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Successful Paths to Becoming a Lean Organization in the Construction Industry

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SUCCESSFUL PATHS TO BECOMING A LEAN ORGANIZATION IN THE

CONSTRUCTION INDUSTRY

by

Robert Warcup

A dissertation submitted in partial fulfillment
of the requirements for the degree

of

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ABSTRACT

Successful Paths to Becoming a Lean Organization in the Construction Industry

by

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Utah State University, 2015

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Lean construction is considered a valuable solution for the declining productivity of the construction industry. This study seeks to answer the general research question: What does it take to become lean? The research explored the possible paths to becoming lean by examining the journeys of three successful lean construction firms in the U.S. The results are intended to assist other construction firms with their own transformations. This study is especially useful to executives and management because it describes the cultural transformation process of each participating company, the expectations of company employees, and the best practices that each company employed.

A qualitative, multiple-case study methodology was used to find common patterns among all three firms as well as unique attributes. Eight research themes shaped the interview dialog that probed the participants' experiences and insights regarding lean—from the companies' initial discovery of lean to their implementation of tools and trainings. The themes further prompted responses regarding the roles that were critical to

successful lean implementation as well as the barriers that inhibited lean adoption. Finally, interviews also sought out strategies to successfully promote and implement lean into the future.

The research discusses the assertions and conclusions that emerged from the findings, which identify several successful paths to becoming lean. Findings show how people, the environment, and actions positively or negatively influence the adoption of a lean culture. The study concludes with recommendations for future firms regarding lean planning to transform the organization into a successful, top-performing, lean construction company. It emphasizes personalized application for each employee to create a positive environment for the new culture to develop. The conclusions also include five phases of lean saturation: discovery and learning, commitment, strategic planning, implementation, and training company partners in lean.

(198 pages)

PUBLIC ABSTRACT

Successful Paths to Becoming a Lean Organization in the Construction Industry

by

Robert D. Warcup, Doctor of Philosophy

Utah State University, 2015

Lean construction is defined as the continuous process of eliminating waste, with the goal of increasing value on construction projects to the owner and to all stakeholders of a project. It has gained considerable momentum since the early 2000s because of its potential for problem-solving and increased productivity, especially as many construction firms still struggle to adapt to an ever-changing industry. This study was designed to assist construction companies, especially company executives and managers, to better understand the requirements of a lean transformation by describing the paths of three highly successful lean construction firms from the U.S.

Nine lean advocates, three from each lean construction firm, answered interview questions about their personal journeys as well as their organizations' journeys. They offered insights into the lean adoption process, including the initial discovery, key employee roles, implementation efforts such as tools and training, as well as barriers and failures experienced along the way. From the participants' insights and experiences, the study identifies common strategies that led their organizations to success. This includes the role of executives as well as regular employees, the effects of company cultures and

organizational structure, common barriers to lean, and the effects of lean trainings.

The study concludes by summarizing the role of people, the environment, and lean actions in becoming lean in today's construction industry. It also offers several recommendations for planning such an important culture change. Recommendations emphasize personalized learning for each employee to create a positive learning environment for the new culture to thrive. The conclusions also include five phases of lean saturation: discovery and learning, commitment, strategic planning, implementation, and training company partners in lean. In short, this study helps construction firms understand what they might do to become lean.

DEDICATION

I want to thank my loving wife and eternal companion, Sarah, for her continuous support throughout the entire doctoral process. Sarah, I will be forever grateful for your consistent understanding, patience, perseverance, and love. In many ways this work was a joint effort, and through it all we became closer as we shouldered and shared new burdens.

I am grateful for my four wonderful children who strive to be true and to do right in their lives each day. Alyssa, Talia, Branyon, and Brianna, I am proud to be your father and I am proud of each of you. You demonstrated a great deal of patience during this process. Your examples of goodness encouraged me along the way more than you know.

To my parents, Doug and Joanne, your drive and example helped provide the strength to tackle such a daunting hurdle in life. I will be forever indebted to you for raising me correctly and teaching me the value of work and education.

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CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Over the past 50 years, the productivity of the U.S. construction industry has steadily declined, while general business productivity in the U.S. has steadily improved. This trend is confirmed by research from several studies. Using numbers from the Bureau of Labor Statistics (BLS), Dr. Paul Teicholz (2004) reported that construction productivity has steadily fallen 0.32% each year while nonconstruction productivity has risen 3.06% each year since 1964, as illustrated in Figure 1. Productivity is measured by dividing industry revenues by total industry work hours.

In addition, Forbes and Ahmed (2010) reported an increase of only 0.78% per year in U.S. construction productivity from 1966 to 2007; in comparison, nonfarm productivity grew 1.75% per year over the same time period. They pointed out that the modest growth of construction productivity equates to less than half the gains of nonagricultural productivity, and add that the productivity of the construction industry still lags far behind all other industries (p. 25).

Finally, a study by the Construction Industry Institute (2004) discovered that, on average, 75% of all construction activities are considered nonvalue adding (Diekmann, Krewedl, Balonick, Stewart, & Won, 2004). The remaining amount is divided into two categories; 15% is considered essential, nonvalue added work, while only 10% is considered value adding. Therefore, the vast majority of all construction work is considered waste by lean standards. The poor results from each of these studies reveal a significant need for improvement in the construction industry.

Index of Construction Labor Productivity, 1964-2012
based on various deflators
in comparison to labor productivity in all nonfarm industries

- C30 deflated by annual construction labor cost index, 1964=100
- C30 deflated by annual consumer price index, 1964=100
- C30 deflated by annual construction value in place index, 1964=100
- C30 deflated by house price index, 1987=100
- C30 deflated by price index of new one-family house under construction, 1964=100
- C30 deflated by price index of new one-family house under construction, 1964=100
- All non-farm industries
- C30 deflated by annual building value in place index, 1964=100

Figure 1. Construction and nonfarm productivity index. The graph compares variations of construction productivity calculations with all nonfarm businesses and illustrates the decline in construction productivity since 1964. Graph by Dr. Paul Teicholz, 2013, found at http://www.aecbytes.com/viewpoint/2013/issue_67.html

Lean construction represents a promising solution to the problem of poor productivity. Lean construction is a business system that encompasses culture, planning, concepts, and tools to maximize value while minimizing all forms of waste (Rubrich, 2012). The general concept of lean thinking was defined by Womack and Jones (2003), "In short, lean thinking is lean because it provides a way to do more and more with less and less—less human effort, less equipment, less time, and less space" (p. 15). Therefore, lean construction seeks to maximize value (doing more) while minimizing waste (less effort, equipment, time, and space).

Lean construction maximizes value by coordinating the requirements of all parties more intensely than traditional management approaches. This coordination benefits not only the construction firms involved, but it also adds value to the owner, the architect, and the engineers as they work together as one team. Collectively, the highly collaborative lean team simultaneously identifies and reduces the waste that naturally occurs in any construction process. In lean construction, waste is measured not only in materials but also in resources, time, motion, production, and even creativity (Liker, 2004; Liker & Meier, 2006).

Benefits and Results of Lean Construction

Lean construction methodologies produce superior results over traditional project management practices, according to research conducted over the past 20 years (Ballard & Howell, 2004; Forbes & Ahmed, 2010). For instance, traditional project management approaches achieve an average completion rate of 54% of all scheduled construction

tasks on a given project each week. However, those projects that properly utilize the Last

Planner System™ (LPS), a lean project planning method, have an average completion

rate of 85% (Ballard & Howell, 2003).

McGraw Hill Construction research and analytics department produced a

comprehensive study on lean construction in their 2013 SmartMarket Report (McGraw

Hill Construction, 2013). Their findings illustrated the benefits of implementing lean

construction practices and concepts;

- 84% of respondents reported achieving higher quality on their projects.

- 80% reported greater customer satisfaction.

- 77% reported improved productivity.

- 64% reported either reduced costs or improved profitability.

- 77% reported improved safety performance.

- 74% reported a reduced project schedule.

- 64% reported greater profitability and/or reduced project costs.

The report also showcased two specific companies and what they gained by

employing specific lean competencies on small portions of their work only. For example,

Rosendin Electric saved an estimated $50,000 in labor costs by value-stream mapping the

fluorescent lighting fixtures on a medical research project. That single task represents just

a small portion of their overall scope of work on the project. The second example states

that the Boldt Company, a leading lean construction firm, reduced man hours on a

hospital project by more than two-thirds (from 24 man hours to 7) through lean

prefabrication efforts on headwalls alone. Again, this task represented just a small portion

of the scope of work for the contractor on this project.

Finally, lean construction leader and innovator Will Lichtig of the Boldt Company, suggested that performance can and will improve considerably when lean has touched every process in the company (information shared during a roundtable meeting, June, 11-12, 2013). Based on his experiences at the Boldt Company, Lichtig predicted that once lean has been fully adopted into every department and is understood by every employee, an organization can realize up to a 30% decrease in project costs and as much as a 50% decrease in schedule durations.

Lean: A Personal Journey

The researcher in this study was previously employed by a national construction firm in both office and field roles. His introduction to lean came about when lean consultants were hired to help the company achieve greater competitive excellence in the market. The consulting company was a highly esteemed, top-performing firm hired during the 2007-2008 recession. At this time, the U.S. economy was declining rapidly and the construction firm was losing money quickly. When the consultants were brought in, every employee was challenged to help solve the crisis. In fact, the researcher's department was specifically challenged to write the lean playbook for the rest of the company so that the other divisions across the country could follow.

The change did not occur overnight, nor was it in any way easy. In fact, quite the opposite was true. It took the right team receiving the information at the right time to implement the new lean philosophy. It required a paradigm shift from each of the

managers and from the executives as well. Had the team not been motivated by the promise of continued employment (or by the possibility of unemployment), it is very unlikely that this researcher, or anyone else for that matter, would have recognized the potential of lean when it was "pitched" or presented to them. Nevertheless, the team accepted the challenge and began their lean journey.

The team soon noticed that their thinking was changing dramatically. The lean concepts they learned helped them put out "the fires" that occupied most of middle management's time. Each person recognized that less time was then required for crisis management, which provided more time to actually manage each project. The team learned to be proactive in their approach and took it upon themselves to teach the new concepts to the trade contractors. After less than 1 year of intense lean implementation, dramatic improvements were seen. The company realized a 40% decrease in schedule durations, direct costs decreased by 13%, and construction quality improved dramatically. At the same time, employees reported feeling more enthusiastic, productive, and satisfied at work. Each employee realized that the team had accomplished more than most companies could even imagine.

Since that time, the researcher determined never to return to traditional construction management approaches. Traditional methods simply left too much profit, too much creativity, and too much success on the table. Consequently, when higher education presented an opportunity to spread the word and to help others use lean to change the industry, the researcher began a more formal approach to his study of lean construction. As he pursued his lean study, the practical tools that he had been using

began to make much more sense; he learned why they were important and why they produced such positive results. He also learned that practicing lean is not as effective as adopting a lean philosophy.

After several discussions with executives, the researcher noticed that many organizations simply do not know where to begin with lean. Most executives want better results, but they do not know what it takes to achieve such results. Furthermore, many executives who have heard of lean do not understand what lean really means. As a result, they cannot see how lean relates to their roles as leaders. These executives might instruct their project managers to "*do* lean construction" on the next project with little or no knowledge of what they are requesting. In addition, many leaders simply cannot see the end-goal of lean, which makes it much more difficult to understand the beginning. By describing the lean adoption paths of three successful construction companies, this study will help executives as well as project managers, superintendents, and even entry-level employees understand what it takes to become a lean organization.

Problem Statement

Many professionals and academics alike agree that lean practices can improve construction project management. While there is a generous amount of research on lean construction implementation, the majority of that research focuses on companies that have implemented only a handful of lean concepts over short periods of time. Conversely, very little research has studied companies that have had considerable success with lean—that is, companies that have successfully made lean part of their culture

through planning, training, and implementation. Companies that want to achieve greater success with lean need guidelines that they can follow. This study aimed to provide such direction by identifying the paths that three construction firms followed to be considered lean successes.

It should be noted that because lean is a never-ending journey of continuous improvement, there is no specific point at which an organization arrives at a fully lean state. Although several companies in the construction industry have many years of lean practice and integration, not a single construction firm in the world is considered completely lean. This study defines a successfully lean organization as a company that utilizes lean planning techniques, uses multiple lean tools and concepts, encourages a lean culture, and has completed several lean projects (Rubrich, 2012). It is also implied that a successfully lean company is financially profitable as are the three companies in this study.

Purpose of the Study

The purpose of this qualitative study was to identify the paths to becoming a successful lean construction company. To that end, this study compared and contrasted the initial adoption of lean by three successful lean U.S. construction firms and tracked their progress over time. The results of this study provide several paths for newcomers to consider on their own journeys. This study also offered guidance to help firms overcome setbacks that they might experience on their own journeys and opened the door for renewed encouragement and direction. Finally, the results of the study allowed leaders to

see the lean potential in their own organizations.

Although each of the three construction firms in the study followed a unique path on their journey, the researcher found similarities among them. This study analyzed both the differences and the similarities. Noting *why* and *how* these transformations occurred provides guidance and direction for newcomers.

Greater insight into the lean process should enable more construction companies to successfully transform their own businesses. This insight should also potentially increase the speed at which organizations are able to change. The results in this qualitative study may not be considered generalizable to every construction firm in the industry. The concept of generalizability is typically associated with quantitative research, where the statistical findings of a small sample are extended to the population at large. "Statistical generalizability is typically not an aim of [qualitative] research; rather the researcher aims to produce generalizability in the context of the study, with the onus on the reader to determine transferability to other contexts" (Case & Light, 2011, p. 188).

However, because the results were triangulated between each of the three participating companies and existing literature on the topic, the resulting findings are replicable and transferable to other firms seeking to become lean. The research in this study not only supports the findings of other lean construction studies but it also provides a greater depth of understanding on the subject.

Transferability is a term that "refers to the applicability of findings in one context…to other contexts or settings" (Williams, 2011, Ch. 5). In this study, the researcher expected the paths of an experienced few to be transferable to other

organizations as "the target context [is] compared to the research context to identify similarities" between companies (Williams, 2011, Ch. 5).

Research Question

This study answered the following question: What does it take for a construction firm to become lean? To help understand and answer this question, three successful lean firms were selected as exemplary cases. Three individuals at each company were interviewed, and their interviews addressed the following related topics: lean discovery, milestones, barriers, key decisions, employee roles, learning, and teaching.

Inquiry Framework

This study used a qualitative multiple-case study research design. The three selected firms were considered the cases of the study, and they were categorically bound by the success that each had experienced from adopting lean as a guiding philosophy. Beyond the three firms, this study further divided data collection by interviewing three individuals at each company to offer a broader perspective to the phenomenon of becoming lean. Qualitative research emphasizes discovery, insight, and understanding from the experiences and the perspectives of those being studied (Merriam, 1988, p. 3). Therefore, this study benefitted from the experiences of those who participated in each company's lean journey.

Qualitative studies are specific not only to the phenomenon being studied but also to the researcher conducting the study (Gall, Gall, & Borg, 2003, p. 441). As such, the

researcher's own interests, experiences, and assumptions were integral to the study. Such personal insights help shape the direction and the design of a study. In this study, the researcher's own personal lean journey informed the research.

The data and findings from each case were examined against the others as well as triangulated with the literature. Findings, therefore, were established based on traditional qualitative standards, which are reviewed in later sections.

Implications and Contributions

While current lean construction research studies describe construction companies that have implemented lean concepts and tools on a limited scale, addressing the regularities and practical issues associated with limited lean implementation, this dissertation expands current research by describing how three firms met this study's criteria for being a successful lean construction company.

Furthermore, this study differed from current studies by emphasizing the participant's perspective rather than the researcher's perspective. Typical research studies on lean construction implementation focused on the researcher's perspective as the researcher works with participants on a construction project. For this study, the researcher believed that the participant's perspective, rather than the researcher's perspective, was of greater practical value to the audience. This study also differed from many current studies by providing an historical case study that examined the past as well as the present.

Statement of Researcher Assumptions

One of the first steps in designing a qualitative study is to establish the researcher's assumptions as they relate to the study. The assumptions help launch the framework for the project. "Researchers ask questions and design their studies based on particular assumptions, beliefs, and/or values. Therefore, their studies are guided by their values and the results, conclusions, and interpretations are also shaped by those values, just as their values are shaped by what they find" (Williams, 2011, Ch. 2). This study was informed by the researcher's personal lean journey. While assumptions indeed reflect the bias of the researcher, such subjectivity helps the researcher better understand the people being studied in context (Williams, 2011, Ch. 2).

The researcher's assumptions relating to becoming lean are as follows.

1. Companies want their results to improve (i.e., productivity, profitability, operational excellence, and so forth). However, individuals struggle with the vision, the motivation, and management's ability to make the necessary changes.

2. When properly implemented, lean can change an organization for the better.

3. Every firm's lean journey will be unique. However, there will be similarities between them. Every company can expect both triumphs and failures during their journey.

4. People are very different. Some individuals will refuse to change their tightly held paradigms, while others will see the benefits and choose to pursue lean on their own. Most need encouragement to change.

5. Not all companies can adopt a lean philosophy due to traditional paradigms

and company cultures.

6. Organizations can learn from the successes and failures of other firms. Those who discover lean may want to know what they might expect if they choose to pursue lean further in their organizations.

7. The path for both seasoned lean organizations as well as newcomers will be deliberate and intentional, requiring effort and discipline.

The researcher's assumptions specific to this study are as follows.

1. Lean practitioners are often excited to share their passion with others. Thus, the researcher expects willing participation from the top lean construction firms.

2. In agreement with qualitative traditions, participants should raise some of the best questions and offer the best solutions.

3. Qualitative methods are adequate for studying lean construction and will provide solid results and findings.

4. Findings and conclusions will be transferable to other organizations.

Limitations

Several limitations existed in the research. The first limitation was the number of participants and companies in the study. Initially, the researcher planned to interview a larger number of participants. However, at the advice of his committee, they determined that nine individuals would be sufficient for a qualitative study. The pilot study confirmed this decision. As stated in the assumptions, the results are transferable other construction firms desiring to become lean.

A second limitation to the study was the narrow selection of participants. The research protocol was open to the possibility of interviewing anyone who fit the criteria whether they were lean enthusiasts or not. The researcher's industry contacts, however, only provided lean enthusiasts to participate. Therefore, many of the experiences and perspectives shared did not allow for as much negative case analysis as the researcher expected. This comes with both benefits as well as concerns. The benefit is that all three companies were highly successful with lean as were all the participants, thus offering best practices from the brightest practitioners. The obvious concern is that the results became more predictable with fewer opposing opinions.

The research was geared toward managers and executives because they have a greater influence on the culture and implementation of lean practices than do others. The perspectives of construction laborers and office administrators were not considered as part of the data collection for this reason.

The third limitation related to prolonged observation. Due to time and funding constraints, the researcher was only allowed a limited amount of time to collect data. The primary source of data collection was through interviews. Broader data collection procedures, such as observations on several projects, would provide greater insight into lean saturation and acceptance at each company. It would also provide greater insight into potential failures and barriers.

Future research should consider adjusting the protocol accordingly. Despite the limitations, however, the researcher was confident that he could accurately answer the original research question, "What does it take to become lean"? Adherence to protocol

and Stake's (2013) processes were critical to maintaining credibility, transferability, dependability, and confirmability in this study.

Definitions

5S: A workplace organization method built around five Japanese terms that begin with an "S" when translated into English: Sort, Straighten, Sweep, Standardize, and Sustain (McGraw Hill Construction, 2013).

A3 Report: A standardized problem solving approach used by Toyota. The report is commonly required to identify a problem, support the claim through analysis, propose a solution, and test the solution—all on an A3-sized (11- x 17-inch) sheet of paper (McGraw Hill Construction, 2013).

Building information modeling (BIM): An intelligent 3D model-based process and platform for computerized planning, design, construction, and management of buildings and infrastructure (http://www.autodesk.com/solutions/building-information-modeling/ overview).

Choosing by advantages (CBA): A decision-making process formulated in the late 1990s by Jim Suhr of Utah State University in which only contrasting advantages of various alternatives are considered when making a decision (McGraw Hill Construction, 2013).

Integrated form of agreement (IFoA): A relational contracting approach that apportions responsibilities and benefits of the contract fairly and transparently, based on trust and partnership between the parties (Forbes & Ahmed, 2010). See also relational

contracting.

Integrated project delivery (IPD): A relational contracting approach that aligns people, systems, business structures, and practices into a process that harnesses [and contractually incentivizes] the talents and insights of all participants to optimize project results, increase value to the owner, reduce waste, and maximize efficiency through all phases of design, fabrication, and construction (Gokhale, 2011). See also relational contracting.

The Last Planner System:™ A production planning system designed to produce predictable work flow and rapid learning in programming, design, construction, and commissioning of projects (Lean Construction Institute, 2014).

Lean champion: A company's lean practitioner responsible for designing and implementing a company's lean transformation strategy at the corporate and project levels (https://www.agc.org/).

Lean construction: The continuous process of eliminating waste, meeting or exceeding all customer requirements, focusing on the entire value stream, and pursuing perfection in the execution of a constructed project (Construction Industry Institute, 2014).

Lean thinking: A philosophy that provides a way to do more and more with less and less—less human effort, less equipment, less time, and less space (Womack & Jones, 2003, p. 15).

Lean tools: The processes, systems, concepts, frameworks, methodologies, and products that when applied help organizations implement lean throughout the workplace.

Examples reported in this study are the LPS, Percent Planned Complete (PPC), 5S, A3

Reports, Choosing by Advantages (CBA), and Value Stream Mapping (VSM).

Additional lean tools exist, which were not cited in this study.

Percent planned complete (PPC): A basic measure of how well the planning

system is working—calculated as the "number of assignments completed on the day

stated" divided by the "total number of assignments made for the week". It measures the

percentage of assignments that are 100% complete as planned (Lean Construction

Institute, 2014).

Relational contracting: A transaction or contracting mechanism that apportions

responsibilities and benefits of the contract fairly and transparently, based on trust and

partnership between the parties. It provides a more efficient and effective system for

construction delivery in projects that require close collaboration for execution. The

relationship between the parties transcends the exchange of goods and services and

displays the attributes of a community with shared values and trust-based interaction

(Forbes & Ahmed, 2010 p. 462). See also integrated form of agreement (IFOA) and

integration project delivery (IPD).

Value-stream mapping (VSM): A diagram of every step involved in the material

and information flows needed to bring a product from request to delivery (Lean

Construction Institute, 2014).

CHAPTER II

REVIEW OF THE LITERATURE

This literature review describes the current state of lean implementation research to lay a foundation for the rest of this study. The review begins by describing the logic used to identify and organize the available literature on the topic. Next, the researcher reviews the methods commonly used in the available research on lean. Then, challenges and barriers to lean adoption are considered. The chapter concludes with a discussion of the known paths to becoming lean.

Literature Selection

The selected research in the literature review focuses specifically on lean implementation in the construction industry. Most of the literature on lean construction is found in the *Lean Construction Journal*, in proceedings from the International Group for Lean Construction (IGLC) conferences, or scattered throughout various engineering, construction, and business journals. Therefore, the researcher made no attempt to use any particular database because such a search would be ineffective. Rather, the researcher scoured research studies from the two journals mentioned above. Then, to expand the search, he explored Google Scholar studies by searching for titles emphasizing *implementation* and direct *application* of lean principles by construction firms.

The review of literature identified studies on lean construction implementation that are relevant to this study. To organize and analyze each study and its contribution to this research, a coding system was developed (see Appendix A) that identified key

characteristics within each study. Key characteristics include methodological findings as well as insights and conclusions from each source. Each study is reviewed below for its contribution to better understand the topic of becoming lean and to the design of this study. The coding sheet lists only those studies that establish a foundation of lean implementation, the focus of this research. It does not include sources on other ancillary topics, such as qualitative research, for example.

Common Methods Used to Study Lean

Case studies are the most common method used to study lean construction as they represent the majority of all true research in the search results. Six of the eight publications were case studies, while many of the other sources were nonresearch-based publications, such as literature reviews, essays, and books. Case-study methodology offers a very useful approach to describe a company's lean journey. The case studies cited within this literature review are a good representation of the majority of lean construction research, although the researcher also found several literature reviews, action research studies, and qualitative and mixed methods studies in the search.

Becker (1968), a case study expert, defined the twofold purpose of case studies: first, the intent is "to arrive at a comprehensive understanding of the groups under study" and second, "to develop general theoretical statements about regularities in social structure and process" (p. 233). In this study, the results will help companies identify the regularities of becoming lean—that is, how to successfully integrate tools, concepts, culture, and planning. Merriam (1988), a qualitative expert, added that the specificity of

case-study research "makes it an especially good design for practical problems" (p. 4).

Thus, case-study methodology is useful for examining lean concepts such as declining

productivity, lean tool implementation, or, in this case, successful paths to becoming

lean.

Concepts Associated with Leanness

Kinnie, Hutchinson, and Purcell (1996) proposed three stages of leanness. Firms

with little to no exposure to lean concepts or practices fall into Stage One, which has

naturally occurred at every organization through downsizing, restructuring, and an

evolving employee status (p. 18). Stage One leanness then equates to the act of merely

existing in the construction industry today. Nothing is required. It is achieved by default.

For this study, Stage One is not considered lean.

The majority of all practicing firms fall into Stage Two leanness (Kinnie et al.,

1996, p. 19). The interpretation of Stage Two includes any organization that attempts to

operate in a more efficient manner. Such companies are striving for flexibility and

improvement, which they seek through teamwork and basic work intensification in an

effort to manage fewer employees and limit company exposure to legal issues. The

employees at these companies may have a varying understanding of lean as described in

this study.

Each firm in this study has achieved what Kinnie and colleagues (1996) classified

as Stage Three leanness: "the ongoing process of managing the lean organization so that

it remains lean and responsive" (p. 20). Stage Three indicates an organization's

determination to continuously improve based on lean principles, which results from deliberate leadership and planning. Kinnie and colleagues suggested that very few organizations actually achieve this stage because of the intense focus that it requires. They further stated that Stage Three organizations focus their efforts on cultural programs, teamwork, and continuous improvement efforts to instill "a capacity for change" within the firm (Kinnie et al., 1996, p. 20).

The researcher's interpretation of this definition suggests that a company that is at Stage Three is practicing lean in large measure throughout the entire company and that most employees have some knowledge of the concepts and the tools. Such companies are very methodical and intentional in their lean initiatives. As stated previously, the three construction firms participating in this study have all achieved Stage Three. However, in addition to meeting the criteria for Stage Three, the companies also meet other objective criteria to be described in chapter three. These criteria help separate the most successful lean companies from Stage Two firms and from other construction firms that may have also entered Stage Three.

Challenges to Implementing Lean

Literature points to several cultural barriers that inhibit successful implementation of lean. Johansen, Porter, and Greenwood (2004) summarized these barriers as (a) historic problems inherent within the industry and (b) industry fragmentation. Historic problems referred to the "basis of commercial engagement" that "results in barriers caused by power imbalances, diversity of allegiance, interests, and commitments" (p. 5).

They defined industry fragmentation problems as "discontinuity producing a lack of trust and a climate of uncertainty in which actors in the process may seek the comforts of a command-and-control approach" (p. 5). These two barriers cause contractors to seek company- or self-optimization at the expense of other contractors and at the expense of the project, rather than seeking project optimization.

Another barrier is that newcomers to lean often stop seeing progress, or even digress, after experiencing success from their initial lean efforts. For instance, organizations that adopt lean tools without understanding the underlying lean philosophy often find that their results can be counterproductive (Fearne & Fowler, 2006). The three construction firms in this study provided insights into such barriers and show how to sustain and expand lean throughout the organization. Liker and Meier (2006) also suggested that to reach a truly lean state, an organization must be very proactive and intentional in its approach. This study also examined evidence to support these claims.

