals in the office and slowly accepted by the organization

10 How well did your office transition to sustainable construction practices? Select one.
- o Not a smooth transition at all
- o There were a few large problems
- o There were some minor problems
- o The transition went well

11 When did your office begin sustainable construction policies? Select one.
- o Less than 1 year ago

- o 1-2 years ago
- o 2-4 years ago
- o 4+ years ago

12 How long did it take your office to become comfortable with sustainable construction? Select one.
- o 0-6 months
- o 7-12 months
- o 1 year and more
- o Not running smoothly yet

13 Does the chain of command in your office encourage and support sustainable construction processes?
- o Yes
- o No

14 How well does USACE keep employees updated with sustainable construction information? Select one.
- o Not well at all
- o Could be better at updating
- o Very good at keeping employees up to date

15 How much training did you (personally) receive on sustainable construction practices in the past year? Select one.
- o Less than 1 days worth
- o 1-2 days
- o 2-4 days
- o 4+ days
- o None at all

16 What type of sustainable construction training did you (personally) receive in the past year? Select all that apply.
- o In office presentation
- o Training manual
- o Meeting (online or in-office)
- o Presentations by sustainability expert
- o Seminar/Webinar (online seminar)
- o Other
- o None

17 Was the sustainable construction training you received sufficient? Select one.

- o Yes, I understand well
- o I still have a few questions
- o Not sufficient
- o I haven't received any training

18 When you have questions relating to sustainability do you know who to ask? Select one.

- o Yes
- o No

19 When you ask questions relating to sustainability do you get an adequate response? Select one.

- o Often
- o Rarely
- o Never

20 How many people are in your office? Fill in the blank.

_____

21 What percentage of people in your office are resistant to changing to sustainable construction?

- o Low (<20%)
- o Medium (20% - 50%)
- o Medium-high (50% - 80%)
- o High (>80%)

22 If there was resistance to the change to sustainable construction, what was done to overcome the resistance? Select one.

- o There was no resistance
- o Nothing was done
- o Offered training
- o Reprimand was given
- o Other

23 What organizational authority is most resistant to sustainable construction (LEED, SPiRiT)? Select all that apply.

- o Base Commander
- o USACE HQ staff
- o USACE Field staff
- o Other
- o No one was resistant

24 Are the Tenant Commands that you work with accepting of the new sustainable construction process? Select one.
- o Most are accepting
- o Few are accepting
- o None are accepting
- o N/A

25 If the Tenant Commands are not accepting, what is done to overcome their resistance? Select all that apply.
- o Meetings with the Tenant Command staff
- o Invited them to seminars/ training
- o The Tenant Commands were given written information (brochures, etc.)
- o Nothing was done
- o Unknown

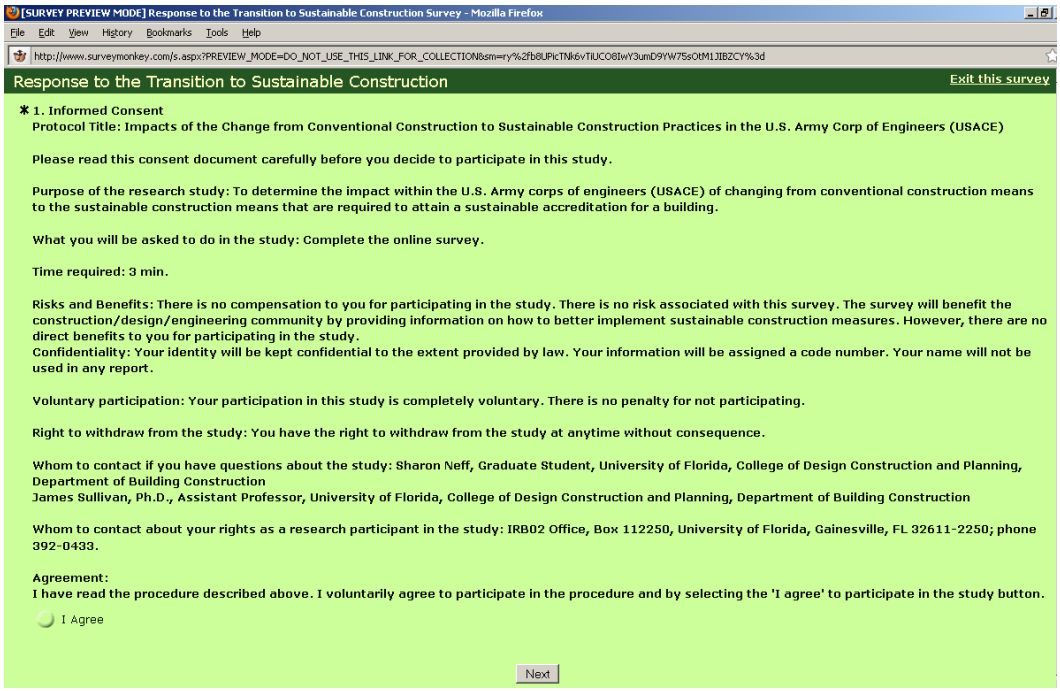
26 Are local construction contractors accepting of the new sustainable construction process? Select one.
- o Most are accepting
- o Few are accepting
- o None are accepting
- o Unknown