It is generally understood that change can be difficult for any organization. The concept of path dependency has been recognized as a barrier that restricts change (David, 2001). Path dependency means that a company's past events and decisions continue to influence present decisions by locking the organization into paths from which it cannot break away (David, 2001). Stated another way, key decisions that a company has made in the past can send the company down a path that creates a company-wide culture or sentiment that may not be conducive to implementing lean. Morrey, Pasquire, Dainty, and Thomson (2012) suggested that only after path dependencies have been identified and explored can new lean paths become adopted. They cited the following specific

examples of path dependencies, listed from broad to narrow: industry traditions, company origins, the adoption of technology and software, major changes in management, and department silos. Each path dependency influences current and future decisions within the company. However, once these path dependencies are identified, a strategy can be created to adopt new paths in order to consciously and intentionally shape the future of the company (Morrey et al., 2012).

Individuals' personal response to innovation and change can also become a barrier to lean adoption within an organization. Simply stated, people adapt to change at different speeds and to different degrees. Rogers' (2010) diffusion of innovation curve, shown in Figure 2, illustrates when categories of individuals within an organization typically adopt an innovation from its entrance into the market to its saturation point within that market. Rogers categories the first 2.5% of a group to adopt a new innovation as innovators; he categories the last 16% as laggards.

Rogers (2010) described the dominant attribute of each category of adopter as follows: "Innovators-venturesome; early adopters-respectful; early majority-deliberate; late majority-skeptical; laggards-traditional" (p. 44). Each category adopts the new innovation until saturation of the new innovation has reached the entire population. The curve describes both an industry-wide saturation as well as the diffusion that occurs within a company by its employees.

The adaptation model of lean diffusion (Green & May, 2005; Scarborough & Terry, 1998), patterned after Rogers' diffusion of innovation theory, follows the same curve. The adaptation model accounts for both local factors affecting management's
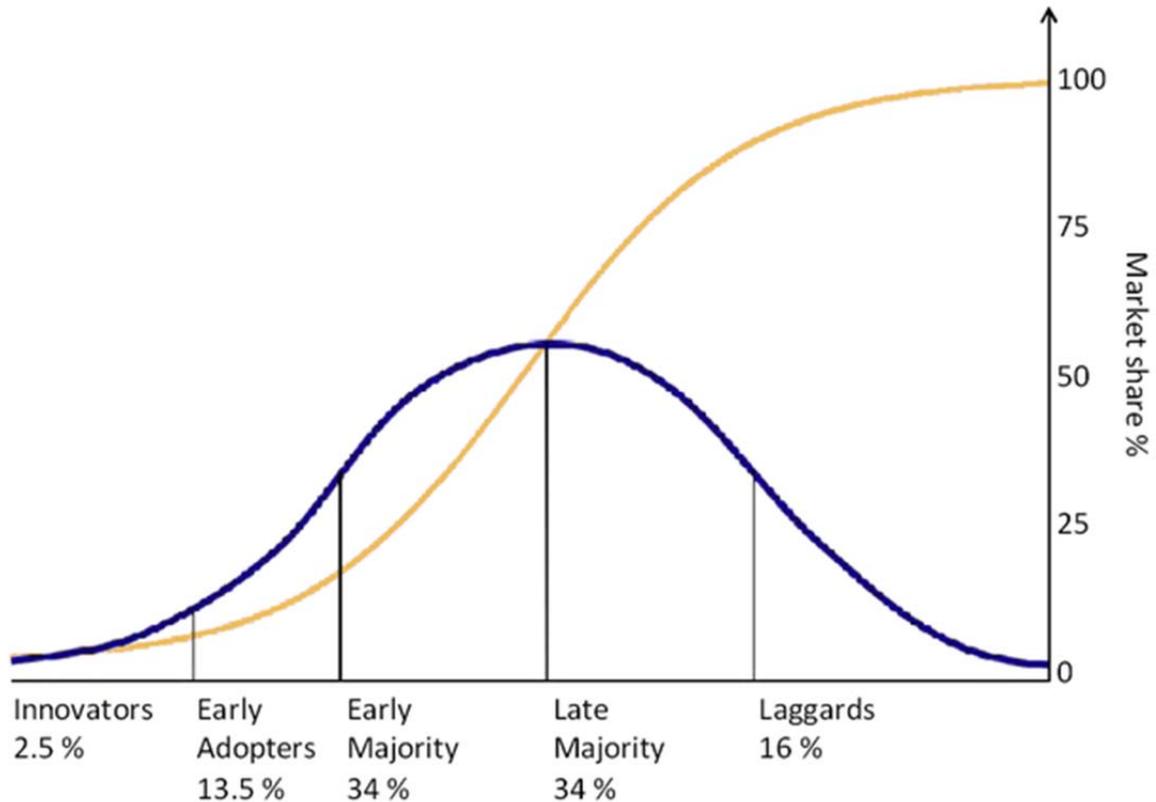
Figure 2. Rogers' diffusion of innovation curve. The curve illustrates the various phases that individuals progress through as they adopt new innovations and processes over time until a new innovation saturates the market. The theory was introduced by E. M. Rogers, 2010, *Diffusion of Innovations*.

decisions and path dependencies in an organization's effort to becoming lean. Examples

of local factors include local labor shortages, market size, and local competitors. Path

dependencies include upper-management changes, family-owned businesses versus

public companies, new programs or initiatives, new software, and so forth. Each factor

affects how a company develops and adopts, or rejects, lean philosophy and

methodologies.

Tradition is another barrier to lean implementation. Like company-level path

dependencies, this industry-level path dependency restricts change as the industry favors

and supports familiar concepts, tools, and practices over unfamiliar processes, tools, and

practices. Indeed, lean constructional management introduces many concepts, tools, and

practices that differ from those of traditional construction management, including the

following.

- Lean construction uses the concept of pull in the Last Planner System (LPS) to improve work flow reliability of the entire project whereas traditional management uses push techniques to dictate the ideas of management to each trade.

- Lean emphasizes early collaboration planning efforts from all parties whereas traditional management scheduling and planning is siloed between the owner, architect, engineers, constructors, and end users.

- Lean construction has formal learning components in the LPS to identify in-process problems early so improvements can be made immediately whereas traditional management uses after-the-fact detection to react to problems.

- Lean values minimal inventory and storage of materials on site and just-in-time delivery of products whereas traditional management stores large quantities of material on site, which are too often damaged, lost, stolen or buried under other materials.

- Lean seeks to optimize project efficiency as a whole through collaborative planning whereas in traditional construction, trade contractors seek to optimize their own companies, often at the expense of others.

- Lean seeks to increase value from the customer's (owner's) perspective whereas traditional management seeks compliance to minimal contractual obligations and recognizes less cost as value.

- Lean optimizes the entire value stream of a product, from the initial order, through manufacturing, delivery and installation whereas traditional management seeks no such optimization.

Based on the researcher's observations and discussions within the lean community, this researcher conservatively estimates that lean industry saturation falls somewhere in the early adopter category of Rogers' (2010) curve. In other words, only a very small minority of firms truly understand what it means to be lean. As the construction industry and individual construction companies address the barriers to lean implementation, an increasing number of organizations will seek an effective path to lean. This study was designed to provide these organizations with the information they need to become successful lean construction companies.

Paths to Becoming Lean

This final section is dedicated to outlining the literature that describes the requirements to becoming lean. The literature covers learning by theory, tools, and simulations. It then covers the change that is required within an organization as it becomes lean. The literature also discusses several proposed patterns or processes that companies should follow as they strive for Stage Three leanness.

Lean experts stated that most organizations pursue lean due to a crisis of some

kind (Liker & Meier, 2006, p. 27). The experts also stated that upper management must commit to lean; otherwise, the effort has little chance of success (Liker & Meier, 2006, p. 39). Many companies that adopt lean choose one of two implementation approaches: a theoretical approach or a lean tools approach. Howell (information shared at a training meeting, April, 4, 2013) suggested that a combination is most advantageous. The three participating construction firms in this study corroborated this in their lean journeys.

Traditionally, the optimum path to becoming a lean organization includes the study of the theory as well as learning through tools and simulations (Howell, information shared at a training meeting, April, 4, 2013). Simulations and tools have become a large part of implementation and understanding within the industry. However, Liker and Meier (2006) stated that the understanding gained through lean tools can be superficial compared to a more theoretical approach such as company book clubs and formal trainings. Experts and practitioners of lean construction argue that a deeper philosophical espousal of lean is achieved through the study of theory, which in turn supports and sustains the implementation of tools over time (Howell, information shared at a training meeting, April, 4, 2013).

Liker and Meier (2006) suggested that many organizations begin their lean journey by implementing lean tools or specific waste-eliminating activities. However, those firms that focus on lean tool implementation without understanding the underlying theory find that the results can be detrimental to their progress (Fearne & Fowler, 2006; Liker & Meier, 2006; Picchi & Granja, 2004). Rather than assuming that all lean tools are universally applicable and can be implemented in every instance, the theory of lean

innovations shows that organizations adapt these tools to fit their own needs somewhere along the diffusion curve (Green & May, 2005). Each company that adopts lean does so based on the company's needs, future goals, and the capability of management to influence the company culture. The theory further states that proactive management increases the likelihood that lean production will be a catalyst for workplace change (Green & May, 2005, p. 13).

Because companies have various backgrounds and cultures, it is logical that an organization must change in order to achieve a truly lean state. Johansen and colleagues (2004) summarized the findings from Alarcón and Diethelm (2001) that suggested several organizational elements critical for successful lean implementation and change.

- A clear methodology, with well-defined and rigorous strategies.

- Clear signals and a high degree of commitment from upper management.

- Establishment of a special organization for implementation, with a clear and rigorous operation.

- Project managers or heads of department are key officers, both for the leadership and commitment that they must exert as well as for removing barriers to the implementation of what is being promoted.

- Knowledge of both the lean concept and the implementation program is fundamental. This requires effective communication.

- The definition of functions, responsibilities, and levels of authority of the company's project managers and/or professionals. (p. 5)

Additional literature identifies the need for a cultural change within all levels of organizations for successful lean transformation (Alarcón & Diethelm, 2001; Nesensohn, Demir, & Bryde, 2012). Leadership and upper-management must not merely commit to lean but must drive it throughout the organization through the deep learning of lean

theory, the removal of barriers, and planning and management (Alarcón & Diethelm, 2001; Nesensohn et al., 2012). The researcher's personal experience lead him to agree on the importance of leadership and upper-management in the change process. It is nearly impossible for any company to reach a highly lean status without the leaders of the firm driving the culture and removing barriers. Therefore, this study examined the leaders at various levels at each of the three participating lean companies.

Additionally, Keiser (2012) suggested that leadership must adapt to the new philosophy by adopting new management paradigms. In other words, if leaders do not change, neither will the organization. Alarcón and Diethelm (2001) further explained that the cultural change required of mid-level managers, craftsmen, and trade contractors is a function of both the level of commitment to learning and training at all levels, especially at higher levels, as well as the leadership abilities of upper management.

Rubrich (2012), lean author and consultant, suggested that positive change cannot take place without effective communication. He stated that culture changes either deliberately or unintentionally. When management effectively communicates change to the rest of the organization, positive change is likely to occur. However, when upper management does not communicate change effectively, employees will "fill the voids" with rumors, which then spawns resistance (pp. 68-70). However, when management openly and honestly announces change, it usually creates interest, enthusiasm, and excitement among employees (p. 71).

Rubrich (2012) also proposed 10 steps for planning a lean transformation. The steps are necessary for the leadership team as well as the top lean performers and trainers

of a company to saturate the company culture and sustain it. He referred to the entire

process as a 10-step policy deployment process. The steps are as follows.

Step 1: Establish a mission and behavioral expectations.

Step 2: Develop business goals.

Step 3: Brainstorm for opportunities to achieve goals.

Step 4: Define parameters to value opportunities.

Step 5: Establish weighting requirements, and rate opportunities and priorities

Step 6: Conduct a reality check.

Step 7: Develop lean implementation plan.

Step 8: Develop a bowling chart.

Step 9: Develop countermeasures.

Step 10: Conduct business monthly reviews.

Rubrich's (2012) process offered excellent insights and resources for companies

on their own lean journeys. By studying three of the top lean construction firms, this

study provides some evidence supporting the need for planning such a large company

transformation. Furthermore, it acknowledges evidence that supports one or more of the

steps of Rubrich's policy deployment process.

When leadership recognizes the value that lean philosophy can have within the

organization, various steps must occur to sustain the efforts and reach lean maturity

(Nesensohn et al., 2012). These steps are referred to as a "True North" compass, which

leads to a lean organization (Nesensohn et al., 2012). True North is a guiding principle

found in writings of Jeffrey Liker, taken from the auto manufacturer Toyota, a true lean

pioneer (Liker, 2004). Nesensohn and colleagues also stated that "it may not be necessary or practicable to implement each step [in a specified, sequential order]. But as long as each step taken is on the path towards True North, the organization will continuously improve their Leanness." Below are the required steps specified by Nesensohn and colleagues.

Step 1: Train employees in the lean philosophy.

Step 2: Build strategic business units.

Step 3: Develop your own lean workshop.

Step 4: Develop an acquisition strategy.

Step 5: Develop an appropriate lean contract.

Step 6: Customize suitable lean techniques.

Step 7: Train employees in the lean techniques.

Step 8: Pre-qualify contractors and designers.

Step 9: Build up a pool of designers/contractors.

Step 10: Select the most suitable planner.

Step 11: Present your aims and commitment to the planner.

Step 12: Train the planner and his team.

Step 13: Get other trade planners on board by the same way.

Step 14: Continue lean trainings and highlight successes.

Step 15: Reduce the workflow variability.

The findings of the Nesensohn and colleagues' (2012) study stated that a lean organization believes that lean philosophy must become second nature within the culture.

Step 2 indicates the need to create a separate lean team, "which will customize over time

the organization's own way of doing Lean Construction and develop acquisition

strategies for projects under the umbrella of Lean." This step coincides with the

recommendation of Alarcón and Diethelm (2001) to make the goals of the lean team clear

and rigorous. These 15 steps heavily influenced the interview questions that this study

used. The development of the interview questions are explained in Chapter III of this

study.

The researcher's own experience in adopting lean coincides with the findings of

Nesensohn and colleagues (2012) in that one strategic lean team is dedicated to building

momentum through persistent implementation and positive results. This study applied

Step 2 by analyzing whether the participating firms began the process by creating a

separate lean team to standardize practices throughout the organization. This study also

included the role of that team in pursuing projects that fit within the new cultural

framework, and whether those new projects allowed the company to capitalize on such an

advantage.

Summary

The studies reviewed in this chapter examined various paths of lean

implementation. They offered successes and failures as well as barriers and best

practices. This study used each of these findings to guide the research efforts. The

resulting qualitative study addressed how each organization originally defined lean and

what caused each organization to become an early adopter. The study also revealed the

learning strategy that management employed to convince their employees and how path

dependency (past decisions) affected implementation. In addition, the study examined

how management drove implementation and removed barriers and identified the strategy

that management used to maintain responsiveness and innovation. These issues, among

others, are explored throughout the study. These results and findings help tell the story of

how three construction companies became successfully lean.

CHAPTER III

METHODOLOGY

Case-Study Method

This study employed a multiple-case study qualitative research methodology to identify successful paths to becoming lean. One of the primary characteristics of qualitative research is the emphasis and study of specific instances, or cases, of a phenomenon (Gall et al., 2003, p. 434). However, case studies are not always qualitative in nature. Stake (2013, p. 435), one of the pioneers of qualitative inquiry, suggested that "as a form of research, case study is defined by interest in individual cases, not by the methods of inquiry used." In fact, Gall and colleagues (2003, p. 435) suggested that case-study research developed as a distinctive methodology to scientific examination partly as a response to perceived restrictions of quantitative methods.

Some researchers select single cases that are particularly interesting to them whether or not the findings are transferable to the audience. Others, however, study multiple cases with the specific purpose of transferring the findings to other situations. Studying multiple cases allows for both. Each firm's path is expected to be unique. However, because the goal of the study is to help other construction firms follow a successful path to becoming lean, transferability must be considered a high priority.

In his book on multiple-case study analysis, Stake (2013, p. 4) explained that when there is no intent to be comparative, the single-case study approach is sufficient. The implementation of lean philosophy, for example, could be considered a single-case

study. The introduction of multiple successful lean construction firms into the study

qualifies this dissertation as a multiple-case study. The term *successful* categorically

binds together the phenomenon of lean implementation and defines the sample also. Only

firms that have successfully implemented lean construction tools, concepts, culture, and

planning over a sustained period were considered for this study. This was based on

specific criteria specified later in this chapter as well as company recommendations from

the founders of the Lean Construction Institute. Therefore, as is common to qualitative

research, the sample was considered a purposive sample rather than a random sample.

Each firm selected is expected to be "information-rich" because it is known to already

possess certain characteristics which are critical to the study (Gall et al., 2003, p. 439).

The phenomenon that this dissertation studied was each company's methods of

lean implementation. According to Stake (2013), the phenomenon in qualitative studies is

considered more of a target than a bull's eye (p. 6). Thus, in the spirit of qualitative

inquiry, there was no attempt to identify one single successful implementation strategy (a

bull's eye). Rather, the intent was to learn what each case could tell us about successful

lean implementation (the target). The multi-case approach studied both what is similar

and what is different about each case in order to better understand the phenomenon of

successful implementation.

While the term *successful* implementation has been emphasized, it should be

noted that poor or less effective implementation attempts by each successful construction

firm will also be studied. Simply because the chosen three firms are successfully lean

today does not mean that they never experienced any implementation failures along the

way. Studying a company's unsuccessful attempts can better contribute to the understandings of successful lean implementation.

Qualitative Methodology

Qualitative research has evolved from several social sciences, such as anthropology, sociology, and psychology, as well as from the humanities, such as art, literature, and philosophy (Gall et al., 2003, p. 476). When discussing their general purpose, Merriam (1988) stated that such studies "are qualitative and hypothesis-generating, rather than quantitative and hypothesis-testing." She referred to qualitative research as naturalistic research, which describes both the approach and the methods most appropriate for collecting and analyzing data. A naturalistic approach, according to Merriam, emphasized discovery, insight, and understanding from the experiences and the perspective of those being studied (p. 3). Such an approach offers great potential to studies such as this one where understanding the lived experience of the participant is the goal.

Qualitative researchers can look to accepted standards as means to frame and design a study. The design of qualitative studies, however, is specific to the phenomenon being studied and to the researcher conducting the study (Gall et al., 2003, p. 441). Therefore, study designs are often closely related to the impressions of the researcher. Peshkin (2000) viewed the essence of qualitative case-study design as interpretation, providing "importance, order, and form" to the study (p. 9). For example, the researcher conceptualized the study by interpreting who, what, and where to conduct the study. His

or her insight will also design how and when it will be carried out. The researcher determined how to best analyze the data and how to share it with others to convey the meaning and the understandings learned throughout the process. The interpretation skills learned through study and experience over time shaped the process of the entire study (Peshkin, 2000).

Qualitative research traditions involve like-minded scholars who agree on legitimate questions to study as well as on the methods used to understand plausible solutions to those questions (Jacob, 1987). These traditions are evidenced in a study as researchers align their project interests with one or more theoretical perspectives of the discipline.

This study investigated successful lean implementations through the lens of a qualitative, historical case study of each organization. An historical perspective seeks to capture the individuals' life experiences from their own perspective (Gall et al., 2003, p. 477). Applied to this study, this perspective sought to investigate the lived experience of various employees learning and implementing lean construction philosophies within each organization.

Company and Participant Selection Criteria

The three companies in this study were chosen because they were recommended by the Lean Construction Institute and because they have achieved what Kinnie and colleagues (1996) considered Stage Three leanness. According to Kinnie and colleagues, Stage Three leanness is "the ongoing process of managing the lean organization…within

the firm (p. 20). In addition, these three companies were chosen because they met the following purposive sampling criteria.

1. The firm must be a national or regional U.S. general contractor.

2. The firm must have been in business for more than 20 years.

3. The firm must have a history of contribution to lean construction advancements and innovation. This criteria will be evident through the following means:

    a. It contributes financially to and is a member of the Lean Construction Institute (LCI) or other trade organizations that promote lean.

    b. Its employees present innovative lean techniques and experiences at major national lean events.

4. The firm must actively train employees in lean tools and theories.

5. The firm must have successfully negotiated several relational contracting projects such as Integrated Form of Agreement (IFOA) or Integrated Project Delivery (IPD).

6. This study will be limited to three companies in the U.S.

The headquarters of the three companies fitting the above criteria were located in the Midwest, the West, and the South. As an additional reference, each company was highly regarded by the Lean Construction Institute founders as a top-performing lean construction firm because of their history of lean dedication and success. Additionally, each company was cited on the Engineering News Record Top 200 U.S. Contractors list (Engineering News Record, 2015). Each company built in multiple states, employed from 500 to 2,600 people, and had annual sales revenues between $380 million to $2.5 billion.

Regarding the minimal number of firms for this study, Stake (2013, p. 22), one of the pioneers of qualitative case study research, suggested that if a multi-case study has fewer than four cases, the benefits may be limited. In order to mitigate this issue, in addition to the three organizations selected, three individuals from each firm were interviewed to add variety and to minimize bias. The criteria for selecting each participant were as follows.

1. Each individual must have been employed by the organization before the term "lean" entered the company's vocabulary.

2. Each individual should occupy a different organizational position within his or her company to maintain variety within the sample.

Possible individuals to interview included project managers, superintendents, seasoned lean experts, and company executives. Because of the rising popularity of lean construction, lean enthusiasts are commonly willing to share their knowledge with others. Therefore, the researcher expected continued support from each of his contacts in arranging interviews and company visits.

Instrumentation

The researcher was considered the interpretation instrument in qualitative studies. Merriam (1988) stated that qualitative research "requires a data collection instrument sensitive to underlying meaning when gathering and interpreting data. Humans are best suited for this task—and best when using methods that make use of human sensibilities such as interviewing, observing, and analyzing" (p. 3). It is the researcher who develops

the themes, interview questions, research design, and protocol based on experience and

qualitative traditions. As the instrument, the researcher is responsible for defining the

phenomenon from different perspectives. Finally, the findings were interpreted by the

researcher based on qualitative standards and are explained in Chapter V.

Research Protocol

The researcher believed that face-to-face interviews would produce richer data

than phone interviews. Furthermore, he believed that participants would be more

accessible and more focused in a face-to-face setting. Personal funds utilized during data

collection allowed the researcher to travel to several states to conduct the interviews in

person. Although each participant was openly willing to participate without any

incentive, the researcher offered each a participant a monetary reward (i.e., a $50 gift

card) after being preselected.

Interview candidates were selected by sending the participant criteria to

executives who were agreeable to contribute to the study. Based on the research criteria,

they appointed several employees to participate. Each participant was then confirmed by

the researcher as interview appointments were made. Each interview lasted

approximately 1 hour. Interviews were conducted in a private setting, such as an office or

a conference room, to minimize distractions. The exact start time of each interview was

prearranged before traveling so that the researcher was assured that each meeting would

take place.

Participants were provided with a letter of consent prior to commencing the

interview (see Appendix D). The letter explained the background of the study as well as the interview procedures. Part of the interview procedure included statements agreeing, or not agreeing, to have the interview voice recorded. If participants did not agree, they had the option to either withdraw or to proceed without being recorded. All participants agreed to be recorded; therefore, the researcher was free to focus on the responses and upcoming questions.

While the researcher was present at each company, he also visited one construction site after interviewing the three participants at one of the companies. During the site visit, he accepted photographs and other artifacts such as company documents and presentations that were offered to him. These types of artifacts were important because they illustrated the depth of the lean culture throughout the organization. The artifacts also triangulated the researcher's own experiences with those offered by the participants. Examples of collected artifacts were photos of lean boards illustrating processes and tools such as the Last Planner System (LPS), Percent Planned Complete (PPC), and visual management. Additionally, a lean boards PowerPoint presentation was given to the researcher by a superintendent from one of the companies along with a lean boards manual from an executive at the same company.

Study Design

As it is with any study, generally accepted rules must be followed to maintain order throughout each phase of inquiry. A general summary of the qualitative research procedure as explained by Williams (2011, Ch. 1) offers seven subprocesses that occur

simultaneously throughout a qualitative study. He explained that each step iwass often

repeated multiple times throughout the project, with each process working together with

all others to advance the study. Therefore, qualitative practices are iterative rather than

linear in nature. The seven steps Williams (2011, Ch. 1) proposed were followed in this

study and are stated below.

1. Develop relationships.

2. Ask questions.

3. Develop a focus.

4. Keep a record.

5. Share with others.

6. Analyze and synthesize.

7. Gather information.

As stated previously, Stake (2013) offered a relevant multi-case study qualitative

approach, which the researcher also chose to follow. With over 13,000 citations to his

multiple-case study approach, he was considered one of the pioneers of qualitative

research. Stake's methods contain a step-by-step process that aligned well with the needs

of this project. The process began by establishing the research question to guide the

study. The research question helped identify what was most important for understanding

the phenomenon of successful lean implementation. As stated previously, the main

question this study asked and answered as, "What does it take for an organization to

become a successful lean construction company"?

Developing Themes

After defining the focus of the study, Stake's (2013) multi-case study process requires the researcher to develop themes. He described themes as a summary or expansion of the research questions (p. 42). Themes provide the primary information about the phenomenon that is essential to the study. The themes were created, in part, based on the researcher's own personal lean implementation experience in industry as well as reviewing the literature on the subject. The themes clarified the general research question for the study and also provided a framework for gathering data.

Shown below are the eight themes that were explored in this study.

1. Discovery—How and why was the discovery of lean found to be useful to the organization and to the individual?

2. People—In what way did people contribute or hinder the success of lean? Who were the key leaders?

3. Tools—In what ways did the organization utilize tools to implement lean?

4. Implementation—What were the implementation strategies and how effective were they?

5. Training—How did the organization emphasize training to its employees and to trade contractors?

6. Culture—What role did the organization's culture play in lean initiatives?

7. Barriers—What resistance occurred? How did path dependencies affect lean implementation?

8. Future—What is the organization doing to drive lean into its future?

Data Collection

The creation of guiding themes prompts the researcher to begin thinking about data collection procedures. Stake (2013) advised that a researcher should first learn all they can through observation, and then fill in the blanks by interviewing people or by finding artifacts and documents to support the study. Since this study was unable make observations of lean efforts in the past, interviews were considered the most important method for collecting data. Beyond the data provided to this study, each interview also corroborated the experiences of the researcher during his time in industry implementing lean. This further validated many of the study's underlying goals and assumptions.

Describing when interviews are the appropriate choice for collecting data, Dexter (1970, p. 11) stated, "Interviewing is the preferred tactic of data collection when…it will get better data or more data or data at less cost than other tactics!" Artifacts were considered secondary to interviews. While they may be more challenging to acquire, possible artifacts include lean training documents and corporate strategies, such as written company resolutions or yearly company goals and missions statements.

Merriam (1988) identified several types of interviewing techniques: highly structured, semistructured, and unstructured or open-ended interviews (p. 73). This study utilized a semistructured approach because highly structured interviews were considered too rigid while unstructured interviews were considered too loose for this type of study. Merriam also suggests that semi-structured interviews are typically guided by a list of questions to be explored, but that the exact order or wording is not predetermined. She further explained that "this format allows the researcher to respond to the situation at

hand, to the emerging worldview of the respondent, and to new ideas on the topic"

throughout the interview (p. 74). The list of interview questions used in this study is

provided in Appendix B.

Although it may be impossible to "escape the human factor" completely, proper

interview protocol requires that the interviewer approaches each interview in a neutral

and non-judgmental way (Merriam, 1988, p. 75). Caution is required in all interview

settings so that the interviewee is not undesirably influenced by leading questions or the

tone accompanying each question. It is the responsibility of the researcher as the

instrument to remain neutral towards the subject in order to capture unbiased responses

from each participant (Merriam, 1988, p. 73).

Additional protocol requires interview questions to be delivered using language

that is familiar to the participant (Merriam, 1988, p. 79). Because lean comes with its

own jargon, and because this study was researching highly successful lean firms, the

researcher expected each of the participants to share "lean lingo," which was indeed the

case in each interview. The use of these lean terms by the researcher helped to establish

trust and rapport with the participants.

Data from each interview was recorded by the use of an audio recording device.

This allowed the researcher to return to the precise wording and tone in each interview

setting at a later date. All recordings were kept confidential, and each was erased at the

end of the study. During a typical recorded interview session, the researcher attempted to

focus on the mood of each response from the participants. He took only minimal notes,

which allowed him to follow tangents, change directions, dig deeper, and read the body

language of the participant.

At times, qualitative researchers adhere to preplanned interview questions. This is referred to as a "grand tour." To qualitative researchers, the grand tour simply means that the interviewer is following the overall theme of the study. However, there are times when subtle remarks, pauses, or tones by the interviewee may spark interest in the researcher, causing him to pursue a "mini tour." A mini tour is a term used by qualitative researchers to describe occasions in which the interviewer follows an interesting tangent in the interview (Williams, 2011, Ch. 5). These tangents are often pursued by the researcher based on intuition. The mini tour can offer a unique variety of data that structured interviews cannot. The mini tour allows for deeper discovery in the analysis process and thick description in the final report.

Because of the semistructured interview approach selected by the researcher, it was unnecessary to ask every single question on the interview question sheet as long as the respondent covered each question in their responses. The researcher began the interview by asking a few general questions to get the conversation started, but he then allowed the respondent to answer in the direction that he or she preferred. Some answers were short while others were quite long. It was the researcher's responsibility to decide whether the respondent was adding value to the study or whether the conversation should be redirected. After describing a story or relating historical facts to the researcher, the respondent may have answered several questions on the list without the researcher asking those questions. During these moments, it was not necessary for the interviewer to ask the next question simply because it was on the list. Rather, semistructured interview

strategies allowed the conversation move along to the next unaddressed question. This followed Merriam's (1988) approach with semistructured interview protocol (p. 73).

Throughout the interview process, the data collection protocol required the use of Stake's (2013) Worksheet #3: Analyst's Case Report. After each interview, the researcher completed this worksheet, officially initiating the analysis and synthesis phase (although several less formal analyses were already taking place). Using the worksheet, the researcher gathered information from interviews and other data collection methods and compared the data to each theme and to the findings from each case. As this worksheet was completed, cross-case factors were initially identified for further analysis at a later date. Impressions were recorded so that future reviews would have contextual information from which the domain analysis could be conducted (Stake, 2013, p. 45). Worksheet #3 provided a valuable audit trail that may be reviewed at any point in the future.

Pilot Study

In the fall of 2013, the researcher conducted a pilot study to this project. The pilot study was part of an advanced qualitative research course required for the doctoral degree. During the course, the researcher developed each of the interview questions along with the research themes. The questions were based on his own experience as he worked in the industry implementing lean construction at his company and on research that was noted in the literature review. The interview questions were validated during the pilot study period by two members of the doctoral committee, one of them being the instructor

of the qualitative course. The questions and themes were considered acceptable with several minor revisions.

The pilot study was then conducted from start to finish, with the exception of writing the final report. Findings were documented and analyzed, which prompted minor modifications to interview questions and techniques. During the pilot study process, the researcher received several commitments to participate in the final dissertation.

The researcher learned several things from the pilot study, which were carried forward to the dissertation. First, he learned the importance of qualitative standards and protocol. Second, the research themes and interview questions were solid. They needed only minor revisions in order to proceed with the actual study. Finally, he learned that the study was worthwhile and that participants were very willing to help. Several participants and industry professionals expressed an eagerness to read the final report. This validated the researcher's decision to proceed with the project.

Audit Trail and Confidentiality

The audit trail began during the pilot study period and continued through the actual project. Creating themes, collecting artifacts, recording interviews, and keeping a journal were all part of the researcher's audit trail. Keeping a journal was important throughout the process because of the evolving nature of conducting research. As data and patterns emerged, they invoked impressions and interpretations which sometimes altered slightly the direction of the study.

The audit trail was stored on the researcher's personal computer, while physical

transcriptions were secured in the researcher's office desk. Recorded interviews could then be reviewed, summarized, and analyzed as needed. The researcher alone had access to the data collected throughout the study. Institutional Review Board standards were also followed in data management and storage.

Qualitative Standards

Like all research endeavors, generally accepted qualitative standards exist from past researchers, which help guide future studies. Standards are set forth to establish reliability and validity in the research. Transparency in all methods, coupled with a logical methodology in the final report, provide insight into both the study and the results. The reader is then able to judge whether the information therein can be transferred to his or her own situation.

Qualitative researchers have a differing view of reliability and validity due to the subjective nature of inquiry and interpretation. Consequently, it is less important to be concerned with the truth or falsity of a situation with respect to an external *perceived* validity (which is the primary concern of validity). Therefore, qualitative researchers argue for alternative standards for judging the quality of research (Trochim, 2006). Lincoln and Guba (1985), qualitative research experts, shared the four qualitative alternatives for judging soundness, as shown in Table 1.

Credibility

The credibility standard demands that (a) the final report of a qualitative study be believable to a critical audience, and (b) that it should be approved by the very

Table 1

Quality Standards for Qualitative Research

Traditional criteria for judging quantitative research	Alternative criteria for judging qualitative research
Internal validity	Credibility
External validity	Transferability
Reliability	Dependability
Objectivity	Confirmability

individuals who provided information during the data collection process (Williams, 2011, Ch. 5). Because the objective of qualitative research is to understand and describe the phenomenon through the eyes of the participant, it is very important that participants are the very individuals approving the legitimacy or credibility of the results. Lincoln and Guba (1985) suggested several important qualitative standards that are necessary to enhance the credibility of a study. They are shared below along with a brief discussion of how they relate to this study.

Prolonged engagement requires the researcher to be present among those individuals being studied long enough to establish trust with them. This trust was earned as the researcher consistently attended LCI events and networked with other members. There is a mutual respect and trust between members as they seek to improve the construction industry. This trust was necessary so that other lean professionals would feel comfortable referring potential candidates for interviews.

Persistent observation suggests that the researcher studies the topic sufficiently so that he is able to determine which pieces of information add value to the study and which

are irrelevant. The pilot study helped establish a solid starting point in this regard. Conducting the actual study solidified that knowledge.

Triangulation, a common standard in all research traditions, validates findings by verifying them with additional, related sources of information. Other means of triangulation include diverse methods of data collection (such as observation, artifact collection, interviews, and so forth) and collecting information from multiple participants. As was previously mentioned, this study triangulates the findings of three different organizations, with three distinct contacts at each firm. It also triangulates data by comparing the findings with previous related research. Finally, a few artifacts were collected along with a minimal amount of information from observations of current practices while visiting one company.

Peer debriefing occurs when the researcher allows a disinterested peer to question the methods, the process, and emergent conclusions. In part, this occurred naturally in the committee review process with each committee member offering suggestions and questioning the researcher's assumptions. It also occurred informally as the researcher bounced ideas and findings off of peers and other members of LCI during lean conferences and events.

Negative case analysis searches the collected data for instances that may contradict the researcher's original line of reasoning. The process provides an analytical procedure that is meant to refine conclusions until they "account for all known cases without exception" (Williams, 2011, Ch. 5). The researcher used negative case analysis in this study when one of his assumptions was not validated by the feedback of the

participants. Based on his own experience, the researcher assumed that each firm would require lean on all projects as a best practice. However, only one of the three companies had gone so far as to require lean on all projects. Therefore, the researcher revised his conclusions to indicate that requiring lean on all projects is not a mandatory best practice but is recommended.

Progressive subjectivity checks record the evolving interpretations throughout the study in the researcher's field notes. By following Stake's (2013) worksheets and keeping a journal during the study, the researcher naturally progressed through the research and adapted the study as needed. The evolving interpretations were recorded in the audit trail and were referred to often during analysis and in the writing of the final report.

Emic or folk perspectives of the participants and *thick descriptions* are often included in the final report. "The emic approach investigates how local people think" (Kottak, 2006, p. 47). It captures how they perceive the world around them and their own rules for behavior. Sharing the emic perspective is often accomplished by using a participant's own words or by sharing specific experiences from their perspective. By adding the voice of the participant, the researcher contributes to the credibility of a study. This researcher used direct quotes when identifying the merged findings from each interview. When drawing conclusions, however, the researcher interpreted and organized participant responses. Thus, the emic perspective actively contributed to the etic conclusions discovered and reported in the study.

Member checking contributes a great deal of credibility by allowing the participant an opportunity to review the collected data to verify appropriate

representation of their position. This protocol was important to this study as several

interviewees took the opportunity to make minor corrections to the researcher's

transcriptions. The revisions had no effect on the data or the interpretation of the

researcher. Changes made were limited to correcting dates, titles, typos, or other minor

terminology inaccuracies.

Transferability

The transferability standard demands that the findings or interpretations of this

study are applicable to other settings (Williams, 2011, Ch. 5). Transferability in

qualitative research is closely synonymous with the concepts of generalizability and

external validity. The uniqueness of qualitative research is that transferability is

determined in part by the reader, not just the researcher. *Thick description* is the strongest

contributor to transferability as it allows the reader to vicariously experience the

perspectives shared in the final report (Williams, 2011, Ch. 5). For this reason, the emic

perspective and storytelling were important in meeting the transferability standard of this

qualitative study—allowing the researcher to approach the most externally valid

information possible on the topic.

Confirmability

Confirmability is comparative to objectivity in quantitative research. As the name

implies, the confirmability standard emphasizes a need to confirm the results and

conclusions of the current study by referencing the findings of other authors in related

studies. Additionally, participants may contribute by sharing their sentiments regarding

the confirmability of the researcher's interpretations as discussed above in the member checking section (Williams, 2011, Ch. 5). Methods for enhancing confirmability included playing the role of "devil's advocate" with respect to the results as well as negative case analysis. The analysis protocol helped provide confirmability as findings of one participant were compared and contrasted with those of others in the study. The confirmability standard was also met through the participants themselves, who occupied different capacities within each organization. Finally, many of the conclusions and recommendations reported in this study are triangulated with other lean researchers and authors in chapter five.

Dependability

While replicability and repeatability are the measure for judging quantitative studies, reliability in qualitative research is accomplished through the qualitative concept of dependability. Because qualitative researchers cannot measure the same thing twice, instead they "emphasize the need to account for the ever-changing context in which research occurs" (Trochim, 2006). Williams (2011, Ch. 5) stated that dependability "refers to the stability or consistency of the inquiry process used over time." He further explained that when checking the dependability of a study, "one looks to see if the researcher has been careless or made mistakes in conceptualizing the study, collecting data, interpreting the findings and reporting results." Robert Stake's process was strictly followed in this study as each of his worksheets was completed and analyzed according to his process. Furthermore, dependability was sought after by the researcher while organizing and presenting the findings in the final report in a logical, transparent manner.

This also allows the audience to understand and judge the quality of the entire process.

Data Analysis

Data analysis occurred in several ways throughout the entire study as the researcher reflected on what was said, observed, and recorded. However, as the "official" data analysis period began it was important to keep in mind the potential threats discussed above and to ensure that proper methods were followed. Williams (2011, Ch. 2) suggested that analyses and syntheses include the researcher's "speculations about what [they] are learning, the themes that are emerging, patterns that [they] may be seeing in participants' experiences, connections between experiences, [their] new ideas, [their] interpretations of the meanings of events and people's comments, and so forth."

Stake's cross-case analysis process was very beneficial to the pilot study. His worksheets were utilized to record and visually display the interrelationship between case findings and themes. The analysis that occurred when findings were compared to each theme led the researcher to make logical conclusions or assertions about the phenomenon as a whole and about each individual case. Stake (2013, p. 41) defined an assertion as the researcher's findings about the phenomenon being studied. Each assertion was based on evidence or, in other words, findings from each case.

Following Stake's (2013) process, after recording themes and evaluating each case, the researcher began the data analysis process by judging the usefulness of each case to the study (p. 49). Stake's process helped the researcher identify which themes were the most prominent in each case by comparing one theme at a time to his own notes

and impressions. As this data were recorded onto Stake's Worksheet #4, several prominent relationships and findings began to emerge that were marked for further study during the next phase. For example, the researcher noticed that upper management consistently played an important role in driving lean throughout each company.

During the next phase of analysis, Stake offered three similar, yet slightly different tracks by which to analyze the data further. Considering the goals of this study, the researcher selected Track II: Merged Case Findings, because it provided a happy medium between an emphasis on individual case findings and an emphasis on the complete transferability of all cases. Worksheet #5B: Case-Findings Matrix is specific to Track II (see Appendix C). It focuses on expanding the theme-case relationships into specific case-based findings (Stake, 2013, p. 59). In other words, Worksheet #5B helped the researcher determine whether specific findings in each case were important. The most compelling findings were again marked and identified for the researcher to compose an assertion at each intersection. This was accomplished by clustering each individual finding with similar findings of another case to identify the most important patterns from the data.

At this point, the researcher began to solidify each assertion based on its supporting evidence. Assertions were prioritized according to their prominence within the study. This was accomplished by completing Worksheet #6: Assertions for the Final Report. Supporting evidence was recorded for each assertion so that individual experiences and stories could be referred to easily in the draft of the final report.

Stake's analysis process naturally seeks triangulation throughout the process as it

identifies and compares new relationships between cases, themes, and findings (Stake,

2013, p. 73). Throughout the analysis phase, various impressions and story lines emerged

and thoughts were continually directed to the contents of the final report. Along with the

final assertions, experiences and stories were also strategically outlined for the writing

phase.

CHAPTER IV

RESEARCH FINDINGS

The purpose of this study was to identify successful paths to implementing lean construction from top lean construction firms in the United States. This was accomplished by soliciting comments, experiences, opinions, and sentiments in a semistructured interview setting. The results help describe, interpret, and outline successful paths by sharing the findings in the participant's own words. The goal is to paint a vivid picture for other companies wishing to begin or continue their own lean journeys.

The participant parameters specified that the three firms selected for the study would have a solid history of lean contributions to the LCI through presentations and financial investments, actively use and train on the LPS, and have successfully negotiated several integrated contracts. The researcher successfully identified three organizations that fit these requirements and conducted interviews with key personnel onsite.

The research protocol also called for the participants to meet several criteria, which was presented in chapter three. It was considered important that all participants were employed by each organization before the term "lean" entered the company's vocabulary. Additionally, interviewees were to occupy various organizational positions within each company to provide greater variety within the sample. Again, the research was able to successfully identify and interview these individuals.

In this study, all participants were males, which was not part of the research criteria. No gender was specified in the protocol, nor was it considered relevant to the

findings of the study. The researcher welcomed any individual who fit the predetermined criteria. Additionally, the employees available to interview during the time of data collection were all highly supportive of lean construction.

Company Profiles and Participant Descriptions

In this study, three companies and nine participants ($N = 9$) were selected. Each company identified three individuals to be interviewed. The findings shown in this section briefly describe each company and each participant. The three companies are listed as Companies A, B, and C, while the participants are listed as 1 through 9.

Company A

Company A was a 90-year-old commercial construction firm located in the Midwest and a founding member of LCI. Factory-rebuild projects represent a major source of their early work. Because of the nature of such projects, where it is critical to keep factory downtime to a minimum, advanced planning is essential and construction schedules are highly detailed. Company A strongly encouraged lean to employees. Currently, Company A builds in various sectors including healthcare, energy, education, research and technical facilities, industrial, commercial, religious, and government.

Participant 1 has worked at Company A for more than 24 years. He began as a project engineer. From there he progressed through various project management roles to director, vice president, and now currently acts as a group president. Participant 1 is one of many lean champions at Company A and presents often at LCI events and other lean conferences.

Participant 2 has worked at Company A for 16 years. He began his career as an intern on factory-rebuild projects and is currently a building information modeling (BIM) manager. Participant 2 was also one of many lean trainers at Company A.

Participant 3 has worked at Company A for 31 years. He began as an estimator and later became a project manager, and currently serves as Sr. Director for Continuous Improvement and Quality. He is also a registered architect and a certified value specialist. Participant 3 often presented at lean events and conferences.

All three participants worked closely with Glenn Ballard and Greg Howell, the founders of LCI, who also acted as lean consultants for Company A at the start of their journey. During this time, the LCI founders were winding down their university teaching careers; therefore, they will be referred to from this point forward as *LCI founder-consultants*. Each employee at Company A collaborated with the LCI founder-consultants to help develop lean construction at the firm.

Company B

Company B was a 20-year-old firm located in the West. Like Company A, Company B strongly encouraged lean to employees and is a founding member of LCI. The company had a strong commitment to the customer and considered itself part of the service industry rather than a manufacturer of buildings. The company currently builds in the following sectors: healthcare, data centers and clean room environments, education, hospitality, research and development, manufacturing, and government.

Participant 4 has worked at Company B for 12 years. He began as a project engineer and is currently a project manager. He has managed several IPD projects in the

healthcare sector. He was very well versed in lean construction practices and philosophies.

Participant 5 has worked at Company B for 21 years. He began his career as a carpenter. He later became a carpenter foreman and currently acts as a superintendent. Participant 5 was a lean champion and certified instructor for the Associated General Contractors of America (AGC) Lean Construction Education Program (LCEP).

Participant 6 has worked at Company B for 10 years. He began as a project engineer. He later became an assistant project manager and currently acts as a project manager. He was also a highly skilled practitioner and lean leader.

Only one of the participants at Company B had worked with the LCI founder-consultants. However, each participant was trained by the company's well-respected lean champion. This individual was attending and presenting at the IGLC conference in Norway at the time of the interviews and was, therefore, unable to meet with the researcher. Like Company A, several other employees from Company B collaborated with the LCI founder-consultants to develop lean construction by applying innovations from lean manufacturing to construction.

Company C

Company C is a 70-year-old firm located in the South and also a founding member of LCI. Unlike Companies A and B, Company C required lean tools on every project. The company required all project teams to utilize weekly work plans with their trade partners and mandated that these and other metrics were displayed visually for all to see. Currently, Company C builds in several sectors, including healthcare, education,

commercial, industrial, and hospitality.

Participant 7 has worked at Company C for 30 years. He began as a project engineer and currently served as general manager and senior vice president in one of the divisions of the company.

Participant 8 has worked at Company C for 27 years. He has served as COO, CEO, and chairman of Company B and was currently an emeritus executive. He was a registered architect with several years of experience with other firms prior to working for Company C.

Participant 9 has worked at Company C for 32 years. He was the acting CEO for Company C at the time of the interview. He also began as a project engineer and later a project manager, then progressed upward through the executive ranks of the company.

Like Companies A and B, employees from Company C collaborated with lean LCI founder-consultants to help develop lean construction. In addition, Company C hired one of the founders of LCI for a short duration to help implement lean on a specific project. Several Company C employees have helped develop the AGC LCEP, and one executive from the company currently occupied a position within the AGC.

Participant Interviews

The remainder of this chapter is dedicated to reporting the data the researcher collected during interviews with each participant. The accounts are organized and reported according to the themes reported in Chapter III. Each individual was interviewed and recorded according to the eight themes discussed in Chapter III. The research

protocol did not require every question to be asked as long as each theme was touched upon by each participant. Participants were allowed to answer each question in as many, or as few, words as they felt necessary. At times the researcher would probe deeper by asking further questions to clarify a response. This is referred to as following a "mini tour" of an intriguing topic (Williams, 2011, Ch. 6). Therefore, several comments may potentially relate to multiple themes while others may not fall precisely into any theme. The researcher organized each statement or account into what he deemed to be the most appropriate structure according to the findings of the study.

Theme 1: Discovery

How and why was the discovery of lean found to be useful to the organization and to the individual?

Participant 1, group president and champion, said, "There was not a true crisis that caused [us] to adopt lean. Rather, [we] were looking for an innovative approach already." Their factory-rebuild projects demanded innovation. Therefore, "this drove the necessity to find a better way to meet the industry demand." For example, prior to lean, the management team instituted a productivity improvement challenge across the company. In an effort to raise productivity by their self-performing construction crews, managers established targets for each crew to meet on various tasks on every project. After great effort from everyone, managers successfully increased productivity by 1% to 3%. However, according to Participant 1, the cost of measuring and tracking these targets "cancelled out any savings" earned. Therefore, "there was no sustainable benefit."

During that time, several employees were invited to meet with the lean

construction university researchers and future founders of LCI. The lean message resonated with the employees, who then shared the message with the CEO of the company. The CEO was already somewhat familiar with lean manufacturing and encouraged the employees to pursue lean construction further.

After learning from the LCI founder-consultants and from other sources, Participant 1 was active in trainings on tools such as the LPS. Regarding its use, he said, "[We] began to see some remarkable gains with that particular process. We launched it on five projects. It soon grew to 40. And, soon [it] became a standard on how we delivered our projects." Shortly thereafter, the company was awarded a university project in which the project team saved the university a considerable amount of money and time by using lean construction principles and tools. Since then, the company has been awarded several high-profile IPD healthcare contracts.

Participant 2, BIM manager and lean trainer, was taught lean thinking during college as an industrial design student. According to him, industrial design used techniques similar to those now common in lean construction although their terminology was different. Consequently, when lean construction was first introduced to him as an intern, Participant 2 said he was very comfortable with it. Since then, he has participated in pull-planning sessions on factory rebuild projects that planned down to as little as ten-minute increments in order to stay on schedule. He has also led several lean teams and taught many individuals on the LPS and other lean concepts.

Participant 3, senior director and architect, said that education and prison projects as well as factory rebuilds were among the first few projects in which lean was

implemented. He explained that Company A's first lean steps were "learning about lean philosophy and applying it to construction. Back then, the company learned from [the future founders of LCI], especially regarding the LPS, pull-planning, and reliable promising…[but] it took a while to call it lean construction." As a registered architect, he applied lean to the design side of the business, noting, "During the early years, the company utilized value analysis and target value design mixed with lean." He added, "Lean exposed that designers and construction crews were often overly optimistic in their analysis of job requirements and did not sufficiently pre-plan." Like Participant 1, he noted that "lean became the common platform." Company employees discovered that "using lean [as] an alternative to traditional construction management strategies would produce the results [Company A] wanted."

Participant 4, project manager at Company B, noted the importance of the LCI founder-consultants at Company B, although he never worked with them directly as an employee. However, as a graduate from a university that offered lean construction courses in the masters of construction management program, he was very familiar with the academic research in lean construction. His university experience prepared him to learn and apply lean prior to implementing it on the job site.

Participant 5, AGC lean instructor and superintendent, shared that Company B was fortunate to employ one of the early innovators of lean construction who introduced it to the rest of the firm in the late 1990s. However, Participant 5's personal introduction to lean came a few years later. During the preconstruction planning phase of his first lean project, he met directly with the LCI founder-consultants to implement pull-planning and

learn the new concepts. Therefore, he was able to learn prior to beginning the actual

project. He stated that his interactions were at first "overwhelming, but then it became

exciting!" Ultimately his team "realized that it should be used everywhere." With a

highly positive tone, Participant 5 described his introduction as an "immersion" into lean

construction. He admitted that "trying to complete a project and learn [at the same time]

could be challenging" because the natural tendency is to "fall back on old ways."

Participant 6, project manager at Company B, said, "[We were] initially attracted

to lean because it minimizes labor costs. However, [the concept] rang true because it

mainly fit the culture of [the company]. It allowed for a great deal of flexibility."

Participant 6 further explained that the principles of lean were a natural marriage with the

culture of the company. However, he also commented on the challenges they faced.

"Lean is tough. The construction industry is tough. Adoption is particularly difficult.

Anytime you are trying to change the way people do things, you're going to be up against

[a barrier]."

Participant 7, division vice president at Company C, shared how leaders at his

organization found lean. Just like the other two companies, they worked closely with the

LCI founder-consultants to help develop and implement lean. When the first lean

champion reported his findings to the CEO, the CEO immediately recognized its value.

Participant 7 claimed that the CEO was a student of lean even before the term lean

became popular in the construction industry. When asked whether there was a company

crisis as the driving force for adopting lean, Participant 7 said that "There was a crisis in

the industry that needed to be overcome, not necessarily a crisis within the organization."

By this statement, he implied that the industry itself was to blame for years of poor and wasteful practices. The CEO at the time recognized lean as a unique approach to such a crisis and a potential solution to the problem.

Participant 8, emeritus executive and architect, explained how Company C initiated several company-wide practices that he considered "a precursor to lean." Their "TeamBuild" concept brought together the essential players in the construction process prior to the construction phase of a project in an effort to improve value. Owners, designers, suppliers, and constructors would participate in these planning sessions to improve planning and coordination.

Participant 9, current CEO at Company C, said that industries and companies in general create "institutionalized waste." "You don't need to use a lot of fancy words or tools. You simply need to see waste and know how to eliminate it." He explained that Company C initially "became familiar with the Toyota series" and many "began to use the [lean] vernacular." Participant 9 also admitted that the construction industry is far behind other industries on innovation and improvement. Finally, like others, he also shared that it was the former CEO who initially made the decision to charter LCI and begin Company C's lean journey.

Listed below is an itemized the summary of merged findings for Theme 1: Discovery.

- The catalyst to adopt lean was not a company crisis. The crisis was in the industry. In other words, executives at all three companies recognized that the industry itself had deep, inherent problems.

- All three companies were searching for solutions to the crisis before lean was introduced.

- LCI founder-consultants played a key role in the adoption of lean at each company.

Theme 2: People

In what way did people contribute or hinder the success of lean? Who were the key leaders?

Participant 1, group president and champion, said that the organization was continually searching for ways to improve the business well before employees heard of lean. Key leaders played a role in this effort. Regarding the importance of upper management in the adoption process, Participant 1 exclaimed:

> Absolutely critical! If it wasn't supported at the upper levels of the company, it wouldn't have given us the comfort of knowing that trying to find a different way of doing something was okay. That [culture] still remains prevalent today.

He continued:

> There is not a textbook you can open up that [explains] "Here's how you do [lean]." There has to be a lot of faith and trust by upper management that the current way of doing things is not going to produce the types of results we want to achieve. So in order to get a different outcome, we have to have a different process.

Continuing further on the importance of the executive role, Participant 1 shared that "much of what is asked of project managers is uncomfortable to them, so if there is no support from upper management, this only confirms that it is okay to *not* use lean" (emphasis added). He described the need for executive support as "unwavering."

Participant 2, BIM manager and lean trainer, also emphasized the importance of

the executive leadership team by stating, "Management support is a big deal. The worst is

when management buckles under pressure." He then explained that when management

was "lax" in the field, it was very easy for others to dismiss lean practices. "When lean

was successful, it wasn't because management was pushing it. It was because

management was walking the walk." He shared that throughout his career, leadership had

been very supportive. He felt they genuinely wanted to help him be successful with the

new lean processes.

When it came to regular employees and managers, Participant 2 suggested that

there are two groups of people, "those who love the theory and the concepts, who read all

the books" as well as those who are "put off" by new practices…. You can't use lean

terms with them because you'll lose them immediately." He concluded that the method of

training such individuals was very important. These methods are covered in the review of

Theme 5: Training.

Participant 3, senior director and architect, shared the importance of team support

by stating:

> The owner's project manager's attitude toward lean is critical. That individual
> takes a lot of heat from the owner's executives. The executives focus a lot on the
> bottom line. They want proof that lean will produce the results that previous
> project methods could never accomplish.

He continued:

> The executive for the construction group is equally critical. When that person is
> also a believer, lean will flow downhill better. It takes several who are willing to
> commit. If you can get the top to *not* argue about lean, the rest will happen, even
> when problems arise during the process. If the upper management waivers, it can
> destroy the whole thing. (emphasis added)

> Regarding project teams, Participant 3 stated, "We have a number of people in the

field who are passionate about lean—planning and problem solving. Their projects are

inspiring!" Regarding the importance of champions and consistency with lean, he said:

> It's becoming more and more clear that you need to have lean coaches and lean power users seeded throughout the group. The big projects are so complex that most individuals want to fall back on old ways. The coaches help the team stay on track and encourage them to continue with the new lean innovations.

He continued:

> Construction teams are short-lived compared to manufacturing teams. It's hard to create and maintain the new type of culture. For example, it can all come apart quickly—even in a day—if the field superintendent isn't interested. It can't work without the field supervisors. They are the individuals that all the field guys look up to.

> Participant 3 shared an experience that indicates the importance of lean

champions. Due to his position on the project team, Participant 3 was responsible for

teaching others lean construction. He bought lots of books, and attended seminars and

hands-on Kaizen events in a nearby manufacturing facility. He admittedly "fumbled

around at times" as he experimented with and implemented lean on the job. However, he

claimed that his passion for lean kept him searching for answers. At one point, he created

his own simulation to teach others. One of the electricians on the project responded to the

training by exclaiming, "I finally get it now!"