27 If the local construction contractors are not accepting, what is done to overcome their resistance? Select all that apply.
- o Meetings with the contractors
- o Invited them to seminars/training
- o The contractors were given written information (brochures, etc.)
- o Nothing was done
- o Unknown

28 Are architecture/engineering firms accepting of the new sustainable construction process? Select one.
- o Most are accepting
- o Few are accepting
- o None are accepting
- o Unknown

29 If the architecture/engineering firms are not accepting what is done to overcome their resistance? Select all that apply.
- o Meetings with the firms

- Invited them to seminars/ training
- The firms were given written information (brochures, etc.)
- Nothing was done
- Unknown



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Response to the Transition to Sustainable Construction — Exit this survey

* 1. Informed Consent
Protocol Title: Impacts of the Change from Conventional Construction to Sustainable Construction Practices in the U.S. Army Corp of Engineers (USACE)

Please read this consent document carefully before you decide to participate in this study.

Purpose of the research study: To determine the impact within the U.S. Army corps of engineers (USACE) of changing from conventional construction means to the sustainable construction means that are required to attain a sustainable accreditation for a building.

What you will be asked to do in the study: Complete the online survey.

Time required: 3 min.

Risks and Benefits: There is no compensation to you for participating in the study. There is no risk associated with this survey. The survey will benefit the construction/design/engineering community by providing information on how to better implement sustainable construction measures. However, there are no direct benefits to you for participating in the study.
Confidentiality: Your identity will be kept confidential to the extent provided by law. Your information will be assigned a code number. Your name will not be used in any report.

Voluntary participation: Your participation in this study is completely voluntary. There is no penalty for not participating.

Right to withdraw from the study: You have the right to withdraw from the study at anytime without consequence.

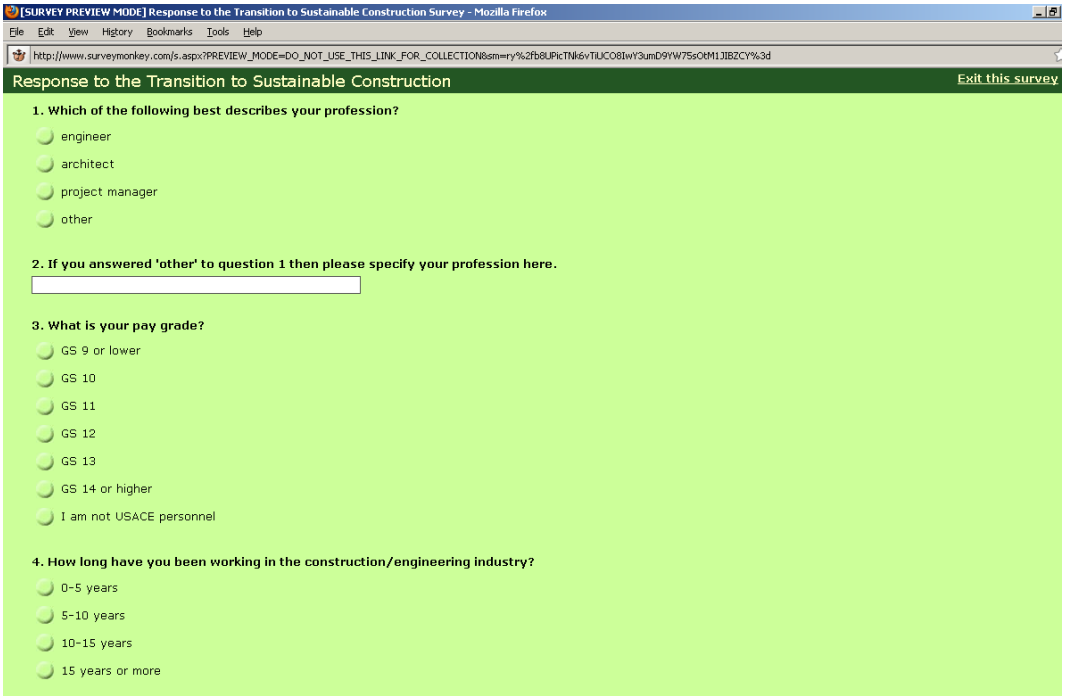
Whom to contact if you have questions about the study: Sharon Neff, Graduate Student, University of Florida, College of Design Construction and Planning, Department of Building Construction
James Sullivan, Ph.D., Assistant Professor, University of Florida, College of Design Construction and Planning, Department of Building Construction

Whom to contact about your rights as a research participant in the study: IRB02 Office, Box 112250, University of Florida, Gainesville, FL 32611-2250; phone 392-0433.