> Participant 4, project manager at Company B, shared his thoughts on lean leaders

by emphatically stating:

> Leaders have been very supportive of lean. Those who have earned the respect of everyone around them encourage others and influence others to spread the word. That's how leadership supports it. It's contrasted to top-down (authoritarian) leadership which might mandate it uniformly across the company. But that's not the way [Company B] does it. Fostering culture is more important. It has to come from within. But leaders do encourage lean.

Regarding the importance of upper management, he stated, "Empowerment from the top is critical. [The executives] also need to remove barriers to allow the individual to succeed or fail."

He also shared the importance of one of the early lean champions at Company B. He stated that one such pioneer and champion is "highly respected and is enabled at the highest levels to be the internal lean leader. He helps foster relationships with [the local universities researching lean]. He has the trust of those at the highest levels within [Company B]." He continued, "Flanked by [the pioneer-champion] are other individuals who follow him and promote lean also. In this manner, lean is propagated within [the company]."

Participant 5, AGC lean instructor and superintendent, chose to emphasize the importance of executive-level support by stating, "Their role is to set goals for each region to use the Last Planner on. They encouraged Last Planner use by challenging teams, publicizing successes, and creating awareness." Adding to this comment, he further stated, "The executives create awareness and promote lean by writing about best lean practices in monthly [company] newsletters. They encourage others to try it." As an AGC champion himself, Participant 5 noted the importance of helping others. "As a lean champion, you need to be supportive. You need to commit those who understand it to bring others along." He also noted the importance of assembling the right project team. He said, "If you can just get the right people in the room and pull-plan…once they get it, they become a team. They borrow ideas, help others lacking in ability, make up time—it becomes a good environment."

Finally, when answering a question about dedicated lean positions within the company, Participant 5 stated, "Rarely are there any dedicated [lean] positions. Most employees are dual role. They are expected to be champions within their positions." That said, Company B had two full-time lean specialists within the company. Their role was to continue its development and to help spread the culture and the practices throughout the organization, according to Company B's needs.

Participant 6, project manager at Company B, when asked about the importance of upper management in lean implementation, exclaimed, "Huge! [Company B] is on a lean journey. We are not where we want to be, but we are where we are because of the executives. That includes two full-time, dedicated lean operations positions." He estimated that 90% of all employees "know of lean." He also explained that most employees know that "the core of lean is about eliminating waste." However, he estimated that only 10% were "skilled practitioners." "We still struggle" he admitted. "But we have a fertile ground of people who believe that continuously improving the way we do business is how we will gain a competitive advantage."

Participant 7, division vice president at Company C, chose to focus his remarks on the importance of lean champions at Company C. He shared that champions are not necessarily hired because of their lean knowledge since most emerge from within the company. "Some employees 'get it' and quickly step up to the challenge. They do something new with lean and share it with others." However, he also admitted that because the industry is dominated with "Type A personalities, sharing better ideas isn't natural." One of the early pioneers and champions at Company C pushed lean by creating

a lean operating system for the company. This champion applied lean manufacturing concepts to the work the company was doing already in the industry. At times, he became frustrated because lean took longer to penetrate the entire organization than he had hoped.

Participant 8, emeritus executive and architect, highlighted the need to lead by example. "It won't simply be a grass roots initiative. Leaders must be involved." He continued with that thought by stating, "When I show others what I am doing [with lean], then ask about what they're doing, it will encourage others to gain interest in lean." He believed that showing interest in others will make them more inclined to respond to ideas from the top. He also recounted a story about two forward-thinking employees who developed the visual management tool of Lean Boards. These two employees were asked to deliver a presentation on Lean Boards to the rest of the organization. They focused on improving project delivery through visual management. At this moment, he was convinced the company was "getting it" and embracing lean.

Participant 9, current CEO at Company C, also stressed the importance of lean leadership. "It takes leadership at the end of the day—someone to decide 'This is what we're going to do!' And that person has to be in a position to influence [the result]." He then referred to lean expert Paul Akers, the author of 2 Second Lean, about creating an environment for lean to flourish. "As Paul Akers says, 'There has to be a passion to implement it.' He continued, "There has to be visible, tangible passion from executives, which is different than dictating [lean]." When asked about dedicated lean positions within the company, Participant 9 stated, "We don't have a lean department or a lean team. We have lean champions. It's a network of people within the organization. We stay

away from departments." Although Company C did not have an official lean department or dedicated lean positions, Participant 9 had recently hired a Vice President of Professional Development and Training to manage lean trainings and promote company values.

A brief itemized summary of the merged findings for Theme 2: People is listed below.

- Executives at all three companies recognized that current construction management methods were inadequate to produce the results they needed.

- Executives at all three companies made the critical decision to embrace lean as the company's operating system moving forward.

- Executives at all three companies did not simply support lean. They drove it throughout the organization by removing barriers and promoting it themselves. They led by example.

- Champions at each company required passion and persistence to experiment, develop, teach, and encourage other employees.

- There were conflicting approaches at each company between mandating lean and simply encouraging lean. Both approaches experienced success.

Theme 3: Tools

In what ways did the organization utilize tools to implement lean?

Participant 1, group president and champion, was positive toward the use of lean tools but also cautious with their use. He suggested that lean tools were seldom implemented "as succinctly as [they] should [be]." Regarding learning from the tools, he

stated:

> You have to follow the tools for a particular period of time to be able to see the benefits of what [to expect when] using that system. Once you do that and [learners become believers], you are able to let the [learners] start innovating a bit with [the tool]—custom fit to the job. They become more outcome-based in their approach.

He further explained:

> Until the person gets far enough up on the learning curve that they are able to see *now* what they couldn't see before, or understand what they couldn't understand before, you almost *have* to make the use of the tools mandatory so that they begin to see things that they could never see from where they were at initially.

Finally regarding tools, Participant 1 stated, "You have to have a practical application to use the tools." He then clarified by suggesting that anyone learning lean construction has to start with the tools because "that's where people begin to internalize [lean] and become a promoter of it."

Participant 2's responses were more appropriately categorized in a different theme.

Participant 3, Sr. Director and architect, reported that lean tools, especially the Last Planner, continually evolved during the early years of lean construction. After having visited a manufacturing facility to learn lean, Participant 3 brought back value-stream mapping and began using it to improve the supply chain. At one point, he also introduced Choosing by Advantages (CBA) by Jim Suhr (1999) into the A3 process. This problem-solving approach was utilized to improve decision-making and approval during the design phase of a project. He stated that doing so "created a common language and culture for the diverse team" of architects, engineers, owner's representatives, and contractors.

Participant 3 also recounted a story about the tool and concept of "go and see" (Liker & Meier, 2006, p. 8). A particular project was experiencing delivery problems with material, which was disrupting the entire schedule on his project. The material needed by the construction crew was never ready on time. Each repair to the schedule seemed to make little or no difference. "The root cause of the problem was buried," he stated. The production manager decided he needed to "go and see" what the problem was. He went to the shop where the material was fabricated and had a conversation with the shop manager, during which "the problem suddenly became visible!" According to the participant, orders traditionally came from the field requesting large quantities by area. However, the shop foreman would respond by fabricating in the order that was most efficient to him. Even though all the parts were delivered, the shop foreman disregarded the installation area information that organized each delivery. Subsequently, this created lots of additional handling in the field because material was simply not organized correctly. The production field manager then asked to have smaller orders delivered in the precise order requested by the field. The simple management tool of "go and see" identified the problem and helped create a solution.

Participant 4's responses were more appropriately categorized in a different theme.

Participant 5, AGC lean instructor and superintendent, said that mentors "train project teams by helping initiate pull planning sessions." Training with tools "is the best way!" he stated. "It's learning in action! It is better than teaching modules," referring to less engaging lecture-type trainings.

Participant 6, project manager at Company B, said that "people begin with the tools." Then they add more tools, which typically come with lean "jargon." He suggested that "ultimately, some people begin to implement it without understanding. It all boils down to seeing waste, eliminating waste."

Participant 7's responses were more appropriately categorized in a different theme.

Participant 8, emeritus executive and architect, explained that one of the early champions at Company C helped initiate an introduction to lean and value-stream mapping training. The introduction emphasized the use of the Last Planner. After some success, however, "eventually it became evident that the organization had become too focused on tools. The tools were inconsistently applied within the company." They focused all training on internal project teams. But it was the trades that seemed to be holding back each project. He continued, "They needed to focus on [training] the last planners for greater success," referring to the trade partner foremen. Despite an overemphasis on tools, Participant 8 stated, "Because of the nature of people, you *have* to start with tools. There's got to be that carrot because theory just won't connect with most" (emphasis added). He continued:

> We focused too long on tools. But I don't think we could have started without the tools because we could not all wrap our heads around a new process. But then there needs to be a heavy dose of theory and understanding. You can't affect the culture otherwise. If you can't affect the culture, it's pretty shallow.

When asked to elaborate on the carrot analogy and its relation to tools, he stated, "Most of us are wired to lighten our load by applying a better tool. Everybody is constantly searching for that better tool that makes their job easier. To me, that's the carrot."

Participant 8, prior to lean, initiated a company-wide push to utilize CPM scheduling in the 1990s. Although CPM scheduling isn't necessarily lean, he emphasized detailed planning to create accurate schedules to achieve greater success. He also noted the use of target costing in design and value-stream mapping in the company. These tools produced positive results for Company C. He noted that the company "continues to develop lean tools today."

Participant 9, current CEO at Company C, discussed several of the early lean tools used by Company C. He mentioned a former CEO who "began mapping processes and value streams." He also pointed out that tools such as BIM, estimating and scheduling software, and all lean tools should be used by everyone in the organization to some degree. "We pride ourselves in being very horizontal," he declared. The company also became familiar with the Toyota Way book series by Jeffrey Liker that teaches lean production principles. He shared that while these learning tools took the company to a certain level over the years, "they found that they were inconsistent with implementation. There was too much focus on the tools." The visit from lean expert and author Paul Akers helped upper management realize the importance of personalizing lean to everyone in the company. This became a new emphasis for the firm moving forward.

A brief, itemized summary of the merged findings for Theme 3: Tools, is blow.

- Utilization of lean tools was a first step for all three companies.

- Tools were initially successful at all three companies. However, the misuse of tools did not consistently produce positive results.

- Tools were ultimately de-emphasized at all three companies. However, they

all agreed that lean tools were absolutely necessary.

Theme 4: Implementation

What were the implementation strategies and how effective were they?

Participant 1, group president and champion, was clear that "[Company A] doesn't force [lean] on its employees." Rather, they create communities of practice within the organization that emphasize innovation. They showcased centers of excellence across the company so other employees can see and benefit.

> The more people that see the successes of others, they take a bigger interest and begin to seek out the practices [themselves]. This produces better results than saying "Thou shalt do this." We may get compliance, but we don't get the results.

He continued by stating, "Success builds success. Get the right leader on the project and others will follow." He further explained that on "critical integrated projects, [Company A] will choose a project manager who firmly believes in lean. That project manager may decide to require lean tools on his projects, but the company never says 'All jobs must do Last Planner processes.'" He also stated, "Nothing we do is complicated in construction; but being disciplined is."

Regarding the difficulty of the implementation process, Participant 1 shared further:

> [Lean] is not rocket science. Most of us are trained engineers. We're trained in pragmatic principles such as one plus one equals two outcomes. The integrated approach is based more on humanities and dealing with personalities. Sometimes the two clash. A mindset that is a great engineer is not going to be a great psychologist.

He continued, "Building the projects is relatively easy. [It's] a pretty simple process. Building the teams and getting the teams to work together takes more of a psychological

aspect. And that's the hardest thing to do." He concluded by stating, "Construction personalities are not touchy-feely. Doing lean can be really tough and requires a lot of work. It's not easy to get the results we're looking for. There is no shortcut."

Participant 2's responses were more appropriately categorized in a different theme.

Participant 3, Sr. Director and architect, stated that "consistency and repeatability are important" when implementing lean. "We need to prove the results over and over. It's hard when project teams change so often." He shared two situations in which learning was unsuccessful mainly because he did not have the resources or time to carry out the initiatives fully. In the first situation, Participant 1 asked employees to fill out index cards identifying the gap between what Company A employees wanted to achieve versus what they actually achieved on a regular basis. The intent was to help the project team understand how lean might help overcome the shortcomings of traditional management approaches. He received lots of feedback but because he didn't have the manpower to address the issues, he had to drop the initiative. He claimed that he now believes that he should have been more persistent in seeking help because it was a wasted learning opportunity.

In the second situation, project executives requested that several project teams create visual display boards to showcase lean progress. Participant 3 said that the company could not get everyone to "buy in" or keep the boards up-to-date because the tool did not make sense to all the teams and because the teams thought that using the boards consistently would be too demanding. Nevertheless, he also added that "the

company *needs* to invest in visual displays at each work site to make processes and

problems visible" (emphasis added).

Participant 4's responses were more appropriately categorized in a different

theme.

Participant 5, AGC lean instructor and superintendent, commented on the success

that lean practices can bring to a project.

> [Company B] is successful because we see the value in using lean practices.… It
> improves planning in all parts of the construction process. [Company B] has
> implemented it whole-heartedly on many projects and realizes the value.

He shared an example about one of his design-build projects that utilized the LPS. "Subs

were hesitant and suspicious [at first]; some were prepared for 'the jump' while others

were not. The initial phase scheduling meeting was largely successful." Soon thereafter,

the team held another meeting to plan again in more detail. Again, they were met with

some resistance by a few trade contractors who were opposed to planning in such great

detail. However, "after six to eight meetings, most were on board and participating with

success." But still, "not everything was perfect. There were hiccups along the way" but

they were determined to push through. "The Last Planner helped make the project

successful."

Regarding the persistence required for success, he stated:

> If you can just get the right people in the room and pull-plan—once they get it,
> they become a team. They borrow ideas, help others lacking in ability, make up
> time. It becomes a good environment.

He also emphasized the learning gained from the experience by stating, "Push through

the learning of lean processes, and success will occur. You may not realize its full

potential, but there can still be success." The "failures that happened on the project, [such as] late procurement items, [bad] weather, out of sequence work, and so forth, were [recognized] using the LPS. The system showed us what we were doing ineffectively. The system worked as it should."

When responding to how lean was driven throughout the company, he responded, "The words 'mandatory' and 'required' are seldom used. [Company B] encourages an entrepreneurial spirit. *Requiring* consistent lean practices is not part of the culture. The consistency would be beneficial, but there has to be a balance" between the entrepreneurial spirit and mandatory, top-down decisions (emphasis added).

Participant 6, project manager at Company B, presumed that [Company B] was initially attracted to lean because it minimized labor costs. However, it also "rang true because it mainly fit the culture.… It allowed for a great deal of flexibility. The principles of lean [produced] a natural marriage" with the company culture. He recalled that Company B's initial introduction with IPD was on a project for a leading CAD software designer. He explained that individuals on the project team identified exactly *what* they needed to build, and precisely *when* they needed it so the project could progress. "It felt like the Last Planner," even though they did not called it by that name at the time (emphasis added).

Participant 7, division vice president at Company C, shared that "[Company C] maximizes technology." Their early efforts focused heavily on technology. However, they realized that its implementation was "overly electronic" so they determined they needed to "de-emphasize technology and go to Lean Boards, which are [more] tactical"

in nature. In addition, rather than meet once per week like typical teams do, they decided

to utilize the Lean Boards daily. Despite a refocus on technology, Company C still

chooses to harness technology when appropriate. For example, many jobsites utilize

building information modeling (BIM) and other common estimating and scheduling

software. Participant 7 stated, "There's a huge connection with BIM and lean application

to remove waste."

Upon visiting a job site after interviewing Participant 7, the researcher was also

shown how superintendents and project managers further maximize technology through

wireless capabilities. BIM360 software was used for the company's quality assurance

program. Checklists were automated and linked with the plans so that the superintendent

could attach photos and notes to the cloud for all trade contractors to see. The trades

could access the information at a wireless Knack TV kiosk on the project. The

superintendent explained that the Knack TV kiosk minimized the waste of tradesmen

searching for information. They were able to log in to the system to retrieve the latest

changes and revisions at any point during the project. These kiosks were located right

where the workers were performing their craft.

Participant 8, emeritus executive and architect, stated, referring to

implementation, "Lean didn't automatically or quickly blossom. It took a long time to

catch on." He explained that their TeamBuild concept preceded lean, which emphasized

preconstruction collaboration and planning with all parties. "[TeamBuild] is the natural

embodiment of lean, allowing lean processes and procedures to be applied easily." He

claimed that when lean was introduced it was a natural progression from TeamBuild. The

company soon began training its own employees with success, but "it took 5 or 6 years from our first efforts for lean to gain real traction." When questioned about whether it made sense to institute a rewards program for employee performance in implementing lean, his response was, "I don't care for rewards programs. Recognition is much better."

Participant 9, current CEO at Company C, discussed the challenge with implementation by referring to tools. "Value-stream [mapping] was a great concept. We still do that when we need to today. But that only takes you so far." He noted that several other implementation attempts were less successful in the end. He claimed that the company was "stagnant" until they began requiring Lean Boards on all projects. "We haven't always [understood] where [the major] crossroads were along the way." But, looking back, he recognized that "Lean Boards was one. 2 Second Lean [a lean manufacturing book by Paul Akers] was another." Participant 9 claimed that both crossroads events helped propel lean deeper into the culture. Participant 9 was the CEO who invited the innovative employees to share a presentation on Lean Boards a few years prior to the interview. He said he tries to "make it a point at each [corporate] meeting" to provide opportunities to "showcase lean innovations." He further claimed that such innovations "provide tangible evidence" to promote lean to other employees.

A brief, itemized summary of the merged findings for Theme 4: Implementation, is found below.

- Implementing lean construction at each company was filled with both successes and failures.

- Implementation required a great deal of persistence to take hold at all

companies.

- Lean worked as expected when implemented properly at each company.

Theme 5: Training

How did the organization emphasize training to its employees and to trade contractors?

Participant 1, group president and champion, stated that "learning by theory is never going to work in construction. Theory is really good, but until you are actually able to apply it in a real world environment, nobody is ever going to [understand]." He continued, "There are very few people who can theoretically talk about a concept and then be able to go out and fully believe in it and implement it, myself included." After this statement, Participant 1 explained that he became a believer only after he saw the results from implementing lean. He later listed several of the training events for employees at Company A. Top lean leaders attend the company's [Lean] Thinking Summit twice each year. These champions then are responsible to train other employees in their divisions. He also suggested that the company had created on-demand or online training that illustrates the fundamentals of lean, such as the Last Planner.

Participant 2, BIM manager and lean trainer, suggested that when he was first hired there was no formal training in lean. However, the company did use consultants often and for long periods of time. He worked with the consultants personally on several projects. Participant 2 claimed that consultants were utilized specifically for Last Planner software and Last Planner knowledge as well as for lean fundamentals such as flow, value, and constraints. He suggested that the consultants were very valuable in the early

stages, "but now [Company A] can stand on its own two feet." After 7 or 8 years of

consulting from the founders of LCI, the company had finally "outgrown" them. "Their

experience only went so far." He felt that the company needed to continue developing

new areas of lean with all its employees, not just the construction teams.

Participant 2 also shared that it is now common for Company A to train mixed

groups in the LPS and other lean processes. Mixed groups include architects, engineers,

trade contractors, and so forth. "When training is project-centered, [Company A] will

train subcontractors for the good of the project." He also noted that the company holds

internal training for project teams and company employees. They are referred to as

"Study Action Teams." Finally, Participant 2 mentioned that it is common for employees

to attend and occasionally present at LCI conferences and trainings.

When discussing the quality of trainers, Participant 2 suggested that the best

teaching is by "doing a real pull-plan on a real project." He explained that trainers must

be "mindful of the approach, [because] training occurs more as mentoring—allowing

trainees to struggle." When Participant 2 teaches, he helps newcomers to lean to ask

questions. "This helps them figure it out on their own rather than being spoon-fed the

answers, which never produces true buy-in." He continued, "People don't want to be

talked at." Rather, "successful trainers bring others along by asking the right questions.

When they 'get there,' the students become the ones asking questions. They have to

figure it out for themselves." However, he also suggested that many within the company

"could not care less about lean theory." As a trainer himself, he noted the importance of

knowing the audience. "Mentors need to bring those individuals [along] without

emphasizing lean terms, but by doing lean together with them. Just do it without the jargon." He further suggested that all employees wanted to do a good job, improve, and take pride in their work. But those resistant to lean should be taught the theory "without them knowing—by mentoring and coaching."

Participant 3, senior director and architect, recalled the training received from the LCI founder-consultants. Early on it was common to be taught with lean Lego simulations, by pull-planning, through book readings, and so forth. Regarding the value of these trainings, he affirmed that they were mostly effective although they were still in development at the time. He said that personalizing lean to each individual seems to produce better results.

Participant 3 also commented on the difficulties of training trade contractors and setting up the supply chain. "If partners aren't on board, it's extremely hard to execute lean." He shared that a lot of training and sharing occurs during local LCI dinners across the United States when trade contractors attend. "The group comes with an attitude of sharing." As he first learned of lean, Participant 3 asked himself, "Why would I want to share something proprietary with our competitors?" However, over time he claimed that by training others, the industry was improving. This produced more lean trade contractors available for future projects.

Participant 4, project manager at Company B, never worked directly with consultants but discussed the company's experience by stating:

> Consultants typically are not hired, but outside consultants have been utilized for specific purposes as needed. [Company B] likes to train its own people internally to propagate lean throughout the organization.

He also mentioned the need to "tailor the training to each [project] team." After a team has been trained, he suggested that it is their responsibility to "run with it and train the trades." In order to deliver an effective training, Participant 4 suggested that "the majority of all training is hands-on with a sprinkling of theory, depending on the audience." He suggested that the Last Planner training is a good hybrid of hands-on and theory. "That's why simulations are so powerful." Finally, when encouraging other project teams to adopt lean on their own projects, he noted that "beyond the classroom setting, the best way to promote lean is to showcase a job site that has adopted lean to a very high level to the rest of the company."

With regards to training the trades, Participant 4 stated, "We have to train the subcontractors on IPD projects because it's part of the contract. That includes a kick-off training, trade and/or design pull-planning, and also a 3-week work plan." He then suggested that such training "requires simulations for understanding. It requires training to get everyone on the same page. After a few cycles, they become 'preachers' themselves."

Participant 5, AGC lean instructor and superintendent, worked directly with the LCI founder-consultants. They "utilized lots of simulations to increase understanding." During that time he worked on a prison project where "only lean was used. Old ways were not used at all." He described his learning experience as a "full immersion" event. The LCI founder-consultants helped the team "write the playbook" as the team was "figuring it out." He claimed it took him 2 months to "get it" sufficiently to implement lean. After that, he entered a stage he referred to as a "refinement period." That time

helped him further internalize the concepts and perfect the implementation. He also mentioned that "[Company B] still brings in consultants to learn specifics on occasion."

Estimates by Participant 5, AGC lean instructor and superintendent, project that 70% of all employees participated in formal lean training back in 2009 and 2010. "From there, [Company B] developed nine modules to help train its employees. These modules included games and concepts." Beyond such formalized trainings, "Mentors also train teams by helping initiate pull-planning sessions with new project teams." He claimed that "this is the best way. It's learning in action" and "it's better than teaching modules." As an LCEP trainer and superintendent, he commonly trained the trade contractors on his projects. "It takes a great amount of effort to train others. [Company B] often invites others to trainings. We know we are only one part of the [project] team." Referring mainly to trade contractors, he concluded, "The more people who 'get it,' the better chance we have to be successful."

Participant 6, project manager at Company B, had never worked with the original LCI founder-consultants. He did, however, work with a lean process consultant later as well as a software consultant on one project that he managed. He said that the company trains employees in the "Culture of Lean program." He suggested that the formal training program is designed to help individuals apply lean principles in a hands-on setting. "This may include simulation games and concept understanding." It is "followed by a half-day of deep-dive learning" and is taught by the champions in the company.

Participant 7, division vice president at Company C, discussed the importance of the LCI founder-consultants early on. When Company C briefly employed one of the

consultants on a local project, it was their first attempt to apply lean to an entire project and to use the Last Planner. On occasion, he noted, the company hires consultants to visit and train the employees. For example, just prior to the interview, Company C, like Company B, invited Paul Akers to speak at a corporate event on his book 2 Second Lean (Akers, 2013).

Beyond consultants, the company also hosts and participates in LCI communities of practice. Participant 7 shared that during the mid to late 1990s, many employees attended LCI trainings. They soon began training their own employees internally. After a while, he shared that the lean champions recognized that they needed to train the trade partners—"especially the key subs." They wanted more "reliable and consistent performance" from the trade contractors. The company training programs currently teach lean thinking and tools as well as other company values and entry-level, project engineer requirements.

Participant 8, emeritus executive and architect, like others, mentioned the LCI founder-consultants and their ability to kick-start lean throughout the company. Champions continued onward by formally training company employees after the consultants. Training was considered a "collateral duty" by experienced lean employees. However, "Leadership realized that training as a collateral duty was not going to get the job done. They needed someone with experience to take the reins and develop and administer the training to the rest of the organization." For this reason, Company C executives hired a vice president of professional development and training. This individual was very determined and passionate about lean. He served on the AGC LCEP

curriculum development team. In regards to the vice president, Participant 8 stated, "He took the message beyond [Company C] to the subcontractors, clients, and others outside the firm."

Participant 9, current CEO at Company C, shared the importance of hiring the LCI founder-consultants during the early years with lean. However, he stated, "I thought [lean] was simple enough to apply. We're practitioners. [I thought] that we could do it ourselves." He then shared that the consulting "served its purpose at the time." He admitted, "We needed them initially."

After success within the organization, the company realized that "We cannot be lean if our subs aren't lean." He cited a few common challenges on all construction projects, such as non-English-speaking craftsmen or less formal education among craftsmen. He felt the company needed a visual system to make participation easy for all, which led to the decision to institute Lean Boards on all projects. He also mentioned another problem with training trade contractors. "It's hard to continue training subcontractors. Sometimes they are the same, but often they are new on new projects. It takes a lot to continually train and teach them." He also stated that "everyone needs to understand some theory.… But, of course, everyone needs the on-the-job experience at some point also."

He recognized the AGC LCEP as one of the solutions to this problem. "You can get a credential. The idea is that people across the nation can learn about [lean]" and become certified. He felt this would greatly help owners and the industry in general produce better value on projects. "We want owners asking for that credential on their

jobs. There's nobody better to drive the industry than owners. We are going to put a

stamp…on our business cards" that showcases the credential. He then concluded, "We

want all our trade partners to get [certified] so that when owners start asking, we can

deliver. It's a win-win."

A brief, itemized summary of the merged findings for Theme 5: Training, is

found below.

- Consultants were used by all three companies for multiple years (5-8 years).

- Hands-on training with some theory was a preferred teaching strategy at each.

- Mentoring was favored over lecturing at each company.

- Training trade contractors was challenging at each company, but necessary.

Theme 6: Culture

What role did the organization's culture play in lean initiatives?

Participant 1, group president and champion, said:

The construction industry is not a whole lot different than it was 50 years ago. It hasn't innovated a great deal. Everyone has a tendency to fall back on what they used on the last job as the latest innovation. But [here at Company A], it's important to make a safe environment where it's okay for our people to innovate and potentially fail.

Concerning the culture of the executive leadership team supporting lean, he stated:

They don't have to necessarily understand it all, but they have to make sure that it's a safe environment for the employees to be practicing a new delivery process and working on innovating.

The cultural expectation of Company A is represented in a slogan often repeated

among management: "You've got a voice, but you don't have a choice." He explained the

slogan by emphasizing that individuals should put their energy into showing management

why lean *will* work, and not why it *can't* work" (emphasis added). When discussing the

culture of the company and how it affects others, Participant 1 stated:

> The culture within [Company A]…is collaborative and innovative in nature. We are more of a negotiated contractor who is trying to solve problems for the owner. Trade contractors are treated as partners. We take that culture to our customers. Owners are tired of the results of conventional construction practices. Most owners don't care except when the industry doesn't produce the results they want.

When questioned about the expenses that come with lean, Participant 1 suggested

that "there is no lean budget." He suggested that "it is integrated in[to] everything we

do." One expense that did exist is that of dedicated lean positions within the company.

Company A has a vice president of process and innovation as well as a vice president of

continuous improvement. These are executive-level champions dedicated to driving lean

throughout the company. For example, the vice president of continuous improvement

might assist the accounting or human resources department by helping employees solve

problems through lean thinking and problem solving.

Participant 2, BIM manager and lean trainer, stated that "it took 9 or 10 years to

realize that the culture had changed." He felt that the company was "getting it" because

they were beginning to "internalize lean practices." He shared that new employees who

showed interest in learning were encouraged to attend LCI Congress conferences and

other such trainings. However, he admitted that the more seasoned lean experts "don't

attend as much anymore." His reasoning was because LCI events typically focus on lean

basics, such as the Last Planner. Many of the veterans are years ahead of the basics.

Another observation noted by Participant 2 was that "having a project culture

different from the company culture is problematic." He was referring to trade partners

who are often unaccustomed to lean. When their conventional company culture is

different from the lean project culture, the two worlds collide. He then provided another

example of differing cultures.

> An individual might be co-located with the team, but the team can't get buy-in
> from the individual. Sometimes you need to remove the company, other times you
> need to change out the individual from the company for the good of the project.

Co-location occurs when employees from several different offices share space in order to

maximize resources, reduce paperwork, and streamline processing through collaboration.

Participant 3, Sr. Director and architect, shared a comment that represented the

culture of Company A very well.

> We are…successful with lean because our management is challenging us to
> become lean leaders. And, many of us believe it is the future of our industry. We
> don't want to go back to the problems of traditional construction.

As previously explained, the company displayed a culture of learning and innovation by

studying from books, at manufacturing facilities, and from consultants. Participant 3

stated, "[Company A] was always very innovative." He shared that employees even

visited lean projects in other countries. From such projects, they brought back tools and

"began focusing on [their own] lean production plans."

When responding to the culture of promoting trainings and the monetary

investment required, Participant 3 stated:

> Games and simulations are common training investments. However, the real
> investment is people. Trainings are expensive to hold, but people always come
> away learning something new. For this reason, the trainings are worth it.

Participant 4, project manager at Company B, had quite a bit to say about the

organizational structure of Company B and its relationship to culture. "We're set up to be

as flat as possible" he remarked. In another context he stated, "Traditional authority structure rules put the super as the top dog. At [Company B], there is no top dog." He followed that comment by sharing how the structure and the culture empower people to take on new things. "We always have a drive to be the best. We don't believe that being the best [occurs] by replicating the formula [of] 50 years ago, because any formula has mistakes." Then he noted the importance of Company B's culture of innovation by stating, "When you replicate that [old] formula blindly, by default you will replicate the mistakes." At Company B, Participant 4 commented that they are encouraged to "[Throw] something against the wall to see if it sticks. If it sticks, great! Celebrate it. If it doesn't stick, that's okay. Tell people why it didn't stick so others don't make the same mistake."

He described the culture well by commenting on the company's lean leaders. "The leadership group of early adopters has a personal interest in lean. They create vision statements and trainings, and they travel to various projects to train and encourage others to implement it on their jobsites." When discussing the monetary investments that lean incurs, Participant 4 suggested that the construction firm "does not increase a project's budget just to do lean on a project." Rather, "It's required to do lean within a normal budget." However, he did recognize the investments in training as well as in dedicated lean positions. "There were no dedicated lean positions early on. Today we have two. They do training but it's not necessarily their primary goal." He explained that beyond lean trainings, they do other things to promote company values and develop the culture.

Participant 4, project manager at Company B, when commenting on the

challenges other firms might face when implementing lean, stated, "More companies want to be lean. They simply don't have the wherewithal to say how, nor do they know how to implement it. It depends on how culturally accepting the workforce is to change." He followed that comment by stating, "If [Company B] is wired for change like the employees believe it is, they are able to adapt [more] quickly [than] others who are not built on that principle." He used the term "recommendatory" to describe the culture of Company B and its approach to promoting lean. He explained that this meant lean is strongly recommended, yet not mandated by upper management. His reasoning is that mandatory lean stifles creativity and the entrepreneurial spirit.

Participant 5, AGC lean instructor and superintendent, commented on the lean saturation level of Company B by stating, "All have heard of lean and may have some simple knowledge about it. Implementation is spotty, however. Some [employees] have their minds focused on other things." When asked how Company B increases the entrepreneurial spirit in its employees, Participant 5 replied, "There is a very rigorous interview and hiring process that identifies each individual's character. Interviewers choose only those with the right qualities."

Participant 6, project manager at Company B, shared, "The top hasn't required lean reports [from each project team] but they have put their money where their mouths are" in other ways. Upper management promotes training and encourages participation from all employees. For example, he shared that upper management agreed to fund Last Planner software development several years prior. "Executives said it with their words, then backed it up with dollars. They then kicked it to employees to figure it out and apply

it." Other financial investments include two full-time employees, flights to events, time

away from the jobsite, trainings, and conferences. Despite the dedication, Participant 6

stated that "spreading a philosophy companywide is challenging. We don't have that top-

down, authoritarian, upper management threatening to fire individuals." Instead, he

shared that upper management encourages others by promoting best practices and

showcasing successes at company functions. He continued:

> Lean is absolutely a top-down philosophy even though you harness the best from the lowest levels. [Company B] struggles with this. It requires cultural reconciliation. The top dogs have to be humble enough to listen to the lowest levels.

Participant 7, division vice president at Company C, stated, "Lean has to start at

the top. But there has to be an element of innovation within the culture also. Without it,

lean is simply a series of tools that don't stick." Again, emphasizing a culture of

innovation, he stated, "Most of us agree that this isn't just about [Company C]. It's about

building our industry." He also shared the importance of building the industry by training

the trades. He stated, "[Company C] models the way for trade partners. It requires

consistency." Each project team provides training for the trade contractors. They provide

resources and always make sure the trade contractors can "see the financial benefit of

applying lean." He continued, "[It's a] business! We've got to drive it back to the

financials. If the financial outcome is better [with lean], it will be attractive." Participant

7 shared that he wants all trade partners to recognize that on their projects, lean is the

element that helps them "meet or beat [their] profit goals."

Concerning the level of lean saturation at Company C, he shared, "To some in the

company, it's still a concept. You can't require someone to 'get it' if they aren't wired

that way." He then explained that as people grow and others leave through attrition, "we will get there." Replying to whether lean was required at Company C, Participant 7 responded with an emphatic "Yes!" He explained that Lean Boards are a standard and required on all projects. "When I walk on a job and the Lean Boards are not being used, we need to 'have a talk.' We are well beyond the point of making that optional." He explained that the language used by project team members tells him whether "they have 'bought in' or not." Participant 7 also shared that individuals are often rewarded with "bigger and better opportunities" when they are proactive with lean. Compensation is affected through promotions. "Innovation should receive recognition."

Participant 8, emeritus executive and architect, expressed a great deal about the culture of Company C when he exclaimed, "We had become so convinced that lean was in the best interest of our clients that we decided, 'Let's do it! There's no question that it is superior!'" This decision was made by the executive team when questioning whether or not lean practices should be mandatory on all projects. "We are a process-oriented firm and perhaps that's the reason [lean succeeded]. It's easy to come to that conclusion."

Participant 8 instituted a critical change to the organizational structure of the company as COO. "I changed the organization of the firm to a more horizontal structure... The old organization wasn't working anymore because department bosses had requirements that didn't match client needs." He continued, "Departments have their own agendas. So client service departments were removed. We then created teams specific to each project that worked at the direction of project directors." He explained that project directors assembled estimating capabilities and construction and preconstruction

capabilities to better deliver the project to the client. "In that kind of arrangement, we can deliver an organized process. But with three separate departments, you can't. So, we were organized in a way that facilitated lean process."

Participant 9, current CEO at Company C, mentioned again the bold decision to require Lean Boards on all projects. He reasoned that he "can go to any jobsite and after two or three questions know how 'bought-in' they are." He stated, "We allow a small amount of flexibility [with Lean Boards] but you must adhere to the minimum standards.... There needs to be some consistency. It's all about management by sight."

When Participant 9 was asked about the company's culture of training others, he remarked, "We're open! We share all the time. We're actively engaged in the AGC LCEP. We presented our Lean Boards document [at an] AGC meeting recently. If anyone wants to learn, they simply need to ask." When asked about why other companies are unsuccessful with lean, he stated, "It makes so much sense to me that I can't understand why others don't see it. I can only guess that it's a lack of leadership commitment. If they aren't committed, I can't see how the organization can be successful."

A brief, itemized summary of the merged findings for Theme 6: Culture, is shown below.

- All three companies displayed a high level of innovation even before lean.
- Organizational structures influenced lean maturity at each company.
- Leaders at each company recognized the importance of leading the lean initiative by example.
- There were conflicting approaches between mandating lean and simply

encouraging lean at each company. A balance between top-down and bottom-up innovation was necessary.

- The consistency of standardizing or requiring lean would have benefited all companies. However, lean was not mandated consistently at two of the three companies.

- Lean was viewed as an investment and therefore incurred expenses at each company (trainings, consultants, memberships, and so forth).

Theme 7: Barriers

What resistance occurred? How did path dependencies affect lean implementation?

Participant 1, group president and champion, shared several statements reflecting the barriers to lean. One statement he commonly hears is, "I've been doing this for 30 years! Don't tell me how to do [my job]!" He referred to that sentiment as an "old-timer mentality." A second barrier he claimed to experience was "getting people to see the value of preplanning." He then suggested that "the majority of individuals in construction today are Type A personalities. The most successful in the industry are usually the best firefighters," meaning those who can solve problems and who "thrive amidst the chaos." He then suggested that the exception may be students and interns coming out of school because "they aren't burdened by old paradigms." He expanded these statements by suggesting that most employees are unable to plan in sufficient detail to achieve the outcomes they are seeking. "We have that problem with subcontractors. Subs commonly allocate only the resources required for a conventional project, which is woefully short of

what is actually required for proper pre-planning."

When the project manager or a project executive has adequately pre-planned, another barrier is that the plan never gets implemented by the superintendent or foreman. "The people actually doing the work have to be the ones included in developing the plan. If you can do this, you will get commitment. Without this, you will only get compliance at best." Finally, he stated that Company A "still fails today" at times. One reason is because "too often employees morph the Last Planner into something they already do. They change the tool into something they are accustomed to. It fails miserably every time." Rather than try to convince them of their errors, he learned to allow the mistakes when resistance was present. "I now let it happen without arguing. Then we can talk about it later after it failed."

Participant 2, BIM manager and lean trainer, noted that "disruptive people" are often barriers to lean. He described them as "those who just don't fit with lean or with the culture of the company." He suggested that sometimes they simply need to be dismissed, but he admitted that doing so was rare. He noted that because such individuals often feel uncomfortable with the culture, they usually discover it on their own and leave. "However, sometimes trainers just need to figure out what these individuals need to propel them forward. Once *they* figure it out, they usually run with it."

Participant 3, senior director and architect, listed three barriers that impede lean implementation on projects as egos, lack of organization, and a lack of knowledge about production rates. "Egos often get in the way. People have made their living firefighting and do not want to change. Those who don't want to change can be a big roadblock to

lean implementation." He then explained that jobsite messiness and a general lack of

organization are detrimental to a lean environment. Finally, regarding production rates,

he shared an example in which he asked multiple employees from the same company

about their production rates for a specific construction task. "When all of them came back

[with] different [answers], [it] showed a lack of consistency in that company and an

inability to make sound plans."

Participant 3 then turned his attention to lean leaders. After discussing the

importance of leadership when implementing lean, he also shared a barrier caused by

poor leadership.

> When leadership doesn't understand what lean does, or they do not promote it, it
> won't happen. When the focus of leadership is numbers rather than problem-
> solving, it won't happen. Leaders must understand that lean is simply exposing
> the problem, then eliminating it and sharing the learning.

Participant 4, project manager at Company B, noted that people and egos can be a

hindrance to implementing lean. He stated:

> Those who buck the system might be reprimanded or fired. There would
> definitely be a frank discussion with their mentor. The reputation of that
> individual influences their future career options with the company. Therefore,
> there is a tendency to want to be successful [by most employees].

He explained that the traditional "command-and-control approach by a superintendent" or

simply a superintendent "implementing a mediocre or bad plan will [also] create

problems." He then turned his comments toward the trades. He shared the barriers that

often arise when hiring trade contractors. "Behaviors are challenged when partnering

with subcontractors with no lean experience." One final challenge expressed by

Participant 4 was the issue of sharing best practices within the company.

> [Company B] doesn't share well. We could do it better. Internal communication is challenging by virtue of [the company's] size and culture. Sharing occurs by word of mouth from the leadership group.

Participant 5, AGC lean instructor and superintendent, stated, "It's challenging to overcome past paradigms. It's difficult to get people to see that lean is the future." He then shared the importance of owners and the problem with traditional paradigms.

> Unless owners require lean practices on projects, the tendency is to do less lean. Many [in the company] will use the Last Planner, however—even when it is not required. The industry is working against 40 years of traditional project management.

He then identified a few common barriers on his own past projects.

> When it's not an IPD contract, you don't always get subs who understand lean. Those who don't understand it or buy in help the wheels fall off the bus. They tend to regress back to old habits.

Participant 6, project manager at Company B, addressed the issue of barriers by stating, "Lean is hard because people can be stubborn. You have to change the way you do contracts and the way you approach problems and owners." On occasion, he explained, "team members have to fix problems, usually because the team deviated from lean." For example, on one occasion Participant 6 held a project team boot camp along with several other lean trainings to prepare the rest of the team members to run the job. The team, not having fully "bought in," eventually stopped following the lean processes as they were intended. As a result, the project began to decline. The team blamed lean and the Last Planner software as the reason for the failures. In reality, Participant 6 explained, "it was because they stopped functioning in a lean fashion." He felt the team was simply using lean as a scapegoat.

Participant 7, division vice president at Company C, acknowledged that the

largest barrier to lean is often people. "Change is tough. Change requires work and

people aren't typically looking for more work." He explained that many will raise their

hand to indicate that they want to learn lean "but nobody really wants to do the lifting.

My theory is that at least 40% of the industry today cannot make the change." He then

explained that the industry will need to shift. The challenge is that the change to lean "is

not small. [It is] not tweaking the old process. [It] is throwing away the old process.… It

takes a lot of work, and it takes a lot of 'brain-matter work.'" He continued:

> It all goes well until the lifting really starts. And when we go into crisis, our latent behaviors come out. Those behaviors are based on the way we have done it our entire career, the way we were taught, the way the industry has done it the last 100 years.

He also shared that one of the biggest problems is academia. He feels they have

been "too slow to change." As a member of the LCI board, he petitioned the group to

influence the construction management accrediting bodies to address the problem. "My

perception is that academics is at least 10 to 20 years behind in what we're teaching when

it comes to delivery process and current technology." He was very pleased to see an

academic researcher studying and promoting lean at the university level.

Participant 8, emeritus executive and architect, like several others, suggested that

people were often a barrier to lean. "Older successful employees have a way of working

and are sometimes hesitant to give up what they know has worked in the past [just] to do

something new. Those with less experience are often easier to convert." He shared that it

took time for younger employees at Company C to move up and to seize the opportunity

to pursue lean.

Participant 9, current CEO at Company C, like the others, shared that people are

the biggest obstacle to lean. "We allow 'brown patches' who don't buy in, but we will not permit them to be an obstacle to the initiative." He then shared, "We love the green patches." The brown patch-green patch analogy refers to negative outlook and positive outlook individuals. Green-patch individuals refer specifically to those who "take an initiative and run with it." These individuals "eventually lead the initiative to others."

Participant 9 also mentioned that another barrier is constantly having to train newcomers on new projects. "Once they 'get it' the job is over, so we have to start all over again on the next job. This is the problem with the industry." He also stated, "We need to get architects and engineers on board. We need to get clients on board. Healthcare 'gets it' because they have their own form of lean." He shared that "everything around us can be an obstacle in the industry. We feel like the lone voice in the forest" as an innovator and early adopter of lean.

A brief, itemized summary of the merged findings for Theme 7: Barriers, is found below.

- People at all levels were considered the largest obstacle to lean at each company.
- Constantly training trade contractors posed a challenge to lean for each company.

Theme 8: Future

What is the organization doing to drive lean into its future?

Participant 1, group president and champion, described that in the future, "[Company A] seeks to further develop the integrated process." He explained that the

integrated approach is such a key part of the culture and is already part of everything they do. They are currently "develop[ing] new construction processes" within the company through the continuous improvement department. They help other departments learn lean through book studies and training.

He shared an interesting story about the positive results of operating with lean at a high level. One of the project managers had planned in such great detail for his project that he "almost felt guilty for being [present] on the job" more. However, he "felt that there was nothing for him to do. The job was so well planned out. Everyone understood what they were supposed to do and where they were supposed to be. There was no chaos, no running around or firefighting." He then explained that when a problem surfaced, "the team had extra resources available to swarm the problem and solve it immediately. It didn't become additional work to be piled upon the work that already existed."

Participant 2 (BIM manager and lean trainer), like Participant 1 (group president and champion), felt that Company A now has the understanding to "take the core of lean and the Last Planner to other parts of the company." He suggested that the company had sufficiently "internalized the concepts culturally" to do so. "The Last Planner is now just a tool in a toolbox that can be applied anywhere." He concluded that applying lean to other parts of the company is a major emphasis of the culture now.

Participant 3, senior director and architect, shared that not all employees at Company A understand lean yet, but, "more and more are taking interest and getting involved." He recognized that personalizing lean to others and their jobs would be important moving forward. He then stated, "The industry will continue to move towards

lean. Traditionalists will leave through attrition. Many experienced with lean are

beginning to say 'I won't work any other way!'"

When asked why Company A was successful with lean, Participant 3 provided

three reasons.

> [First], consistency and repeatability are important. [Second], contract types are important. Contracts enable or restrict lean. The integrated form of agreement is ideal and allows for sharing between teams. [Company A] is successful with lean because we are promoting this type of agreement. The risks and rewards are much more equitable for all parties and it creates the collaborative atmosphere needed. [Third], co-location makes projects successful; 100% co-location produces the culture and atmosphere of one unit. It's an environment in which all parties are working together for one common purpose.… [We are] successful with lean because we are learning to leverage co-location.

Regarding the future of lean at Company B, Participant 4, project manager at

Company B, said that "it's starting to spread. I don't think we've 'got it' in that every

project will utilize it consistently, but most want to do it."

Participant 5, AGC lean instructor and superintendent, explaining why other

construction companies have not adopted lean, asked, "Why fix what's not broken?" In

other words, he was asking "Why do anything different if we are still making money in

the industry?" He continued, "They can't see the value lean offers." Looking towards the

future of lean at other companies, he then stated, "There will be a tipping point in the

future for most GCs (general contractors) and subs where most will embrace it" out of

necessity.

Participant 6, project manager at Company B, described the future of lean at

Company B by sharing his excitement for Paul Aker's comments when he came to speak.

"His message was 'Fix what bugs you.'" Participant 6 continued to share the excitement

of everyone in the organization after listening to Paul Akers and his passion for lean. He then referred to Akers' philosophy of quizzing all employees about lean by stating, "If everyone knew what the eight wastes were, or what 5S is, it would be a great level of success for [Company B]." He then took that comment further by suggesting that upper management has the responsibility of visiting each project team to check up on their Lean Boards. If the executives would consistently ask, "Show me your visual controls. Show me your PPC…the company would get a quick culture change." He then explained, "[Lean] needs to be felt on a personal level. You can say whatever you want. But it's what you check up on that [determines] what you get. Unless you put a metric behind it, you won't send the message you are seeking." He concluded, "Simply stated, the company needs to be able to see and eliminate waste."

Participant 7, when asked to share experiences where he recognized that the company was "getting it," stated, "I'm not sure we're there. But we are clearly a leader in the industry. We can see that tipping point but we're not there yet." He then explained that the tipping point is a time and a place where lean is the obvious answer for everyone. He also described it as the point when project execution is completely lean and "nothing less is acceptable." He continued by sharing that lean has not completely permeated the organization yet. "It starts with awareness."

Participant 7 then explained how influential Paul Akers' message had been to the company. The leadership team decided to prepare every employee for the visit by purchasing the book 2 Second Lean and requiring that all read it beforehand. Upper management also took the challenge. In a fun, enthusiastic spirit, they publicized that

each employee would take a 20-question quiz on the contents of the book. The intent was

to send a message on the importance of lean and to generate interest at all levels.

Participant 7 stated that most employees achieved high scores and had a fun time with the

challenge. The executives also notified their employees that there was a potential to be

called on for an on-the-spot verbal quiz. Executives asked employees to recite the eight

wastes of lean or the five lean principles that Company C emphasizes. He believed the

events surrounding Paul Akers' visit were very influential to the future culture of the

organization.

Participant 8, emeritus executive and architect, was equally enthusiastic about

Paul Akers' visit. He talked at length about the excitement within the company that grew

from employees posting videos to the internet about improving the way they work. "You

can't make people do things. You need to change their outlook on life. They have to be

culturally interested in changing the way they work." He continued, "People need to

come to work not just to work, but to improve the way they work. That's not second

nature for people to behave that way. The more people we can get to adopt that principle,

lean would be a breeze." However, he also admitted that "we aren't making the progress

on that initiative that is necessary. We need to improve." He agreed with Paul Akers'

outlook about leading by example. "You can't just tell people to do it." He recognized

that the "senior management hasn't figured it out completely."

Coming from an architectural background, Participant 8 shared that it was much

more difficult to apply lean in pre-construction because "we aren't in charge during that

process.… It's difficult because someone else is calling the shots. One of my dreams is to

become better at dealing with architects, engineers, and clients so we can influence the process more." He felt that lean design could potentially provide more value than lean construction "because everything is fluid at that point [in the process]." He shared that "lean design is challenging because architects and engineers don't think that way. The client is surely not thinking that way."

Participant 9, current CEO of Company C, had a great deal to say about the future of lean and the firm. Much of what he shared referred back to Paul Akers' influence on the company. He stated that this event helped "evolve us into the next generation of lean within the company." He then quoted Akers by stating "it's 90% about the people and 10% about processes." After the visit by Akers, the company began creating videos as described in the book. He stated, "I created a 2 Second Lean video on 'How can I eliminate waste or fix what bugs me as I sit at my desk each day?'" He then commented, "Employees see that it's important. Then they have a decision to make. 'Do I want to be a part of this?'"

He continued, "Our first attempt was top down. Grass roots is always better—when it comes from the lowest levels. When anyone can understand, then you might have better success. All great ideas stop at middle management. Organic is always better." He felt Akers' approach to lean personalized the message so that everyone could contribute to the effort. "We can all create a video. Upper management needs to set the tone and be the example. That's how it spreads." He concluded his comments on 2 Second Lean by stating that it "offered tangible evidence and was a lot of fun. People just had fun!"

Participant 9, however, had more to share regarding the future of lean at Company

C. He recounted another example of tangible evidence in which he recognized that the

organization was "getting it." He referred to the Lean Boards initiative. "Seeing Lean

Boards at each job, getting positive answers to lean questions, having great discussions of

what worked and what was a bit challenging" all offered evidence that lean saturation

was occurring. When asked about how to proceed with lean into the future, he

rhetorically asked:

> How do you proceed? We still don't know what the end looks like today. Early on
> in our journey it was about creating value maps for all processes to identify waste.
> We wanted to see and eliminate waste for everything.

He continued:

> Early on it was about establishing our goals, then pulling back to achieve those
> goals. We used value-stream mapping to help us identify waste and get rid of the
> bottlenecks. Now it's about seeing waste in our everyday lives.

Participant 9 claimed that personalizing the message of lean to all was the direction the

company needed to pursue going forward.

A brief, itemized summary of the merged findings for Theme 8: Future, are found

below.

- Lean tools were applied to many facets of each organization, not simply the

  construction department. Personalizing lean to each individual helped promote

  lean internally.

- 2 Second Lean, by Paul Akers, had an obvious influence over two of the three

  companies. Akers' message as a guest speaker to the two companies was a

  catalyst leading to greater lean saturation at both companies.

Summary of Research Findings

The merged findings identified similarities and differences in each company's path to becoming lean. For example, all three companies began investigating lean because they considered it a potential solution to the crisis in the construction industry. All three companies also credited executive leadership with the success of lean, although not all companies agreed that lean should be required on all projects. All three companies utilized lean tools as a first step at their companies and emphasized the importance of consistency in implementing them. All three companies encouraged the use of consultants, hands-on training, and mentoring in learning lean and considered training trade contractors a challenging but important step. All three companies considered people the largest barrier to lean adoption, and all three recognized the importance of personalizing lean to each employee.

Using Stake's multiple-case study protocol, each finding was considered and analyzed to produce assertions and conclusions. These results identify best practices for successful lean implementation and the critical steps to becoming lean.

CHAPTER V

DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

This chapter presents the patterns that emerged from the data and findings discussed in Chapter IV. The purpose of this qualitative study was to examine how construction companies became lean. To examine these factors, a qualitative study was conducted at three successful lean construction companies across the U.S. At each of these firms, three individuals were interviewed to seek an understanding to the general research question posed in this study: What does it take to become lean?

To answer this general question, the study explored eight themes that clarified the question and provided a framework for gathering data. From these themes, interview questions were developed. Responses were analyzed to provide the data for this chapter, which is organized as follows.

- First, the natural lean progression of all three companies is reported.

- Second, three major areas are discussed as they influenced the lean transformations at each company; *people, environment, and actions.*

- Third, conclusions and recommendations for organizations on their own lean journeys will be presented through five essential strategic phases.

- Fourth, recommendations for future research are suggested.

Each of these sections provide part of the roadmap, or path, answering the general research question of the study. Each section is designed to help executives, champions, and practitioners alike navigate their own lean journey with success.

Introductory Discussion: Natural Lean Progression

The introductory discussion on the *natural lean progression* addresses the path each company took to become lean and the major milestones that occurred during their journey. By using this information, companies that have begun or wish to begin to implement lean can identify where they currently lie in the progression and plan next steps on their lean journeys.

Natural lean progression is informed by the following themes.

- Theme 2: People—In what way did people contribute or hinder the success of lean? Who were the key leaders?

- Theme 6: Culture—What role did the organization's culture play in lean initiatives?

- Theme 8: Future—What is the organization doing to drive lean into its future?

Table 2 shows the broad, generalized steps that the three successful companies took in their lean progression. It is important to note that the natural progressions were imperfect because each company was navigating an unknown path at the time.

After discovering lean and experiencing early success during the *learning period*, upper management at each company arrived at an important crossroads. The question was not whether to simply continue onward with lean haphazardly as they had done to that point. The real question executives faced was whether to fully commit to lean as the future operating system of the company. This decision became a *critical turning point* for each organization as they wholeheartedly committed to lean. Participant 8, emeritus executive and architect, stated, "We had become so convinced that lean was in the best

Table 2

Progression of Lean Implementation at Companies A, B, and C

Natural steps to lean	Focus during each step
Lean discovery	• Innovative leaders are constantly searching for improved methods • Lean is discovered and attempted on a few specific projects with promising success
Learning period	• Consultants are hired to teach and help establish a lean culture • Champions learn, teach, and implement tools, bringing greater success
Critical turning point	• Executive leadership wholeheartedly commits to lean • Mixed results on projects—acceptable success on some projects but also a lack of success on other projects, usually due to "a la carte" implementation
Culture development	• Dedicated teachers and programs are established to deepen the implementation efforts • Refocus of lean efforts, de-emphasizing tools while emphasizing a true lean culture
Saturation beginnings	• Personalization of lean to all employees; lean is utilized in all departments; the majority of employees implements lean

interest of our clients that we decided 'Let's do it!' There's no question that it is

superior!" This decision was based mainly on the early success that lean produced on

several projects. The decision was also based on feedback during the learning period as

employees discovered that lean was the solution to many of the problems that their

traditional system could not solve.