Agreement:
I have read the procedure described above. I voluntarily agree to participate in the procedure and by selecting the 'I agree' to participate in the study button.

- I Agree

Next



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Response to the Transition to Sustainable Construction — Exit this survey

1. Which of the following best describes your profession?
- engineer
- architect
- project manager
- other

2. If you answered 'other' to question 1 then please specify your profession here.

3. What is your pay grade?
- GS 9 or lower
- GS 10
- GS 11
- GS 12
- GS 13
- GS 14 or higher
- I am not USACE personnel

4. How long have you been working in the construction/engineering industry?
- 0-5 years
- 5-10 years
- 10-15 years
- 15 years or more

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Response to the Transition to Sustainable Construction

Exit this survey

1. Please answer yes or no to the following questions.

	Yes	No
Do you recycle at home?		
Are you the main person responsible for sustainable construction practices on your project team?		
Are you personally interested in sustainable construction?		
Were you interested in sustainable construction prior to the mandate to use the SPiRiT and/or LEED rating systems for MILCON projects?		
Have you had any training for sustainable construction in the past year?		
Do you believe that the USACE has done a good job with training personnel on how to build to the LEED standard?		
Does top management in your office encourage and support sustainable construction process and practices?		
Does the USACE keep employees updated with sustainable construction (LEED) information well?		
When you have questions relating to sustainability do you know who to ask (within the USACE)?		
When you ask questions relating		

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Response to the Transition to Sustainable Construction

Exit this survey

1. What types of sustainable construction training have you received in the last year? Choose all that apply.

- [ ] in-office presentation
- [ ] training manual
- [ ] meeting (online or in-office)
- [ ] presentation by sustainability expert
- [ ] seminar/webinar (online seminar)
- [ ] other
- [ ] none

2. If you selected 'other' in the answer above then please specify the other types of training here.

3. How much training have you received on sustainable construction (LEED and/or SPiRiT)in the past year?

- less than one days worth
- 1-2 days
- 2-4 days
- 4+ days
- no training at all

4. Was the sustainable construction training you have received sufficient? Make a selection based on the following scale, 1 being very inadequate and 5 being above and beyond adequate.

- 1

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Response to the Transition to Sustainable Construction

Exit this survey

1. Why did you first become involved in sustainable construction (LEED/SPiRiT)? Choose all that apply.

- [ ] Office mandate
- [ ] Personal interest
- [ ] Other

2. If you choose personal interest, how did you become interested? Choose all that apply.

- [ ] Became interested after attending a class or seminar
- [ ] Became interested through main stream media exposure
- [ ] Through a colleague in the office
- [ ] Conference, publication, other, etc.,

3. If you choose 'other' please explain here.

4. How many projects has your office built using the LEED or SPiRiT rating systems in the last 5 years?

- ( ) none
- ( ) 1-3
- ( ) 4-6
- ( ) 6+

5. How did your office change to sustainable construction practices?

- ( ) an immediate mandated change

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BIOGRAPHICAL SKETCH

Sharon M. Neff was born in San Antonio, Texas, to Andrew M. Neff and Elizabeth A. Neff. Sharon's interest in design, construction and the military can be attributed to her family's background, her father and paternal grandfather were engineers and her father and both of her grandfathers were in the military. Upon graduating high school in 2003, Sharon attended the University of Florida where she became interested in sustainable design and construction. While Sharon was earning her undergraduate degree Sharon met her fiancé. In 2007 Sharon earned her Bachelor of Science in Design with a major in interior design. After receiving her bachelor's degree Sharon worked in the construction industry as a design professional. During that time working she was inspired to return to school and pursue a Master of Science in Building Construction with a concentration in sustainable construction. While Sharon was pursuing her master's degree her fiancé was commissioned as an officer in the U.S. Army. Shortly after graduation Sharon will be getting married and she and her husband will be relocating to Fort Bragg, North Carolina where she will pursue a career in building construction.