Employees naturally respond to what is important to the leader, both good and

bad. Therefore, when executives decided to commit to lean and then follow up that

commitment with action, much of the company followed. That conscious commitment is

extremely critical. As Participant 9, current CEO of Company C, stated, "It takes

leadership at the end of the day—someone to decide this is what we're going to do, and that person has to be in a position to influence it." Commitment must come from upper management because others, including the lean champion, are not in a position to influence company culture to such a high degree. Soon after this critical turning point, each company began *developing the lean culture* by means of tools, trainings, dedicated positions, and so forth. During this period, lean produced noticeable results on most projects, yet negligible results on others for reasons that are addressed in subsequent sections of this chapter.

The final step on Table 2, *saturation beginnings*, is the point at which each company began to deepen the lean culture. This step did not occur in an instant. In fact, based on several casual comments from participants at each company about *personalizing* lean to all employees, it seemed to be a recent development for all three companies at the time of the interviews. Personalized lean is a theme that helped propel each company to the "next-generation commitment to lean," as stated by Participant 9, and it could not have been reached without the initial commitment to lean at the critical turning point just mentioned. Personalizing lean to each employee's role saturated lean culture company-wide more quickly than did any other action. This topic surfaces several times throughout the remainder of this chapter during the discussion of people, environment, and actions.

Journey to Lean: People

The discussion on *people* addresses the influence that individuals in various roles have in an organization's lean journey. Individual roles are categorized as executives,

champions, and other employees.

The impact of people on lean implementation is informed by the following themes.

- Theme 1: Initial Discovery—How and why was the discovery of lean found to be useful to the organization?

- Theme 2: Driving Lean—In what way did people contribute or hinder the success of lean? Who were the key leaders?

- Theme 6: Culture—What role did the organization's culture play in lean initiatives?

- Theme 7: Barriers—What resistance occurred? How did path dependencies affect lean implementation?

Lean expert and author Paul Akers (2013) stated that 90% of lean is about people and 10% is about processes. While Akers' percentages were not scientifically determined as part of this study, the findings of this study corroborated his emphasis on the importance of people over processes. Consequently, it is also important to understand which people are the most influential players in a lean transformation. Table 3 provides a high-level overview of the key participants at each organization and the role they played.

The table highlights two major groups of contributors to successful lean adoption, namely executives and lean champions. Together, these two roles are critical to the discovery and implementation process because of the influence they have on others inside and outside of the company.

Table 3

People Involved in Lean Implementation

People influencing lean	Company A	Company B	Company C
Discovery of lean by:	• Future lean champion	• Future lean champion	• Company CEO
Executives	• All companies had executives that advanced lean through top-down approaches: investments, promoting lean champions, trainings, encouraging lean at company events		
	• All companies had executives that empowered employees and removed barriers (instilled a bottom-up interest)		
Champions	• Lean champions at all companies were passionate, innovative, driven, and persistent in implementing lean		
	• Lean champions at all companies were responsible in large part for lean success		
Early adopters and early majority adopters	• These employees needed encouragement and top-down persistence to implement lean		
	• Many of these employees enjoyed the challenge of learning and implementing lean		
Late majority and laggards	• These employees were usually seasoned professionals that were resistant to abandon traditional management techniques		

Executives

Executives shared two critical characteristics that allowed them to quickly recognize the power of lean: first, current state awareness; and second, a driving spirit of innovation. The progressive leaders at all three companies recognized the inherent weaknesses of the construction industry and had enough self-awareness to see the weaknesses or needs within their own firms as well. Not only did they have vision, but they also possessed the drive and the wisdom to act on that vision rather than concede to traditional industry norms.

Several of the participants mentioned the *crisis* in the construction industry. This

simply refers to the problems that have crept into the industry over time. For the most part, they are similar to problems in any industry. Examples include complex contracts, a high potential for litigation, poor communication between parties (fragmentation), inadequate preplanning, and high levels of subcontracted work, which relinquish control and which often produce language barriers. In essence, each of the eight wastes from lean philosophy illuminates the crisis in the industry.

Several executives echoed the sentiments of Participant 1, who stated, "The current way of doing things [was] not going to produce the types of results we want[ed] to achieve, so in order to get a different outcome, we [had] to have a different process." Participant 2, BIM manager and lean trainer, stated it slightly differently. He recognized that the industry *crisis*, or the inherent problems in the industry, produced a "gap between what [the company] wanted to achieve versus what they actually achieve[d]." He also noted that "current methods [were] not adequate." The common failures caused by "industry fragmentation" as reported by Johansen and colleagues (2004), exposed a problem which these forward-thinking leaders felt a need to mitigate.

Executives at all three companies also valued and supported innovation. Even before their formal introduction to lean, these executives were constantly looking for new ways to overcome the industry crisis. Participant 1, group president and champion, pointed out that industry problems constantly prompted them to search for a better way to deliver their projects. He further noted that owners and clients were also tired of the results but didn't know how to change them. At the time of lean discovery, each company was busy implementing several new metrics or approaches to make their projects more

productive and efficient. As a result, when the future lean champions met with the LCI founder-consultants, they quickly recognized the potential of lean as a way to achieve better results.

Executives, in turn, drove lean by using their influence to share their commitment for it: empowering their workforce, removing obstacles, funding lean, and endorsing it themselves. Although not all executives in this study were lean experts, executives were one of the most important drivers of lean. This finding coincides with Nesensohn and colleagues (2012), who suggested that executives cannot merely commit to lean; rather, they must constantly drive it throughout the organization for it to take root. They drive it through learning, planning, and management and by removing barriers.

The executives at the three firms in this study intentionally created an innovative culture but, in most cases, this culture did not reach the entire construction department. They did, however, empower their best employees by challenging them to learn and to develop and apply lean construction techniques on their projects. Several of these employees soon emerged as lean champions and became very influential in the propagation of lean. As Participant 3, senior director and architect, stated, "Our management is [constantly] challenging us to become lean leaders, and many of us believe it is the future of our industry." Clearly, innovation thrived when managers encouraged it. Regarding culture, Rubrich (2012) explained that executives create a company culture, either intentionally or inadvertently. A lack of transparency and communication to all levels of the company causes those at lower levels to assume the worst, thus inadvertently creating a negative culture.

Executives also removed barriers to lean. The first common barrier was funding. Executives at all three companies funded trainings, conference attendance, and consultants. As Participant 6, project manager at Company B, put it, they "put their money where their mouth [was].… Executives said it with their words, then backed it up with dollars." The second barrier that executives removed was the fear of failure. As Participant 1 stated, "It's important to make…a safe environment where it's okay for our people to innovate and potentially fail." Participant 4, a project manager at Company B, said:

> It's always about experimentation—trying new things and not being afraid of failure—throwing something against the wall to see if it sticks. If it sticks, great! Celebrate it. If it doesn't stick, that's okay. Tell people why it didn't stick so others don't make the same mistake.

The active rather than passive way in which each executive approached lean was instrumental in the company's lean success. Another active means by which executives influenced the company was partnership and trust with the top performers at their companies. These performers became skilled practitioners, promoters, and even champions of lean. As Participant 6 stated, "We are where we are because of the executives.… Lean is absolutely a top-down philosophy even though you harness the best of it from the lowest levels." These findings are consistent with Alarcón and Diethelm (2001), who stated that "clear signals and a high degree of commitment from upper management" are necessary for successful lean implementation.

Participant 2, BIM manager and lean trainer, along with several others, commented on the importance of executive leadership leading by example. He stated, "When lean was successful, it wasn't because management was pushing it. It was

because management was walking the walk." Although it was not necessary for executives to be lean champions or skilled practitioners, it was necessary that they participated in trainings and attended book clubs and conferences with their employees. They needed to understand the theory well enough to recognize which inputs were needed and which outcomes could be expected. Without lean theory to guide them, executives would naturally grab an old-fashioned instrument from their traditional tool belt that would undoubtedly undermine the new philosophy.

Liker and Meier (2006, p. 25) expressed several thoughts that echo the findings of this study. "The responsibility for living the philosophy falls straight on the shoulders of a particular and easily identifiable group: leadership." They further explain that this group "[has] to live the philosophy every day in a very consistent manner. Leaders have to lead by example…consistently" (p. 25). In a similar tone, Akers (2013) admonished, "As a leader you must be fully engaged with your people in the process, otherwise lean will look like the flavor of the month, just another business tool to be pushed aside when management returns home from the next business conference" (p. 75).

Any company wishing to commit to lean today must have at least one leader in the organization that has sufficient authority and possesses the same visionary qualities of the executives that were interviewed. Because this research did not explore ordinary, non-lean organizations and leaders but focused instead on successful lean companies, a more exhaustive study of lean-leadership characteristics is better reserved for future research.

Champions

Almost as important as executive leadership is the role of the lean champion. The

early majority group might also include future lean champions. They were the heart and

soul at each of the participating organizations. Champions were highly innovative

employees who recognized the value of lean, and who passionately and persistently

encouraged others. They were responsible for most of the lean training at their

organizations. From Rogers' (2010) diffusion of innovation curve, the researcher

concludes that most of an organization's lean champions will emerge from the early

adopter group on the curve.

Champions are very influential in the success of lean because they are the top

performers referenced earlier. They are executive-level managers and should report

directly to the CEO or president so that their influence can be felt both above and below

(George, Rowlands, & Kastle, 2006). Based on the findings of this study, champions are

inherently driven to succeed, and lean offers a greater potential for practical success than

does traditional management. It is for this reason that they are operate on the executive

level. Lean cannot succeed without a champion because no other individual has the

passion to learn, implement, and drive such a new, unique paradigm shift throughout the

organization. Champions rise to the occasion and thrive on a challenge.

Several current champion-executives in this study began their journeys managing

projects. According to the interviewees in this study, champions typically start by

implementing the LPS, usually on their own projects. Although they learn to see lean as

the obvious answer sooner than others, they still pass through a learning period. For

example, when Participant 3, Sr. Director and architect, was introduced to lean, he asked

himself, "What's [lean] got to do with me?" However, once he started to connect its

philosophy together with the problems of the industry, he later "began to understand why all [the] problems were occurring."

The researcher concludes that top performers need continued support and encouragement from leaders at the executive level; they cannot be left alone to figure out the logistics of learning and implementing lean construction. Top performers and future champions thrive when the fear of failure is removed and when they are empowered by the executive team. Liker and Meier (2006) likewise explained that when the fear of failure, or blame, is removed by shifting the responsibility for errors from people to the system, they "are free to focus on creating more effective systems and actually solving problems, rather than defending themselves" (p. 186). After experiencing success on several projects, champions typically begin informally training and encouraging other project teams.

Because they are self-motivated, it is not uncommon for champions to study lean on their own to deepen their knowledge. They are often the first to create value-stream maps or conduct pull-planning sessions. They will commonly track Percent Planned Complete (PPC) with consistency simply to test the results of their own projects against results of past research. In addition, champions will share their findings with anyone willing to listen.

Regular Employees: Early Majority,
Late Majority, And Laggards

While executives and lean champions are often the early adopters in Rogers' (2010) diffusion of innovation curve, the remaining employees complete the curve as

early majority adopters, late majority adopters, or laggards. The early majority group

includes those who were receptive to lean and willing to receive something new without

resistance. Although they might have been promoters or power users, they hesitantly tried

out lean tools. They needed encouragement, direction, and reinforcement from above as

motivation.

The late majority adopters were those who only adopted lean when upper

management was watching, but lacked the motivation to be consistent. Finally, the

laggards were those who constantly resisted the new paradigm. These individuals were

often older, seasoned field personnel that didn't want to learn anything new. For example,

just as Participant 7, division vice president at Company C, stated:

> Many in construction tend to be strong headed. Change is tough. It requires work
> and very few want more work. Many will raise their hand that they want to learn
> lean, but nobody really wants to do the lifting.

For this reason, executives must actively drive the lean culture, whereas champions must

be passionately persistent. This same executive estimated that at least 40% of all

employees will not or cannot make the lean shift and that most are not receptive to big

change. Akers (2013), CEO and author, expressed that during his introduction to lean he

experienced a "whiplash of emotions." But, "the changes, hard as they were to accept,

brought significant rewards" (p. 37).

As the lean culture began to spread, it was common that resistant employees

began to realize that they didn't fit into the new culture. Often, the late majority adopters

and laggards were individuals who were highly respected for their successes with their

traditional "command-and-control" styles. Because they had experienced success in their

careers using non-lean management methods, they were reluctant to change. While there are plenty of examples of seasoned professionals accepting lean, several of the participants cited the older generation of field personnel as more hesitant than the younger generation. Participant 3, senior director and architect, stated:

> People have made their living firefighting and do not want to change. This doesn't mean that all old people don't want to change. But it does mean that those who don't want to change can be a big roadblock to lean implementation.

Regarding resistant employees, the researcher identified an interesting pattern in the data. Each and every participant blamed the individual, rather than the process, for resisting lean. Each of them expressed sentiments similar to that of Participant 3 who cited "old-timers" and egos as common barriers. The researcher finds this an interesting paradox because lean philosophy states that blaming the individual is never the right approach. Instead, lean suggests that the process itself should be analyzed and broken down to discover the root cause of the problem. Rather than blame people, managers and leaders should re-evaluate the adoption process and consider how it might be improved and personalized to each employee in the company for better results. Because executives and champions typically embrace lean more quickly than others, as Participant 7, division vice president at Company C, suggested, they may become frustrated with others who don't accept it as easily. Even for a champion, there is a tendency to revert back to old habits such as blaming others. After reflecting on the companies' process, executives and champions will most likely discover a gap between lean theory's respect for people and the traditional methods utilized to promote the culture.

The simple, fundamental concept of personalized, continuous improvement had

been introduced recently at Companies B and C by a guest speaker, Paul Akers (2013).

According to Akers, it is absolutely critical to first, make lean fun, and second, make it

unbelievably simple so that anyone can be successful (2013, pp. 60-64). This is one

reason Akers decided to write his book. He claimed that while lean can be very

invigorating to some, most books are overly technical and quite dull in their approach.

In his inspiring visit to Companies B and C, Akers spoke about driving the culture

by making lean fun by through small, systematic improvements by every employee,

every day—whether on a construction site or in the office. Many companies tend to do

the opposite; they make lean highly systematic and technical. In contrast, fun, simple,

personalized lean means that employees are recognized often for finding ways to remove

waste from their daily job responsibilities. Participant 9, the current CEO of Company C,

stated that this learning event helped his company "evolve into the next generation of

lean." This message is one of the crucial elements to saturating a company through

personalized lean.

According to Liker and Meier (2006), the "lean conversion" process should

contain the following features: empowerment, training, respect, policy, safety, continued

support, and follow-up, not to mention Akers' (2013) contributions of simplicity and fun.

The process should *pull* in individuals through mentoring and discovery rather than *push*

or force lean into anyone's role. Pull might simply be another way of stating that lean

must be personalized to each employee.

Personalized lean means that all employees at any level should be challenged and

empowered to continuously improve the way they work. As mentioned previously,

personalized lean was a major milestone that all three companies realized (see Table 3).

Participant 8, emeritus executive and architect, stated:

> You can't make people do things. You need to change their outlook on life. They have to be culturally interested in changing the way they work. People need to come to work not just to work, but to improve the way they work. It's not second nature for people to behave that way. The more people we can get to adopt that principle, lean would be a breeze.

Journey to Lean: Environment

The discussion on *environment* addresses the influence of company culture on lean implementation. A culture of innovation and security that begins at the executive level and permeates the entire organization facilitates lean implementation, as can organizational structure.

The impact of environment on lean implementation is informed by the following themes.

- Theme 3: Tools—In what ways did the organization utilize tools to implement lean?

- Theme 4: Implementation—What were the implementation strategies and how effective were they?

- Theme 6: Culture—What role did the organization's culture play in lean initiatives?

- Theme 7: Barriers—What resistance occurred? How did path dependencies affect lean implementation?

Employees in various roles throughout each of the three organizations influenced

Table 4

Company Environment While Adopting Lean

Company environment	Company A	Company B	Company C
Company culture	• Highly progressive and innovative	• Highly entrepreneurial, innovative, and diverse	• Highly standardized and innovative[a]
Organizational structure	• Traditional hierarchical structure	• Horizontal since the company began • Hierarchy is considered "taboo"	• Initially hierarchical • Departments later removed to become horizontal
Establishing lean	• Lean is strongly encouraged by upper management • Lean is required only on specific projects	• Lean is strongly encouraged by upper management • Lean is required only on specific projects	• Lean is required on *all* projects • Visual management techniques are required on *all* projects
Barriers and failures	• Early failures were caused at all companies by "a la carte" implementation • Over-emphasis on tools for all companies became problematic • All three companies experienced resistance from internal employees and external trade contractors • All companies had traditional paradigms (path dependencies) that had to be overcome by deliberate means		

[a] The term "standardized" in the context of this research is defined as consistent implementation efforts at all job sites and throughout the entire organization.

their company cultures. Table 4 provides an overview of the major environmental attributes that promoted or hindered lean at each organization. Culture and organizational structure worked together to shape the manner in which each company established lean.

Company Culture, Organizational Structure, and Establishing Lean

The first obvious similarity among each of the participating companies was a strong culture of innovation. This commonality is what propelled these organizations forward. Recall that when each company discovered lean, they had already been

searching for innovative solutions to industry problems. Upon discovering and experiencing quick success with lean, executives at each company determined that they would become founding members of the LCI to further propagate a lean culture and influence innovation throughout their organizations. They also made the decision to hire consultants to teach and train their organizations. Executives, top performers, and champions demonstrated a strong spirit of innovation and, consequently, many regular employees responded and followed accordingly. Any company wishing to take their own lean journey should foster this same spirit of innovation within their culture.

One particular surprise from the interviews occurred as Companies B and C offered up valuable insights about the enabling role of their horizontal organizational structures. Most construction firms have a traditional hierarchy containing several vertical layers: from top leadership down to the common employee. However, two of the three companies in this study were extremely horizontal, while the third operated with a traditional structure. Despite these differences, all three companies reported to one centralized location within their respective organizations.

According to participants at those two horizontal companies, their organizational structure was a huge enabler to lean. Participant 4, project manager at Company B, stated, "We're set up to be as flat as possible.… It's taboo to say, 'I'm a PE or a PM or... whatever.' That empowers people to take on new things." He recognized how the non-traditional, horizontal structure at Company B enhanced innovation and inspired entrepreneurialism. Employees were encouraged to "[throw] something against the wall to see if it sticks." Participant 8, emeritus executive and architect, said that he felt so

strongly about the barriers that their traditional hierarchical structure presented that he removed departments and created a more horizontal organization. Participant 9, current CEO at Company C, said that this bold move greatly enhanced the company's ability to innovate and perform because he found that "all good ideas stop at middle management."

Despite the positive references to horizontal structure from two of the three companies, the findings illustrate that there is no single correct organizational structure required to be successful with lean. The results may, however, hint that a horizontal structure might be more conducive as newcomers seek to transform their organizations. Such a conclusion must be made by the reader as they take their own company situation into account.

A second interesting finding is that Companies A and B differed from Company C about whether or not to mandate lean practices. Company C was the only organization to require lean on *all* projects. Participants from the other two companies noted that while requiring lean would indeed improve consistency, they feared that doing so would alienate too many employees. Instead, executives at those companies chose to require lean only on certain critical projects, such as high-profile jobs with rigorous schedules and extremely tight budgets. Companies A and B awarded such projects to lean champions and top lean performers only.

Participant 6, project manager at Company B, "Those [lean specialists] who have earned the respect of everyone around them encourage others and influence others to spread the word. That's how leadership supports it. It's contrasted to top-down authoritarian leadership which might mandate it uniformly across the company. But that's

not the way we [do] it. Fostering culture is more important. It has to come from within."

This same project manager called their approach to lean "recommendatory."

Although Companies A and B did not require lean on all projects, they

acknowledged the potential value of mandatory lean. Below are comments from both

companies that illustrate what the benefits might be if their companies chose to require

lean on all project.

- "Much of what is asked of project managers is uncomfortable to [project teams], so if there is no support from upper management, this only confirms that it is okay to *not* use lean" Champion and executive at Company A

- "Until the person gets far enough up on the learning curve that they are able to see *now* what they couldn't see before, or understand what they couldn't understand before, you almost *have* to make the use of the tools *mandatory* so that they begin to see things that they could never see from where they were at initially." Champion and executive at Company A

- "*[The] consistency and repeatability [that lean delivers] are important. We need to prove the results over and over.*" Champion and executive at Company A

- "Requiring consistent lean practices is not part of [our] culture. *The consistency would be beneficial,* but there has to be a balance… [Ultimately] we realized that it should be used everywhere" Champion and superintendent at Company B

- "The top hasn't required lean reports," but if management stopped by and asked each project to "show me your visual controls, show me your PPC … *the company would get a quick culture change.* It needs to be felt on a personal level. You can say whatever you want, but *it's what you check up on that [determines] what you get. Unless you put a metric behind it you won't send the message you are seeking.*" Champion and project engineer at Company B

Based on these comments, the success of Company C, who required lean on all

projects, and the researcher's own experiences, mandating lean, can be a positive

experience for a company when it is instituted correctly. Liker (2004) agreed; among his

tips for transitioning a company to a lean enterprise is his advice to "Make it mandatory." According to Liker, "if a company looks at lean transformation as a nice thing to do in any spare time or as voluntary, it simply won't happen" (p. 304).

Success, however, requires more than simply establishing new policy. Regarding this very dilemma of requiring lean practices from all company employees, Liker and Meier (2006) cited a study by Adler (1999) as he studied the issue at Toyota. They "discovered that much of what had been written on the unintended consequences of bureaucracy was avoided by Toyota, which used the standardization of bureaucracy along with employee empowerment to create an 'enabling' bureaucracy." Liker and Meier further explained that although Toyota may mandate lean practices, the empowerment component allows for "flexibility and true innovation" (p. 111).

From a motivational perspective, the well-known researcher and motivational psychologist Frederick Herzberg (1966) cited several factors that contribute to job satisfaction and another set of factors that contribute to job dissatisfaction in the workplace. One of the factors causing dissatisfaction is company policy. He suggested that when company policy is poorly administered, it will lead to dissatisfaction. However, when policy is positively administered, it will not contribute to satisfaction but is neutralized and has little to no effect. Herzberg also explained that motivational factors such as recognition, achievement, the work itself, advancement, and growth all contribute to satisfaction in the workplace. Therefore, simply mandating a lean policy without also providing positive motivational factors will likely create a negative environment for most employees. At least to the early adopters and the early majority, lean seems to produce an

opportunity for achievement, advancement, and growth. The work itself can be more interesting and enjoyable when these factors are present.

Company C successfully instituted a lean standardization requirement by coupling it with positive motivational factors such as those that Paul Akers (2013) recommended. For example, in a positive, enthusiastic manner, Company C executives required all employees to read Akers' book 2 Second Lean prior to his visit. They further prepared for his visit by quizzing all employees about several lean factors, such as the eight wastes, the five S's, and so forth. Management made the experience fun for all, rather than simply mandating the directive to lower levels.

Even more enthusiasm for lean resulted when Company C responded to Akers' challenge to make 2 Second Lean videos. The objective of the video challenge was for employees to identify one simple process at work to improve, make the necessary changes to the process, quantify the results (by saved time, money, or resources), then to make a video sharing the results with others on the internet. Executives, construction professionals, and administrative personnel all posted videos. Participant 9, current CEO at Company C, stated:

> The company began creating videos on "How can I eliminate waste or fix what bugs me as I sit at my desk each day?" We can all create a video.… I created a 2-Second Lean video. Employees saw that it was important.

In fact, Participant 9 considered the making of 2 Second Lean videos as one of the most influential changes the company has made because by doing so, each employee began personalizing lean to their individual roles. Creating their videos helped all of the employees understand, internalize, and apply basic lean principles. As CEO, Participant 9

also credited lean videos with helping the organization "evolve into the next generation of lean within the company."

Similar to Company C, Company B had already taken steps to expand and personalize lean throughout the organization. They too created 2 Second Lean videos. However, while the event indeed brought a renewed enthusiasm, it was not encouraged by the executives as strongly as it was at Company C. As a result, far fewer employees participated in the challenge and the results were not as far reaching.

Even though Company A had not invited Paul Akers to speak at a company event, their firm had realized the importance of personalizing lean to each employee. For example, the BIM manager and lean champion from Company A stated:

> [We] now have the understanding to take the core of lean and the Last Planner to other parts of the company. [We have] internalized the concepts culturally.… The Last Planner is now just a tool in a toolbox that can be applied anywhere.

The company began utilizing these tools in other departments. Whether it was accounts payable, accounting, marketing, or construction, any employee benefits by personalizing lean principles and tools to their job. Company A's Continuous Improvement Department was created to help employees in all departments to solve their own problems and improve their own processes.

Barriers and Failures

While each company promoted lean slightly differently, all three maintained a high level of enthusiasm and innovation. Despite the different approaches, each company experienced many of the same barriers and failures. Their experiences were, therefore, combined on Table 4 above.

Even the best, most successful companies will run into barriers. Akers shares a brief experience recounting the barriers his company faced. "I have to admit…[lean] started to feel like a grind." He noticed that he had become the sole driving force behind the effort. He found that whenever he was present, the company would see great progress. But, when he was away on business, "things just seemed to linger where they left. It was like pushing a train." He then stated, "I believe this may be the point at which many people give up on lean." Such difficulties are guaranteed to surface throughout the process.

Barriers and failures should not always be considered as negative, however. Rather, barriers and failures are part of the natural progression of the lean implementation process. According to Akers (2013), "The number one way people learn is by making mistakes. If you rob your culture of this experience you will rob yourself of the boundless innovations that could await you" (p. 64). The researcher expects other firms to experience the same issues as they progress to more comprehensive levels of lean maturity. Thus, any company attempting to learn and implement something new will experience and learn from problems.

Each of the barriers and failures of the three companies in this study seemed to be highly intertwined in that the cause of any one failure may be due to several factors. The major issues discovered at each company were (a) a la carte lean, (b) an overemphasis on lean tools, (c) internal employee resistance, and (d) path dependencies.

A la carte lean is a term that stuck during the pilot study interviews. It refers to an inconsistent application of lean tools on a project: picking and choosing elements of a

tool but neglecting the whole of it. For instance, project managers may choose to add a few simple elements of the pull-planning process but neglect to carry out the important measures, such as PPC, the 6-week look-ahead, and formalized learning. In such a case, pull-planning benefits are neutralized because there is no weekly scoring incentive for trades to commit to the plan. If PPC is not tracked regularly, then it is portrayed as unimportant to the project team. The same is true for the other neglected elements of the system when they are removed or forgotten.

Each company experienced a lack of positive results when employees were haphazard in the implementation process—a-la-carte lean. In contrast, when companies were deliberate in following lean concepts and tools with exactness, their projects offered a much greater level of success. This does not mean that the system itself is rigid or inflexible. It simply means that greater success is realized when the tool is maximized. The system itself can and should be adapted to fit the needs of each individual project.

When employees perceived a failure in a lean tool such as the LPS, they often blamed the tool itself. However, as previously noted, it was actually poor or inconsistent utilization of the tool that caused the failures. Participant 5, AGC lean instructor and superintendent shared that weather, out of sequence work, and other delays were recognized using the LPS. "The system showed us what we were doing ineffectively. The system worked as it should." This statement explained that proper use of the tools exposed problems—it did not create them. This result is fundamental to lean philosophy. Only when problems are uncovered can they then be corrected. Otherwise, they remain— only to contribute waste into the system or the process.

The second common barrier to implementation was an overemphasis on lean tools. Almost every interviewee expressed this concern. Tool use can be a challenging issue because lean is a philosophy that assists practitioners in solving problems, and tools are simply a highly developed strategy or problem-solving approach (see Chapter I definitions: Lean tools). When practitioners implement a tool without understanding the underlying lean concepts, they accept the tool as lean rather than *thinking* in a lean fashion (Fearne & Fowler, 2006). Liker and Meier (2006) added, "We often see organizations place the tool before the understanding." They explained that often a company will proclaim, "'We are going to implement visual control' as if it were an individual piece of a jigsaw puzzle to be added" (p. 82).

This lack of understanding can cause poor outcomes because decisions are often based on lingering traditional management ideas rather than lean principles. So, while lean tools are in use, decisions based on old management paradigms counteract any positive results. But which comes first: the tool or thinking lean? In reality, lean theory and the use of lean tools need to grow together.

For this reason, the researcher considers the overemphasis on tools is a growing pain. Employees cannot fully understand the philosophy without training. But training alone will not suffice. Until lean is actually implemented, employees will not fully grasp the concepts. Even then, it takes years of doing lean to internalize it. Tools are merely a method of training and implementation. Just as Participant 1 stated, "You have to follow the tools for a particular period of time to be able to see the benefits of what you are able to [achieve] with…that system." It takes time for the learning to take root. Therefore,

tools are necessary to the learning process.

Every interviewee suggested that theory alone is insufficient for grasping the new concepts. Training must include a hands-on element to be effective. So, when employees stated that lean tools were overemphasized, it was because they pushed lean tools onto project teams that did not have a complete understanding of the concepts. If Paul Akers is correct, these mistakes are what build innovation. When requiring lean practices (whole tools, not a la carte tools) in a spirit of fun and simplicity, employees are free to grow and improve the utilization of a given tool as they increase in their understanding of that tool. In other words, true understanding grows in parallel with the application of the associated tool.

Employee resistance to lean was the third barrier or failure common to all three companies. This topic was considered previously and will not receive much attention here. Lean tends to move people out of their comfort zones. The traditional command-and-control approach may seem easier than having to collaborate with others and intensely preplan. Therefore, it is easy to fall back into old habits. According to the participants, acceptance seems to be more challenging for long time, seasoned professionals.

One subtle finding worth noting was the sentiment by Participant 7, division vice president at Company C, about hiring college graduates who are not burdened with traditional training. They are more easily adaptable to new methods even though their college training may not support progressive strategies such as lean. Akers (2013) suggests hiring new employees with two predominant characteristics: humility and

curiosity.

> We want people who don't act and feel like they know it all.… The minute we get somebody in an interview who tells us about everything they know and who is not really intrigued about what we're doing and the way we conduct ourselves, we know that this person doesn't really possess the characteristics we need [for] our team. (p. 97)

Finally, the fourth and final barrier or failure to lean implementation common to all three companies was the issue of path dependency. Path dependency, again, is defined as a company's past events and decisions, which continue to influence present decisions by locking the organization into paths from which it cannot break away (David, 2001). It should be noted that path dependencies were less of a barrier for the three organizations in this study because each of them had consciously and deliberately promoted lean to overcome traditional industry problems. However, two examples that were evident to the researcher were technology and unwilling leaders.

At some point in their histories, each company felt like technology would be more effective when coupled with lean. However, all but one has since abandoned their lean tool software endeavors because lean was found to be more effective on its own without the technology they had developed.

While lean is not antitechnology, it *is* very manual and very visual. This is one reason why its tools are effective. The hands-on, collaborative approach to pull-planning, for example, allows the group to regulate each other and hold one another accountable for their actions. It provides a perfect environment for social marketing to guide the team. The manual and visual approach symbolically commits each team member to the project and to the rest of the group. In contrast, technology removes the manual influence, and

subsequently, the level of commitment also.

An executive at Company C shared this sentiment when he explained that their lean implementation was so "overly electronic" that they determined to "de-emphasize technology" and go to visual display walls because they are more "tactical." Lean is not in opposition to technology. Instead, lean experts demand that users "stop using technology in a way that produces waste" (Liker & Meier, 2006). Often technology is introduced as a substitute for thinking, which will always drive waste into the process. Only technology that augments human capability and supports lean philosophy should be introduced after much research (p. 198, p. 207).

Beyond technology, leaders who are fully committed to their traditional paradigms are included in the final path dependency. Even though all three companies made the transition from a traditional company to a lean company, they each still struggled with traditional leaders making traditional decisions at some point in their histories. The influence of these traditionalists slowed the progression of lean.

Those new to lean must realize that opposition is to be expected. It is for this reason that executives and the champions are so heavily emphasized. They must be persistent and passionate despite the guaranteed resistance. They set the tone for the rest of the organization to follow. Liker and Meier (2006) pointed out a common trend with those companies that are able to push beyond the barriers and failures.

> Some individual [companies] take off with lean and get way ahead of the pack, and many (often most) lag behind and implement lean in ritual and superficial ways. What's the difference between them? The answer is always leadership. (p. 429)

They suggested that there always has to be at least one high-level manager or executive

that believes in lean, has a vision, and knows how to lead (p. 429).

Journey to Lean: Actions

The discussion on *actions* identifies the activities that a company should take to successfully implement lean. Actions refer to implementation efforts such as hiring consultants, funding training events, and investing in appropriate software.

The impact of company actions to lean implementation is informed by the following themes.

- Theme 2: Driving Lean—In what way did people contribute or hinder the success of lean? Who were the key leaders?

- Theme 3: Tools—In what ways did the organization utilize tools to implement lean?

- Theme 4: Implementation—What were the implementation strategies and how effective were they?

- Theme 5: Training—How did the organization emphasize training to its employees and to subcontractors?

Table 5 illustrates that the majority of actions by each company were similar in nature. The actions offer effective suggestions to other construction firms attempting to begin or enhance their own lean journeys. Because each of the three companies viewed lean as an investment, it was easier for them to see the return on that investment. Viewing lean as merely a cost limits one's perspective because it can be difficult for everyone in the organization to see past the bottom line during the initial phases of implementation.

Table 5

Lean Implementation Actions

Lean actions	Company A	Company B	Company C
Consultants	• All companies utilized consultants for 5+ years • Consultants helped maintain consistency and accuracy of implementations		
Investments	• All companies were LCI founding members • All companies paid for consultants and company training events • All companies funded conference participation for their employees • All companies funded software implementations related to lean construction		
Company trainings	• All companies relied upon internal lean champions to develop formal and informal training programs • All companies ultimately hired or promoted dedicated trainers to spread the culture of lean (although they do not presently train exclusively on lean)		
Trade contractor trainings	• Companies A and B committed to train trade contractors on select lean/integrated projects		• Company C trains trade contractors on all projects

Consultants and Specific Investments

The LCI founder-consultants were still developing the Last Planner and other lean tools when they first approached the three companies in this study. They worked closely with each company for more than five years and as much as ten years. The major roles of the consultants were to keep the employees motivated, keep them on track, and teach them the new concepts. Each company agreed that the consultants were absolutely necessary to the establishment of a lean culture. Because most people find lean to be counterintuitive initially (Associated General Contractors of America, n.d.), it is critical that consultants are utilized to help employees understand the philosophy and properly implement the tools.

The use of consultants also introduces a greater level of commitment to the

organization. Any organization today that is either beginning their journey or has only been traveling that path for a short while should consider the use of consultants. Their influence will enhance the speed of adoption and deepen the understanding of employees. Ultimately, the lean culture became engrained enough within the three companies that they each outgrew the consultants. As noted previously, however, they still hire consultants today when the specific need arises.

While consultants were one of the first investments made by Companies A, B, and C, the second investment by the executives was to become a founding member of the newly established organization. This gave them access to the experts on an as-needed basis as well as a training resource for future employees. Other lean investments included conferences and trainings held by LCI and other lean associations. It didn't take long for the champions at these organizations to prepare and deliver elaborate presentations for a growing LCI membership body. Today, the champions at the three participating companies are still leading the industry by presenting new findings and sharing new implementation approaches to LCI members. Again, any company wishing to enhance their own lean journey must also consider the financial investment of lean associations as an opportunity to influence their culture more quickly.

As previously noted, technology was another investment consideration. Although many of the lean technological pursuits have since been abandoned, technology itself has not been abandoned. Each company is highly committed to BIM technologies, cloud-based platforms, as well as several other software packages. Technologies designed to enable lean were very common among all three companies, whereas technologies

designed to administer lean were less effective. Their use of technology is heavily based on helping their trade partners eliminate wasted time and effort on the job site.

Company Trainings

The third area of discussion from Table 5 is company trainings. Interviews showed that none of the participating companies had formal lean training during their initial adoption other than those from the consultants. Most training included project teams sharing results and best practices with others. Because results were so positive initially and because each company had committed to lean construction as its operating system, formalized training became an obvious need. Formal training today includes established lean instruction modules delivered in a classroom setting that company employees take throughout their careers. The very best trainings also include a hands-on element with learners *doing* lean on their own projects or in their own office roles. These trainings were part of a standard curriculum that all superintendents, project managers, and project engineers were encouraged to take part in.

Each of the companies still administers informal training as needed. Tools such as value-stream mapping and the LPS were taught by champions and consultants to project teams. Sometimes these trainings were held on projects by initiating pull-planning sessions with the project team. Other times they were taught theoretically in a classroom setting using simulations as a learning method. Online trainings were also made available for those individuals who were on projects far from the main office. All these programs were developed to help establish the culture of lean, to teach problem solving, and to learn to properly apply lean tools. Supplementary methods such as book clubs were also

utilized to encourage questions and discussions from learners. Such methods were always coupled with a discussion of what occurs on real projects.

After several years, champions realized that the formalized training was becoming less effective. Trainers were not always effective teachers and learners were not always enthusiastic about learning. A superior practitioner is not necessarily a great trainer. Champions quickly learned that it was important not to lecture about lean during training events. The best teachers were able to persuade even resistant learners to discover lean by asking the right questions. They acted more as mentors than teachers. These individuals inherently knew how to ask the right questions and let learners struggle just enough to pique their interest in finding their own solutions with the new skills they had learned. They guided the conversation so that learners could figure it out on their own rather than spoon-feeding learners all the answers. Recall the words of Participant B, a seasoned teacher and trainer, who said, "People don't want to be talked at. Successful trainers bring others along by asking the right questions. When they [begin to catch on], the students become the ones asking questions."

For this reason, all three companies determined that dedicated positions were necessary to focus on the professional development of their employees. One executive remarked, "Before [adding such a position], training was done by members of the firm as a collateral duty. Leadership realized that training as a collateral duty was not going to get the job done." They needed a dedicated position. All of the companies hired at least one individual to teach and manage all trainings in the organization. This corroborates Alarcón and Diethelm's (2001) research, which suggested that a "special organization"

within the company is necessary and that clear "definition of functions, responsibilities, and levels of authority" is important to a successful lean implementation.

Not all training positions were completely dedicated lean positions. However, all three companies promoted or hired champions to promote lean along with other professional development attributes. Several of the titles of these dedicated positions include VP of process and innovation, director of continuous improvement, VP of learning and people development, senior director of continuous improvement and quality, and lean/virtual building coordinator. Dedicated professional development positions indeed allowed these three companies to progress beyond what normal "dual-role" employees could do. Beyond simply teaching, these individuals are also responsible for further research and development of lean principles and for finding lean solutions to problems occurring in other departments.

Trade Contractor Trainings

Champions and executives also learned that internal training was insufficient because the majority of the trade contractors who were hired on a project were not lean. Because lean concepts are often seen as counterintuitive, and because lean is less effective when project teams are made of trade contractors from traditional cultures, newcomers should expect to not only implement lean, but also to share it. As Participant 9, current CEO at Company C, stated, "We cannot be lean if our subs aren't lean!" This can be both exciting and frustrating. Training trade contractors is exciting when the job begins to flow and when foremen are making reliable promises and contributing by offering up money-saving ideas for the project. The problem, however, is that "once they

'get it,' the project is over so we have to start all over again on the next job," as stated by Participant 9. Getting to that point, however, was not easy.

Training for all three companies grew to include instruction and participation with clients, owners, architects, and engineers as well as trade contractors. At times, this became costly and very time consuming, but it seemed to pay off for each of them considering their level of lean excellence today. The old adage, "The teacher learns more than the student" is indeed true. The mandatory use of visual lean displays on all projects by Company C became an exceptional training tool. Every trade contractor was required to contribute to the weekly work plan, the delivery board, the constraint log, and the inspection board on a regular basis. Akers (2013) suggested that employees experience a great deal of pride and become more eager to learn as they teach others. Additionally, an employee's "buy-in" also increases, which strengthens the entire program. Companies A and B used similar methods, although it was not mandated.

Confirming the findings in this study regarding training, Liker and Meier (2006) shared the importance of establishing a "lean learning enterprise." In the construction industry, this would include the network of companies working together on the project at hand. They suggested study groups for the top suppliers (trade contractors) in which they learn together by doing. As much as possible, they recommend keeping classroom instruction to a minimum because the best learning occurs on the job when trade contractors and designers take ownership of their work (p. 289).

Conclusions

The purpose of this qualitative study was to identify the various paths to becoming a successful lean construction company. A primary motivation of the research was to help newcomers navigate their own journey by providing guidance and insight from those who have successfully traveled the lean road. Although there is no single correct method to follow to become lean, the three companies studied showed evidence of connected patterns and relationships. The similarities and the occasional differences that were identified offer great insight into the lean process and provide increased awareness and perhaps an accelerated adoption path for those new to lean. This section proposes the researcher's recommendations and conclusions for other organizations on their own lean journeys. Conclusions are based on participant interviews and supported by lean research and other experts.

Based on the findings of this study, below are the five essential phases to becoming a successful lean organization in the construction industry.

Phase 1: Lean discovery and learning period

Phase 2: Critical turning point and commitment

Phase 3: Lean strategy development

Phase 4: Lean culture saturation

Phase 5: Partner Training

The researcher recommends that organizations that are new to lean construction proceed through each phase linearly. However, they can also expect overlap from one phase to another, especially during the last three phases. Each phase is both essential and

equally important to the transformation. Below is a description of each phase, with greater attention allocated to phases 3 and 4 because much of the information in the other phases has been sufficiently covered in previous sections.

As noted multiple times, executives are the key to lean saturation. Lean implementation begins with their leadership and only continues forward zealously with their commitment and drive. Executives must be prepared to question their own traditional strategies as well as the outdated tactics of the industry. If they are willing to critically assess their own company's past performance, executives will likely acknowledge the gap between current and desired results. This gap typically inspires forward-thinking executives to drive changes and make improvements. Executives may also acknowledge that a new system is needed to overcome the inadequacies of the industry. The strong desire to change the future direction of the organization is vital to the success of lean.

Phase 1: Lean Discovery and Learning Period

Conclusions from this study show that executives and employees with a progressive outlook will be naturally drawn to lean because of the excitement for it within the industry as well as its many stories of success. As executives and employees search for answers to the challenges of today's construction industry, lean will emerge as a likely solution. As a result, forward-thinking executives will seek to understand and apply lean. To that end, they must be willing to invest in learning and training, and to test lean sufficiently to determine its value. Consultants, associations, trainings, and other

learning methods should be utilized frequently. As this investment is made, employees should be challenged and empowered to learn and experiment with lean without fear of failure.

The first phase of lean recommends that lean be personalized to as many employees as possible. The recommendation to personalize lean is based on the statements from multiple participants who claimed that personalized lean was the most effective way of introducing lean and training all employees on it. Employees should be taught to utilize lean problem-solving tools and planning to improve the way they work each day. Personalized lean is the natural starting point to help companies create and maintain a new energy within the entire organization. With personalized lean, everyone in the organization should feel empowered to improve the way they work. When this occurs, top performers will emerge and lean successes will follow.

During this phase, employee attitudes will range from negative and resistant to positive and exuberant. That is expected. However, these attitudes do not diminish the value of personalized lean and its positive message of change. In fact, executives can utilize this feedback to identify future lean leaders. Lean leaders are typically employees who demonstrate a positive attitude towards change, are successful and committed, and show high levels of innovation. Lean leaders may emerge from construction personnel as well as administrative employees. It should be noted that this research indicates that top performers with traditional command-and-control styles do not always perform well in a lean setting. Nevertheless, by introducing lean to all employees rather than to only a limited group, executives have a larger pool from which to identify possible leaders.

**Phase 2: Critical Turning Point and
Commitment to Lean**

Depending on the level of early success with lean, executives will reach the

critical turning point at which they will decide whether or not to wholeheartedly commit

to lean construction as the future operating system of the company. Of course, success is

largely dependent upon the seriousness of the executive team in leading the initiative.

Although this phase in the sequence may not be long in duration, it is absolutely critical

to the success of the initiative. Without a true commitment, lean has little chance of

success. When executives do commit, however, the real work begins.

Phase 3: Lean Strategy Development

The conclusions from this study as well as those from other experts (Alarcón &

Diethelm, 2001; Liker & Meier, 2006; Nesensohn et al., 2012; Rubrich, 2012) indicated

that lean success is highly dependent on how deliberate a company pursues lean. Lean

must become a driving impetus of the organization to achieve maximum results.

Once lean is targeted as the future operating system of the company, executives

must create and oversee a lean team. The team's mission is to design and carry out the

company's lean saturation plan. The focus of the team should be on developing people by

making the journey enjoyable and simple so all can succeed. The plan should be

sufficiently detailed with a mission statement, goals, milestones, achievements, and

individual recognition indicators. It should not be overly technical or systematic, as this

will discourage participants and hinder results.

The lean saturation plan is really a blueprint to change the culture of the entire

company. Liker and Meier (2006) stated:

> Changing a culture is a challenge. Before you run out and start creating a culture, understand that cultures just don't happen. Cultures are created over time. They arise out of need, in response to the system that exists to support them; or if there is no support structure, the culture that develops is one of self-sufficiency, "Every man for himself." (p. 173)

This statement confirmed the findings of this study that a lean culture must be deliberately established and will not emerge haphazardly. It also shows that when a culture is positive and enjoyable, employees will respond accordingly. When it is stressful and complex, employees will resist.

The saturation plan should be developed by a team of champions, top-performing practitioners, and executives (Rubrich, 2012). This includes construction personnel as well as office personnel, with leadership from at least one forward-thinking executive. Following Liker and Meier's (2006) advice, planning to change a culture requires the right people focused on the right things.

> A committed leader must provide the resources to keep things moving. This includes top-notch people to work on lean as well as financial support and accountability for delivering results. It must be clear that this is important to the company, and that participation is *not optional*. (p. 432, emphasis added)

Executive support, as stated previously, is necessary during every phase. Other employees did not have the ability to approve resources, provide financial support, or require accountability.

To stay consistent with experienced, successful lean companies, the focus of the culture change should not change from people to profits or productivity. Profits and productivity are byproducts of a lean culture, but they are not the focus. If they are the focus, the team's lean efforts will fail (Akers, 2013; Fearne & Fowler, 2006; Picchi &

Granja, 2004). The focus must be much larger. The focus should continue to be on

developing people, as stated by several participants.

> Lean is supremely about people. We're in the business of changing and improving
> humanity. At its core, lean is about nothing other than teaching, training, refining,
> learning, and improving the condition of people. Lean is not a mechanical system
> for eliminating waste. It's a methodology to change people's minds about the way
> they see work. (Akers, 2013, p. 114)

The three companies in this study were initially interested in results, such as

profits, shortened schedule durations, and productivity. After 10 years of focusing on

processes, they only recently began to realize that people were the real answer.

Personalizing lean to each individual is what created the culture that offered solutions to

achieving those early anticipated results. This realization is what allowed all three

companies to create a culture of developing people. Also during the strategy phase,

trainers should be selected from successful practitioners. Trainers must possess a strong

ability to lead and teach others to discovery, rather than "talking at" or lecturing other

employees. Training should maintain an inquisitive, positive atmosphere for all

employees while empowering and assisting top performers to innovate and excel beyond

minimum standards. Practices should eventually be standardized across projects and

departments to illustrate the commitment of the organization.

Because Akers was cited by at least half of the participants as providing the "next

generation of lean commitment" at their organizations, a quote relating to people would

be appropriate. After visiting Toyota in Japan, he said:

> I had just spent the last 5 years focusing on waste and continuous improvement. [I
> found that] Toyota, on the other hand, was obsessed with building a culture
> through teaching and training its people. In contrast, I was trying to convince my
> people to embrace lean thinking by initiating "lean events." My mistake had to do

with my incorrect focus on processes. I needed to focus on building a culture of people who understand and embrace continuous improvement. (Akers, 2013, p. 40)

Building and developing people by helping them grow and achieve great results fits very well with the literature on motivation by Herzberg (1966), which was cited previously. Lean motivates by producing a greater capacity to problem solve, utilize collaboration tools, and enhance planning abilities.

With a focus on people, the lean strategy team can begin writing the playbook for the rest of the organization. There are several excellent resources to help with this task. Larry Rubrich (2012) offered his 10-step policy deployment process while Nesensohn and colleagues (2012) offered their 15-step "True North" guiding principles, both cited in Chapter II of this study. These and other resources offer great insight, which can and should be considered. However, they are somewhat contrary to the findings learned from this study in one simple regard. They offer tips on changing culture through policy deployment. However, creating a lean culture will not occur from policy alone. The lean team has to reach people's hearts. The evidence from this study shows that a positive and simple plan is critical to changing a culture that has existed for years. The plan must reach each individual on a personal level to change their perspective regarding the way they work. Thus, in construction terms, the lean culture change should include the following conditions, which were modified from Akers (2013).

- Set fun, simple goals and expectations for all employees.

- Reinforce those expectations through regular lean activities and reports.

- Celebrating successes regularly and often.

Phase 4: Lean Culture Saturation

The conclusions from this study and other literature (Akers, 2013; Alarcon et al., 2001; Liker & Meier, 2006; Nesensohn et al., 2012; Rubrich, 2012) illustrated the importance of setting expectations for lean with each employee. Personalizing that message creates an understanding of each employee's contribution to the lean initiative and to the company as a whole.

For newcomers to lean, the researcher recommends following the three conditions in the above section as the focus of the implementation phase during the saturation period. First, the team should set fun and simple expectations from all employees at every level, in every department. It is important that everyone understands their personal contribution to the new culture. Recall that workplace motivation stems from recognition, achievement, advancement, the work itself, and growth (Herzberg, 1966). For example, the lean strategy team might task project managers with holding daily field huddles in which they track Percent Planned Complete (PPC) and plan with their trade contractors. They could be further responsible for training others on their projects to eliminate waste and share the results. Office employees might be tasked with improving their work each day. The executive team is responsible for removing barriers, empowering others, and leading by example. Each of these tasks contributes to Herzberg's motivational factors.

Second, expectations can be reinforced by standardizing lean activities on every project. The lean strategy team might require reports from both the office and field on a regular basis. Time should be built into each role so that all employees can easily meet or exceed the expectations. When time is not built in and such tasks are perceived as extra

work, employees will resist. This can be accomplished as executives, project leaders, and office leaders reinforce these expectations. Recall that standardized activities and reports, when coupled with positive zeal, will produce an atmosphere of enabling accountability or "enabling bureaucracy" as cited previously by Adler (1999).

The most logical way to allocate time for lean learning, activities, and reports comes in the form of daily huddles or daily meetings. Whether on the job site or in the office, short daily meetings offer great potential. Daily huddles are considered a best practice in the industry already. They offer an opportunity to organize the work to be performed daily and provide a review of the previous day's successes and failures. Taken to the next level, a few additional features could be suggested that Akers shared with Companies B and C. First, a different employee should lead the meeting every day, giving the opportunity for leadership growth. Second, participants should share highlights from company book readings on lean or on other important topics. Third, they should share personal stories of continuous improvement in an A3 storytelling format. Fourth, they should review company values and relate them to current business conditions.

None of the companies in this study had taken lean to this level. The idea provides built-in learning and growth to all employees. As trade contractors attend the daily huddle meetings on site, they are made active participants in the process. From an office perspective, daily meetings could follow this general format to improve communication, motivation, company processes, and morale in general. Additional best practices such as Lean Boards, 2 Second Lean videos, and standardized reports provide a path for any company to transform the organization into a fun, successful, world-class lean

construction company. Despite the successful paths reported throughout this study by Companies A, B and C, there is still opportunity for future lean growth.

As a recommendation for saturation, project teams should produce standardized lean reports to account for project successes and failures. They might also be required to provide a recovery plan when the project is not performing well. Project teams should report or present on their successes so that others can learn from them. Successes should be presented by the very individuals who excelled, offering gratification and validity to their work, and offering best practices to other employees. Executives, on the other hand, should plan to visit each project team regularly to inspect the team's Lean Boards and attend their meetings. At the corporate office, upper management should walk the halls regularly, quizzing and probing the employees on the eight lean wastes or other company values in a positive, enthusiastic manner.

Third, the lean strategy team and the executive team should emphasize the new lean program by recognizing employees for their successes and contributions on a regular basis. This might include treating an entire project team or a specific department to lunch after consistently tracking PPC for 6 months or an achievement award at a company function for completing an entire project in a lean fashion. Reinforcement also comes as executives "walk the walk" by attending trainings, posting their own videos, having deep conversations with others regarding lean philosophy, and reporting their own lean solutions when appropriate. Additional support might come through quarterly performance reviews where personal and company-specific goals are established and reported quarterly. These are just a few ideas for the lean strategy team to build upon.

The team should seek to customize to the needs of their organization.

Company C utilized this very pattern with success on several levels. They first set the expectation of mandatory lean practices on all projects. They did so by standardizing all projects so each team utilized Lean Boards as a visual management technique. Lean Boards showcase a weekly work plan in poster size displayed in a prominent location on the job for all to see. Second, the system was reinforced regularly as each team met together for the daily huddle and the weekly planning meeting. During this meeting, they tracked PPC among other lean metrics. These standardized reports were then sent to the main office so executives could keep a pulse on each project. Finally, the system and the behaviors were reinforced as executives visited the job regularly and asked the team to explain the results on their Lean Boards. They publicly recognized the successes of the team or offered guidance in private as needed. They provided opportunities for the team to share their best practices at company events, with further opportunities to praise each team member for their contributions to lean.

As the lean team follows these suggestions, they should be better prepared to establish goals and expectations for saturating the culture with lean. The planning phase is designed to help them begin to visualize the future state of the organization and design a path to get there. Planning will help the team choose the right people to carry out the strategy as well as set guidelines for each position. It will help them understand how to bring out the best in others.

Phase 5: Partner Training

Conclusions form this study show that lean companies are always lean trainers.

Existing literature supports that finding (Akers, 2013 ; Liker & Meier, 2006; Nesensohn et al., 2012). Most employees should be actively involved in training employees from other construction-related firms (e.g., trade contractor employees, designer employees, owner's representatives, etc.). Office personnel should help their counterparts at other firms just as project managers and superintendents train the trade contractors on site. Owners, engineers, designers, and trade partners alike need to understand the new system so that they can expand their relationship and work better together. Organizations will continuously improve and grow together, thus improving the industry as a whole.

While great challenges exist when training trade contractors and other partners (e.g. turnover after each project), it is a necessary step for them and for a company's own employees. Real growth occurs when employees share with and train others. They take greater pride in their work and seek to become better at what they do (Akers, 2013). Trainings on the jobsite include daily huddles, offering opportunities for attending foremen to lead, learn, plan, and participate in greater levels than they are accustomed. Office personnel can invite their counterparts to the main office to show them how and why the changes are occurring. It provides an opportunity to spread bits of lean knowledge and best practices to company partners.

Summary

Of the three companies in this study, Company C was the most deliberate with their lean journey. This is because their goal was not simply to be successful with lean. Instead, they focused on building people and building the industry as a whole. As Participant 7, division vice president at Company C, stated, "Most of us agree that this

isn't just about [Company C]. It's about building our industry." As they focused on the talents of their people, they were also able to improve the industry.

Each of the successful companies in this study passed through the five phases outlined above at some point. Some of their actions, however, created failures or delayed success (overemphasis on lean tools, egos, a la carte lean, etc.). The findings and phases outlined above have been organized in such a manner as to produce greater success for newcomers early on in the process through early participation from all employees. Maintaining a focus on developing people by developing a positive, yet simplistic saturation plan will have the greatest effect on the new lean culture.

Despite the success of each company, there remains further room for improvement. As evidenced by the three companies in this study, lean is a never-ending journey of continuous improvement. As newcomers progress along their own paths to lean, they will see opportunities for continued growth that will position them for increased success as highly effective lean organizations.

Recommendations for Future Study

The limitations of this study as well as its findings identified several opportunities for future research.

1. Future research should consider interviewing a greater variety of individuals, including those who might be impartial and possibly resistant towards lean. The limitation of this study was that all participants selected by the researcher's industry contacts were highly supportive of lean. Much could be learned about those who are not

so enthusiastic.

2. An opportunity exists in identifying the personal attributes inherent in champions, early adopters, and innovators. Understanding who has potential to become a champion and how to harness their talents could prove to be highly advantageous for lean companies. Hiring and empowering such individuals could affect the rest of the organization positively when understood and controlled.

3. Another recommendation stems from the interests of this researcher that studies the power of challenging and empowering employees to learn and implement lean. It relates to utilizing lean as a motivational carrot for certain employees.

4. Teaching lean requires sharp pedagogical skills, not just practical implementation ability. Identifying natural trainers and equipping them with the appropriate skills should also be studied further. The impact has the potential to extend, broaden and quicken a company's progression.

5. Finally, the study of lean learning ability and perception would benefit the early majority, the late majority, and the laggards within a company. Understanding how to reach each group effectively would allow for improved implementation and saturation.

Just as companies continuously strive to become lean, lean construction as a system is continuously improving as well. Innovative employees are finding new ways to implement lean concepts at their organizations. Lean is an exciting journey that is just beginning in the construction industry. Properly harnessing lean provides the potential to transform a construction firm into a top-performing, world-class organization.

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APPENDICES

Appendix A

Coding Table

Count	Author & Year	Title	Method	Country of Study	Findings	Implications for Dissertation
1	Akers, (2013)	2 Second Lean	Book (manufacturing)	United States	Lean must be simple and fun, not complex and overly technical	Make lean simple and fun, otherwise it will not stick.
2	Alarcon & Diethelm (2001)	Organizing to introduce lean practices in construction companies	Case Study	Chile	LPS implementation was hindered by not considering cultural, organizational, and systematic problems within an organization	Organizational elements to successful implementation: well-defined strategy, upper-management commitment, special organization for implement., committed key officers, knowledge of concepts & strategy, clear roles.
3	Associated General Contractors of America, (n.d.)	Organizing to introduce lean practices in construction companies	Webinar	United States	Lean can often be counterintuitive when first learning.	Lean can often be counterintuitive when first learning.
4	Ballard & Howell (2003)	Competing construction paradigms	Forum Essay	United States	Description of lean construction concepts and future outlook of lean in construction.	Productivity improves when measuring PPC (54% - 85%).
5	Ballard & Howell (2003)	An update on the last planner	Case Study	United States	Traditional PPC = 54%, Lean LPS PPC = 85%	Traditional PPC = 54%, Lean LPS PPC = 85%
6	Diekman, Kredwedl, Balonick, Stewart, & Won, (2004)	Application of lean manufacturing principles to construction. A report to The Construction Industry Institute	Mixed Methods	United States	Value-added production time = 10%, Essential non-value added time = 15%, Wasted time = 75%	Value-added production time = 10%, Essential non-value added time = 15%, Wasted time = 75%
7	Fearne, A. & Fowler, N. (2006)	Efficiency versus effectiveness in construction supply chains: the dangers of "lean" thinking in isolation	Literature Review	United Kingdom	Lean thinking implemented in isolation reduced responsiveness and flexibility to respond to uncertainty	Lean principles implemented in isolation are limiting. A broader/stronger implementation has potential for full lean benefits
8	Forbes & Ahmed (2010)	Modern construction: Lean project delivery and integrated practices	Literature Review	N/A	Lean philosophy is superior to traditional management practices	Traditional PPC = 54%, Lean LPS PPC = 85%
9	Green & May (2005)	Lean construction: Arenas of enactment, models of diffusion and the meaning of 'leanness'	Literature Review	United Kingdom	Lean in construction is not straight forward and requires implementation improvements	The term 'lean' is difficult to understand and agree upon. Adaptation model of lean diffusion causes companies to customize lean to the needs of the organization based on the past and the present.
10	Howell, (2013)	LCI Colorado Community of Practice meeting	Presentation	United States	Learning to be lean requires a balance of both theory and application	Learning to be lean requires a balance of both theory and application
11	Johansen, Porter, & Greenwood (2004)	Implementing lean: UK culture and system change	Case Study	United Kingdom	LPS implementation was hindered by not considering cultural, organizational, and systematic problems within an organization	Organizational elements to successful implementation: well-defined strategy, upper-management commitment, special organization for implement., committed key officers, knowledge of concepts & strategy, clear roles.
12	Keiser, J. A. (2012)	Leadership and cultural change: Necessary components of a lean transformation	Literature Review	United States	Lean transformation requires a cultural change AND leadership must adapt by adopting new paradigms.	Lean transformation requires a cultural change AND leadership must adapt by adopting new paradigms.
13	Kinnie, Hutchinson, & Purcell (1996)	The People Implications of Leaner Ways of Working	Forum Essay	United Kingdom	Three Stages of Leanness: 1) becoming lean, 2) leanness as an end point, & 3) maintaining leanness.	Three Stages of Leanness: 1) becoming lean, 2) leanness as an end point, & 3) maintaining leanness.
14	Liker (2004)	The Toyota Way	Book	N/A	Lean philosophy is superior to traditional management practices	True North principle
15	Liker & Meier, (2006)	Toyota Way Fieldbook	Book	United States	Upper management must drive lean. Teaching lean theory is critical to culture.	Both are required in lean construction also
16	Lichtig, (2013)	Construction User's Round Table meeting	Presentation	United States	Lean has great potential when all departments are fully utilizing it.	Potential = 30% decrease in costs, 20% - 50% decrease in schedule durations
17	McGraw Hill Construction Research and Analytics, (2013)	Lean construction: Leveraging collaboration and advanced practices to increase project efficiency	Mixed Methods	United States	Lean surveys show respondents can expect huge benefits	• 84% - higher quality • 80% - greater customer satisfaction • 77% - improved productivity • 64% - reduced costs or improved profits • 77% - improved safety • 74% - reduced project schedule • 64% - greater profitability reduced costs
18	Morrey, Dainty, Pasquire, & Thomson (2012)	Path dependency to path creation: Enabling strategic lean implementation	Case Study: Action Research - researcher acting as consultant	United Kingdom	Path dependencies inhibit lean change. They can be overcome once identified so new lean paths might be realized.	Path dependencies inhibit lean change. They can be overcome once identified so new lean paths might be realized.
19	Nesensohn, Demir, & Bryde (2012)	Developing a 'True North' best practice lean company with navigational compass	Case Study	Germany	Cultural change must take place so that lean becomes second nature to the organization.	15 step True North compass
20	Picchi & Granja (2004)	Construction sites: Using lean principles to seek broader implementations	Case Study		Lean tools without understanding theory can be detrimental to the project.	Efficiency will sometimes destroy effectiveness if lean is implemented poorly
21	Rogers (2010)	Diffusion of Innovations	N/A	N/A	Innovation curve	Innovation curve
22	Rubrich, (2012)	An introduction to lean construction	Book	United States	Lean construction requires culture, concepts, tools, and planning.	Successful adoption requires all four elements of lean construction.
23	Scarborough & Terry (1998)	Forget Japan: the very British response to lean production	Forum Essay	United Kingdom	Lean production may act as a catalyst for workplace change.	Lean production may act as a catalyst for workplace change.
24	Teicholz, P. (2004)	AECBytes Website	Productivity Analysis	United States	Productivity of U.S. Construction industry has been declining consistently since 1964.	Declining productivity creates an opportunity for improvement - lean construction.
25	Womack & Jones, (2010	Lean thinking: banish waste and create wealth in your corporation	Book (manufacturing)	United States	Definition of lean thinking	Definition of lean thinking

Appendix B

Interview Questions

Successful paths to becoming a lean organization in the construction industry:

Interview Questions

General demographic:
- State your name, your title, number of years with the company.
- Describe the responsibilities you have had in your various positions with the company as they relate to lean initiatives.
- Define your position on the importance of lean at your organization (I'm looking for answers anywhere between essential and extremely helpful to unnecessary and completely worthless).

Initial adoption:
- How was lean originally discovered? Was there a crisis involved?
- What prompted the initial change to embrace lean philosophies?
- What role did upper management initially play in the process? Did management merely accept it or did they push it?
- Who pushed the philosophy the most?
- How was information shared/publicized originally?
- How did the company initially proceed even though the individuals may not have had a perfect understanding of lean or its potential?
- Share any experiences or stories on early implementation.
- Share opinions on early implementation efforts.

Paths:
- How much theoretical training was required for each position (PM, Super, Lean Coach, Executive, PE)?
- How did the organization utilize the tools (LPS, VSM, standing in the circle, and so forth)
- How were consultants utilized?
- What other methods of learning have been tried? Were they successful?
- What didn't work or was less successful?
- What type of balance do you feel is required between theory, tools, and implementation for a strong conversion?
- What types of roadblocks did the company face when implementing it?
- What were the major cross-roads during the conversion process?
- How was lean a priority?
- Was there ever a point when you realized that the company was "getting it?" That lean initiatives were successful?
- What experiences show successful implementation?
- What experiences show unsuccessful attempts?

Current culture:
- Why do you feel that lean has been successful?
- What activities, values, trainings, and so forth are common in the organization now?
- How does the current culture compare now to traditional construction companies?
- How is information shared among all departments?
- How much responsibility has the company assumed to teach suppliers, subcontractors, and so forth?
- What outside trainings/conferences are attended? By whom?
- What is the company's philosophy on monetary investments to promote lean within the organization?
- Are there any dedicated lean positions in the organization? Has there ever been?
- Do employees at all levels understand lean? Are there any stories illustrating antagonism towards lean?
- How do employees participate and/or contribute to the lean efforts of the organization?
- How is the "emphasis" at your organization different than at other successful lean companies?
- What are the organization's future plans for lean?
- What do you think the ideal lean training program would be like?
- Suppose I had little knowledge of lean. What would I notice on my first day that might be different from other companies? How would I be introduced to the philosophy?
- What would the typical responsibilities be for a typical PM each day/week/month? For a superintendent? For a project engineer? For the corporate lean trainer? For an executive?
- For the unbelievers, how might your company help them learn to see the value of lean?
- How lean is the entire company? What percentage of the organization is operating with lean at a high level?

Appendix C

Completed Version of Stake's Worksheet #5

Merged Findings	Discovery	People / Drive	Tools	Implement	Training	Culture	Barriers	Future
1 Recognition of a broken industry (crisis)	Industry "crisis" prompted leaders to search for a better way. Researcher-Consultants helped companies discover lean.	Awareness that current CM methods were not producing adequate results. Industry demanded an innovative approach.	All began with tools. Some LPS, others VSM.	Lean was an obvious answer to the industry crisis because it produced superior results.	Champions pushed training - always looking to take it to the next level.	Crisis recognition instilled a culture of innovation within. It also changed the organizational structures.	Subcontractors, designers, even employees often hindered the lean initiatives.	Organizations are continually looking to change the industry.
2 Executive influence	One CEO discovered lean, but mostly it was the lean champions that discovered it.	Critical decision to embrace lean. Execs backed lean with words, money, & actions. Execs empowered champions to drive lean.	Tools first utilized: VSM, TVD, LPS, etc.	Executives empowered champions to innovate without fear of failure. Promotion from executives was critical.	When executives don't understand lean, it will not progress. They need training just like everyone else.	Lean may start from the top but must also be reflected below. Lean leaders lead by example.	When leadership does not actively promote or remove barriers, it will thwart lean efforts.	Leadership must lead by example to set the tone for others.
3 Champion influence	One CEO discovered lean, but mostly it was the lean champions that discovered it.	Champions require passion and persistence to experiment, develop, teach & encourage others.		Those who embrace lean have a responsibility to share it. They keep others on track.	Champions were important drivers of lean. They require persistence and passion to push through inertia.		See Barriers list	
4 Spirit of innovation	Each organization had precursor initiatives that welcomed lean.	Lean innovation is rewarded by advancement.				Compnay B: high entrepreneurial spirit, Company C: highly standardized, Company A: highly progressive. All required innovation with out fear of failure.	Development of lean construction from manufacturing required great innovation.	
5 Consultants	All organizations met with LCI founders for university level research and consulting.			Consultants helped all three companies for 5+ years.	Consultants with training (simulations, tools & concepts) and with software.	Consultants helped internalize concepts and establish lean culture. Companies outgrew consultants.		
6 Mandatory lean		Mandatory lean practices required at only one company. Strongly encouraged & promoted at the other two.	Specific jobs necessitate lean tools at all three companies.	Mandatory readings, tests, pop quizzes, visual displays at one organization.		Deep desire to deliberately change the culture of the organization and the industry.	Recognition from two other organizations that there is a benefit to mandatory lean. Fear of requiring lean may stifle entrepreneurial spirit.	
7 Trainings - theoretical & practical	No formal training at first.	Formal training is necessary to drive lean.	Training is most effectively taught through hands-on learning applications with some theory.	Training evolved over time.	Mentoring is preferred. Trainings should not give answers - rather, they should help learners discover lean.	Training of subs critical. Subs are hesitant at first, but eventually buy in.	Resistant individuals must be taught without them knowing, without jargon.	Personalized lean is the best approach because it comes from within.
8 Financial Investments		Multiple memberships, trainings (direct & indirect), software, consultants, etc. common to all.	Technology when appropriate	No specific lean budget	Formal training of employees and subcontractors	Lean is an investment (consultants, training, memberships, etc.).		
9 Failures		Most failures occurr because of people.	A la carte implementation of lean tools, over-emphasis on tools	People, paradigms, traditions, lack of support, inconsistency, recommandatory, lack of control, etc.	Lack of detailed planning	Inertia and tradition is difficult to overcome. Lean is hard.	Most failures occurr because of people.	
	Discovery	Drive	Tools	Implement	Training	Culture	Barriers	Future

Appendix D

Informed Consent Letter

Informed Consent Letter

Title of Study: Successful paths to becoming a lean organization in the construction industry

Principal Investigator:

Rob Warcup
Assistant Professor of Construction Management
Utah Valley University
800 W. University Pkwy, GT 613, MS 118
801 863-8167
Robert.warcup@uvu.edu

Background:
You are being invited to take part in a research study on lean construction. Before you decide to participate, it is important that you understand why the research is being done and what it will involve. Please take the time to read the following information carefully. Please ask the researcher if there is anything that is not clear or if you need more information.

The purpose of this study is to understand the path that the three most lean construction firms took to achieve their current lean status. Your company has been selected because of its high level of lean innovation and culture.

Study Procedure:

Your expected time commitment for this study is approximately 1 hour. Participants will be interviewed regarding their experiences during the implementation period of their company's lean journey. At no point will the interviewer ask you to reveal any financial information, nor will he request any trade secrets. Each interview may cover the following topics: your company's initial adoption of lean philosophy, roles of key players, the role of the executives, training programs, successes, failures, barriers, and so forth. The questions will solicit your opinions and your personal experiences as well as major company milestones. The only questions regarding financial issues will inquire whether funding was allocated for lean company initiatives. Each interview will be voice recorded. At a future date you will receive an opportunity to review a summary of the conversation at which time you will be able to clarify any misunderstandings that may have occurred and correct any grammar if necessary. Direct quotes may be used in the final report, however, all personal names will be withheld.

Risks:

The risks of this study are minimal. These risks are similar to those you experience when disclosing work-related information to others. You may decline to answer any or all

questions and you may terminate your involvement at any time if you choose.

Benefits:

There will be no direct benefit to you for your participation in this study. However, we hope that the information obtained from this study may increase your awareness and that of others regarding successful lean construction implementation programs. We also hope that it will spark an interest in others to learn more about lean construction principles and philosophies.

Confidentiality:

All responses and interviews will be kept confidential. Each conversation will be voice recorded, however, the researcher will keep all interview data secured in his office. It should be noted that the low number of interviews required by this study (less than ten) increases the chance that anonymity could be lost. The researcher will follow all reasonable steps to keep each participant unidentifiable; however, he cannot guarantee the complete anonymity of the participants after the findings are published.

Person to Contact:

Should you have any questions about the research or any related matters, please contact the researcher at Robert.warcup@uvu.edu.

Institutional Review Board:

If you have questions regarding your rights as a research subject, or if problems arise which you do not feel you can discuss with the Investigator, please contact the Institutional Review Board Office at (801) 863-8156.

Voluntary Participation:

Your participation in this study is voluntary. It is up to you to decide whether or not to take part in this study. If you do decide to take part in this study, you will be asked to sign this consent form. If you decide to take part in this study, you are still free to withdraw at any time and without giving a reason. You are free to not answer any question or questions if you choose. This will not affect the relationship you have with the researcher.

Unforeseeable Risks:

There may be risks that are not anticipated. However, every effort will be made to minimize any risks.

Costs to Subject:

There are no costs to you for your participation in this study

Compensation:

There will be a small token of appreciation gifted to those who complete the interview. You will be asked to sign a document acknowledging receipt of the gift for researcher's accounting purposes.

Consent:

By signing this consent form, I confirm that I have read and understood the information and have had the opportunity to ask questions. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving a reason and without cost. I understand that I will be given a copy of this consent form. I voluntarily agree to take part in this study.

Signature _____ Date _____

CURRICULUM VITAE

ROBERT D. WARCUP

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Construction Technologies
(801) 863-8167
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Education

PhD, Utah State University, 2015
Major: Technology and Engineering Education
Dissertation Title: Successful Paths to Becoming a Lean Organization in the
    Construction Industry

MBA, University of Nevada Reno, 2004.

BS, Brigham Young University, 2000.
Major: Construction Management
Minor: Business Management
Minor: Spanish

Licensures and Certifications

Utah General Contractor's License Exam, Utah Division of Occupational
    Licensing. (March 4, 2010).

Arizona General Contractor's License, Arizona Registrar of Contractors.
    (November 19, 2008).

Professional Memberships

Lean Construction Institute. (February 2012 - Present).

Committee Member, American Society of Professional Estimators: Chapter 51 -
    Great Salt Lake. (March 2011 - Present).

Associate General Contractors of America UVU Student Association. (April 2009
    - Present).

National Association of Home Builders Student Association. (March 2009 - Present).

Utah Valley Home Builders Association. (March 2009 - Present).

Development Activities Attended

Webinar, "vPlanner, the Visual Planning Solution for Lean Project Delivery," Ghafari Associates. (February 12, 2015).

Webinar, "Reliable Delivery of Capital Projects with Lean Integrated Project Delivery," LCI. (January 28, 2015).

Faculty Internship, "Faculty in Business Externship," Zwick Construction, Salt Lake City, UT. (April 20, 2014 - July 29, 2014).

Webinar, "A Lean Coach's Analysis of Last Planner Successes and Failures," LCI. (June 10, 2014).

Continuing Education Program, "OSHA 502: Update for Construction Industry Outreach Trainers," Mountain West OSHA Training Center, Salt Lake City, UT. (March 19, 2014 - March 21, 2014).

Self-Study Program, "AGC Lean Construction Education Program," AGC of America. (February 28, 2014).

Webinar, "Lean Construction 101," AGC of America. (December 3, 2013).

Conference Attendance, "15th Annual LCI Congress: Look How Far We've Come," LCI, Dallas, TX. (October 22, 2013 - October 25, 2013).

Conference Attendance, "AGC Building Contractor's Conference," AGC of America, Colorado Springs, CO. (October 16, 2013 - October 19, 2013).

Self-Study Program, "Blue Beam Training," Orange Blade Consultants, Surprise, AZ. (August 23, 2013).

Webinar, "Management by Values: Developing a Lean Culture," AGC of America. (August 22, 2013).

Webinar, "Seeing Value: Applying Lean Thinking to Construction Operations," AGC of America. (July 19, 2013).

Conference Attendance, "The Role of Design in Lean," LCI, P2SL, AIA, Colorado Springs, CO. (June 13, 2013 - June 14, 2013).

Conference Attendance, "Production Systems to Collective Enterprises: Turning your excuses into advantages," CURT, LCI, AIA, AGC, Colorado Springs, CO. (June 12, 2013).

Faculty Internship, "Faculty in Business Externship," DPR Construction, Salt Lake City, UT. (April 29, 2013 - May 10, 2013).

Self-Study Program, "Lean Construction," LCI Colorado Community of Practice, Denver, CO. (March 2013).

Self-Study Program, "The Integrated Project Delivery Method," Construction Specifications Institute, Salt Lake City, UT. (February 20, 2013).

Self-Study Program, "Practical Process Improvement," ThermoFisher, Logan, UT. (September 12, 2012 - December 5, 2012).

Conference Attendance, "14th Annual LCI Congress: Improving the Way We Work," LCI, Arlington, VA. (October 9, 2012 - October 12, 2012).

Conference Attendance, "Becoming the Messenger," National Science Foundation, Salt Lake City, UT. (August 22, 2012).

Conference Attendance, "20th Annual International Group for Lean Construction," IGLC, San Diego, CA. (July 16, 2012 - July 20, 2012).

Conference Attendance, "2013 Summer Lean Summit," CURT, Colorado Springs, CO. (June 12, 2012).

Conference Attendance, "Lean Construction Academic Forum," LCI, Boulder, CO. (May 14, 2012 - May 16, 2012).

Faculty Internship, "Faculty in Business Externship," Sunroc Building Products, Lindon, UT. (April 24, 2012 - May 11, 2012).

Faculty Internship, "Faculty in Business Externship," Zwick Construction, Salt Lake City, UT. (April 28, 2011 - May 13, 2011).

Self-Study Program, "Green Building for Building Professionals," National Association of Home Builders, Salt Lake City, UT. (April 28, 2011 - April 29, 2011).

Faculty Internship, "Faculty in Business Externship," WW Clyde, Springville, UT. (April 4, 2010 - May 29, 2010).

Self-Study Program, "The Dumbest Generation," UVU Center for the Study of Ethics, Orem, UT. (May 3, 2010 - May 7, 2010).

Self-Study Program, "Learning Circle: Developing Learner-Centered Teaching," UVU Faculty Center for Teaching Excellence, Orem, UT. (January 2010 - April 2010).

Continuing Education Program, "OSHA 500: Trainer Course in OSHA Standards for Construction," Mountain West OSHA Training Center, Salt Lake City, UT. (March 23, 2010 - March 26, 2010).

Self-Study Program, "OSHA 510: Occupational Safety and Health Standards for the Construction Industry," Mountain West OSHA Training Center, Salt Lake City, UT. (February 26, 2010 - March 2, 2010).

Self-Study Program, "Learning Circle: Learner-Centered Teaching," UVU Faculty Center for Teaching Excellence, Orem, UT. (September 2009 - December 2009).

Continuing Education Program, "Heavy Bid 101 Training," HCSS, Las Vegas, NV. (November 19, 2009 - November 20, 2009).

Conference Attendance, "Intermountain Great Teacher's Summit," UVU, Heber, UT. (October 22, 2009 - October 24, 2009).

Continuing Education Program, "Building Science Infrared Thermography," Infrared Training Center (ITC) & Building Science Institute, Orem, UT. (July 2009).

TEACHING

Teaching Experience

Utah Valley University
BCCM 1260, Computer Estimating, 3 courses.
CMGT 1150, Construction Safety, 6 courses.
CMGT 2010, Construction Materials and Methods II, 6 courses.
CMGT 2040, Safety and Job Site Management, 1 course.
CMGT 281R, Internship, 1 course.
CMGT 3030, Construction Estimating, 12 courses.

CMGT 3040, Construction Job Site Management, 7 courses.
CMGT 4500, Senior Capstone, 3 courses.
CMGT 459R, Current Topics in Construction, 2 courses.
CMGT 481R, Internship, 1 course.
CMGT 489R, Construction Undergraduate Research, 2 courses.

CURRICULUM DEVELOPMENT

Courses Restructured

Utah Valley University
CMGT 459R, Current Topics in Construction
CMGT 4500, Capstone

Courses Developed

Utah Valley University
CMGT 1150, Construction Safety (2011)
CMGT 1030, Foundations of Architecture and Construction (2013)
CMGT 2010, Construction Materials and Methods II (2009)
CMGT 2040, Safety and Job Site Management (2010)
CMGT 3030, Construction Estimating (2009)
CMGT 3040, Construction Job Site Management (2011)
CMGT 489R, Construction Undergraduate Research (2012)

RESEARCH

Published Intellectual Contributions

Refereed Journal Articles

Warcup, R. D., Reeve, E. (2014). Teaching the Last Planner System with the
Villego Simulation. *To appear in Lean Construction Journal*.
leanconstructionjournal.org

Presentations Given

Warcup, R. D. (Leader), AGC Lunch and Learn, "Lean Construction: Utilizing
the Weekly Work Plan and PPC to improve Production," AGC of Utah, Salt
Lake City, UT. (February 12, 2015).

Warcup, R. D. (Leader), CSI Lunch and Learn, "Intro to Lean Construction," CSI Utah Chapter, Sandy, UT. (January 21, 2015).

Warcup, R. D. (Leader), AGC Lunch and Learn, "Intro to Lean Construction," AGC of Utah, Salt Lake City, UT. (October 14, 2014).

Warcup, R. D. (Presenter & Author), UVU Engagement Week, "Lean Construction and Undergraduate Research," Office of Engaged Learning, UVU. (March 26, 2014).

Warcup, R. D. (Presenter & Author), ASC Faculty Presentations, "Lean Construction and Undergraduate Research," Associated Schools of Construction, Sparks, NV. (February 6, 2014).

Hallsted, B. K. (Presenter & Author), Arendt, A. (Presenter & Author), Warcup, R. D. (Presenter & Author), Writing for Social Change, "Advances in Battery Technology," Utah Valley University, UVU. (November 15, 2013).

Warcup, R. D. (Presenter & Author), UVHBA Contractor Training, "Lean Residential Construction," Utah Valley Home Builders Association, Orem, UT. (September 15, 2013).

Warcup, R. D. (Presenter & Author), Lean Construction Academic Forum, "Lean Home Building," LCI, Boulder, CO. (May 16, 2012).

Contracts, Grants and Sponsored Research

Grants

Warcup, R. D. (Principal), Numerous Perkins Grant Awards, Sponsored by Career and Technical Education, Federal, $30,000.00 (approx.). (March 2009 - Present).

Warcup, R. D., "Lean Construction and Undergraduate Research," Sponsored by GEL Grant, Utah Valley University, $3,742.00. (July 2014).

Warcup, R. D., "Tools and Methods of instruction for the Last Planner System," Sponsored by College of T&C Summer Research Grant, Utah Valley University, $6,350.00. (June 2013 - August 2013).

Warcup, R. D. (Co-Principal), "Helping Haiti Initiative," Sponsored by GEL Grant, Utah Valley University, $2,500.00. (March 2013).

Warcup, R. D. (Principal), "Lean Heavy Civil Construction," Sponsored by College of T&C Summer Research Grant, Utah Valley University, $6,350.00. (June 2012 - August 2012).

SERVICE

Department Service

Program Coordinator, Construction Management Program. (March 2012 - Present).

Committee Member, Concurrent Enrollment. (August 2010 - Present).

Training Organizer, Department Safety, CMGT Lab Forklift Training. (October 7, 2013).

College Service

Committee Member, College of Technology and Computing Grants Committee. (March 2014 - Present).

Faculty Advisor, Associated Schools of Construction (ASC). (February 5, 2014 - February 8, 2014).

Faculty Advisor, Associated Schools of Construction (ASC). (February 6, 2013 - February 9, 2013).

Guest Case Study, Digital Media Course - Trudy Christensen. (September 2012 - December 14, 2012).

Faculty Advisor, Associated Schools of Construction (ASC). (February 8, 2011 - February 11, 2011).

Judge, BYU CM Challenge. (November 12, 2010).

Faculty Advisor, Associated Schools of Construction (ASC). (February 2, 2010 - February 5, 2010).

Faculty Mentor, National Association of Home Builders Student Competitions. (January 19, 2010 - January 22, 2010).

University Service

Committee Member, Career and Technical Education (CTE). (September 2009 - Present).

Committee Member, Hiring Committee for the Dean of the College of Technology and Computing. (November 2012 - March 2013).

Thermal Image Investigator, UVU ROTC Sustainability Analysis. (September 17, 2009).

Public Service

Discussant, Empowering Your Tomorrow, Orem, UT. (September 24, 2011).

Consulting

For Profit Organization, Zwick Construction, Salt Lake City, UT. (February 15, 2013 - Present).

For Profit Organization, Hensel Phelps Construction, Nogales, AZ. (May 19, 2014).

For Profit Organization, Geneva Rock Products, Orem, UT. (December 13, 2013).